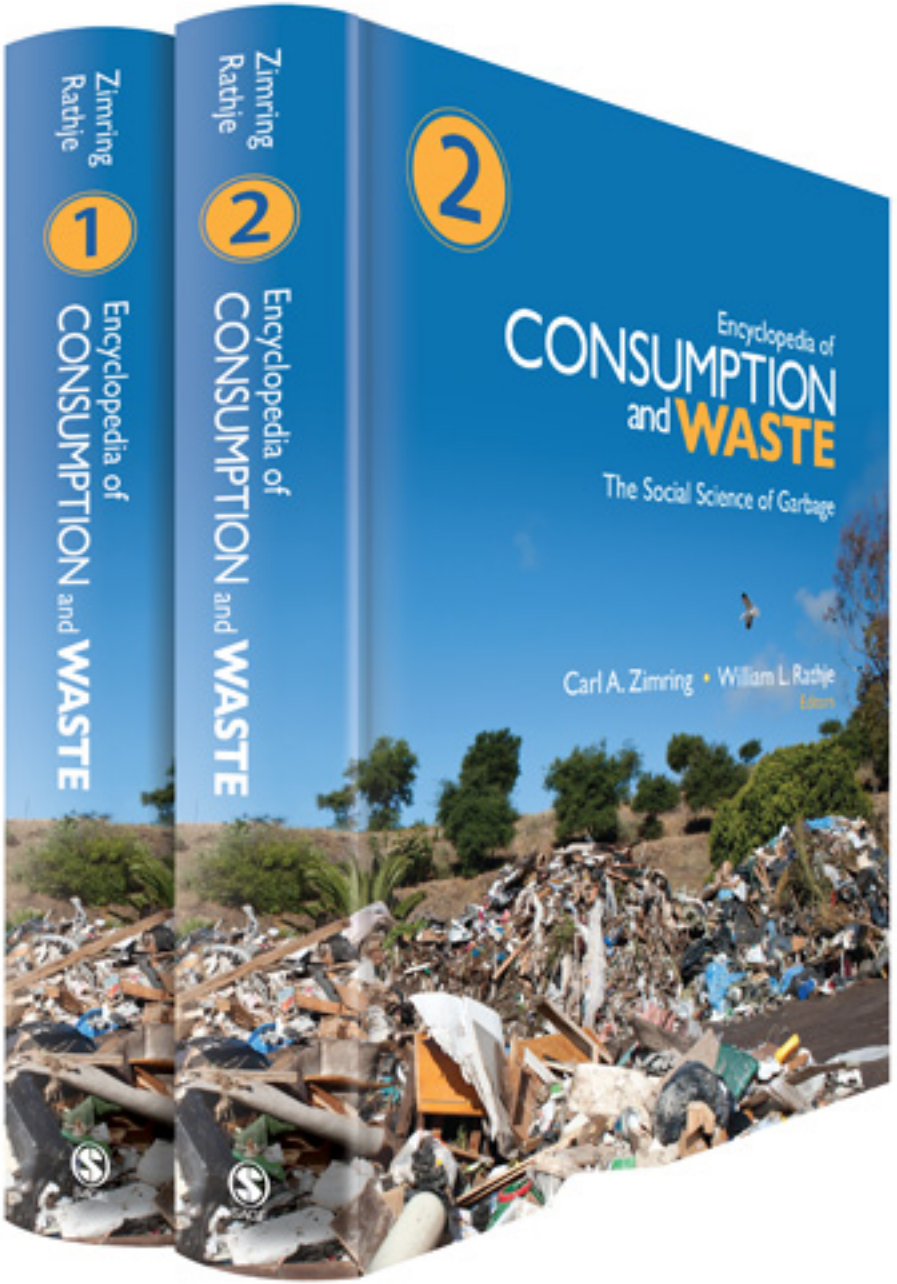
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and WASTE
The Social Science of Garbage
Carl A. Zimring • William L. Rathje
Editors

Encyclopedia of CONSUMPTION and WASTE

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Encyclopedia of CONSUMPTION and WASTE

The Social Science of Garbage

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Weather and Waste

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Consulting Editor William L. Rathje is the founder and director of the Garbage Project, which conducts archaeological studies of modern refuse. Rathje received his B.A. from the University of Arizona in 1967 and his Ph.D., which focused on the archaeology of the ancient Maya, from Harvard University in 1971; he is currently professor emeritus at the University of Arizona and a consulting professor at Stanford University.

Since 1973, the Garbage Project has studied fresh refuse to document household-level food waste, diet and nutrition, recycling, and discard of hazardous wastes; in addition, since 1987, the project has excavated 21 landfills across North America to record the quantities of various types of buried refuse and what happens to these materials over time. *Garbology*, the term coined to describe Rathje's research, is now in the *Oxford English Dictionary.* In 1991, Rathje won the prestigious AAAS/Westinghouse Award for Public Understanding of Science and Technology, and in 1992 he received the AAA Solon T. Kimball Award for Public and Applied Anthropology.

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Introduction

So much of our stuff lacks worth or merit. That, at least, is what we assume and establish with our routines. Every day, we put unwanted material in toilets and garbage bins, regularly flushing it away or taking it out in bags to be transported far away from our homes by others. The names we give this material—*waste*, *garbage*, *refuse*, *trash*, *rubbish*—have pejorative definitions. Worthless. Rejected and useless matter of any kind. Unimportant.

This material is certainly rejected by someone, but it is far from unimportant. What we classify and dispose of as wastes provides rich insight into our behavior, social structures, and treatment of our environment. In the 1966 book *Purity and Danger*, anthropologist Mary Douglas stated that dirt is matter that is out of place and that a common thread in all human societies is the development of taboos to regulate waste and establish order from chaos. Over the half-century since that book was published, social scientists have challenged and advanced theories of waste and value, using observed behavior and the materials humans leave behind as evidence. Archaeologists have long studied artifacts of refuse from the distant past as a portal into ancient civilizations lacking written testaments, but examining what we throw away today tells a story in real time and becomes an important and useful tool for academic study. Our trash is a testament; what we throw away says much about our values, our habits, and our lives.

Sometimes what we throw away is uncomfortably revealing, as Bob Dylan found out in 1971. The singer had moved to New York's Greenwich Village when he found fanatic A. J. Weberman rifling through his garbage can in search of clues about Dylan's life. (What Weberman found were bills, receipts, correspondence, coffee grounds and diapers—evidence of a young family and a mind in need of stimulation.) Weberman called his investigations into Dylan's discards "garbagology," claiming his research would provide insight into the songwriter's art.

Weberman's research method and findings may have strained credulity, but his attention to the value of garbage did not. In the early 1970s, substantial developments in the social sciences advanced our

understandings of waste in the modern world. Historians deepened their investigations of public health and pollution; in particular, Joel Tarr analyzed the political and technological systems that societies developed to find appropriate sinks for sewage, garbage, and industrial wastes. Young archaeologist William Rathje began an excavation of a landfill in Tuscon, Arizona, in 1973 in order to analyze the waste stream of that community. His research became known as the Garbage Project and spawned concerted examination of the record modern societies leave in the trash.

Close examination of waste practices reveals rich complexities. While dictionary definitions of garbage describe it as "filth" and "worthless," scholars are careful to note that perceptions of waste and the value of material are neither static nor universally shared. Discarded objects may become antiques, embarking on a journey from valued new object to disvalued old object to newly valued vintage object. Beverage companies take old cans and bottles removed from households to make new cans and bottles. Material from demolished buildings is used to construct new ones. Even human excrement, widely feared and flushed away to prevent disease, is collected to fertilize fields. (If filth is one definition of waste, another definition is "the inefficient squandering of resources.") One man's trash may be another man's treasure; how and why both parties classify the material is a subject of ample study.

We do not know what Bob Dylan thinks of this research field, but he certainly protested Weberman snooping through what the singer felt was his private property. Whatever questions Weberman's research method and findings raised, they did not, at least in a legal sense, invade Dylan's privacy. Waste as property was the subject of the 1988 legal decision *California v. Greenwood*, in which the U.S. Supreme Court ruled that a person should have no reasonable expectation of privacy concerning any material that person knowingly threw away. Given the billions of dollars spent by municipalities each year to landfill, incinerate, recycle, or otherwise handle waste, the question of who owns these discards is not trivial. The industries and public programs devoted to waste around the world range from sophisticated technology capturing methane from landfills to open pits where workers risk their health harvesting precious metals by burning old computers shipped from thousands of miles away.

In a globalized economy, waste is a truly global commodity—and a global burden. At the same time, the burdens of waste management often are local, with municipal governments responsible for making sure the streets are free of waste. When they fail to perform this task, as the Italian city of Naples infamously did in 2008, the results include physical dangers to the community and widespread ridicule of local political leaders. Effective waste management is an expectation of modern society.

Today, academic investigations into garbage range widely in method, geographic scope, and chronology. Excavations at landfills join close examination of municipal waste management systems, policy history, industrial research, marketing, design, and psychology. All of these approaches allow us to better understand the complexities of our consumption and waste, complexities regularly on display in our minds, our homes, and our communities.

Mine is no exception. I live in a village located just west of Chicago that prides itself on its progressive values. The residents enjoy curbside recycling services, tree-lined streets, and several parks. Seasonal farmers' markets allow residents to purchase locally grown organic produce. While many suburbanites have to drive to work in the city, we can commute via two Chicago Transit Authority train lines that run through the village, reducing carbon emissions we might otherwise produce with automobiles.

In 2010, the elevated line nearest where I live painted several panels on its viaducts with images promoting the international "350.org" campaign. Established by environmental scholar Bill McKibben in 2007, the campaign attempts to get carbon consumption under 350 parts per million carbon dioxide in order to combat global climate change before it produces devastating effects on the atmosphere, oceans, disease vectors, food sources, coastlines and myriad other entities vital to life on Earth. A successful campaign requires substantial reforms to the consumption of energy, packaging, food, and materials in the industrialized world, and the village's embrace of the 350 campaign demonstrates a hopeful awareness of the challenges ahead.

One walks less than a block from the westernmost train station with a 350.org panel before

encountering an upscale boutique with a sign in its window promising "inner peace through impulse purchasing." A joke, to be sure, but one that resonates as an uncomfortable truth. We seek fulfillment through the goods and services we acquire, consume, and dispose of, often blurring the line between needs and wants. Throughout the village, plastic bags carrying goods manufactured all over the world are regularly bought and sold. (But not, ultimately, disposed of locally. Garbage and recyclables leave the village on trucks hauling them to waste management facilities in poorer communities many miles away.) The proximity of the impulse-purchasing sign to images promoting the 350 campaign indicates the complexity of our challenges in the early 21st century: We consume to fulfill our needs and wants, yet our consumption has effects that may be terribly consequential to the land, air, water, other species, other people, and ourselves.

The tensions in my village are ones found across the planet. Consumption and its concomitant waste are defining aspects of our societies. What we consume, why we consume it, and what we do with the remnants of that consumption reveal how we organize our landscapes, our economies, our social structures, and our values. The wastes we leave behind, in the form of landfills, atmospheric pollution, estate inventories, and the ruins of civilization, are sources for social scientists to interpret.

Even attempts to erase our wastes are revealing. After the terrorist Osama bin Laden was found and killed in a residential neighborhood in Abbottabad, Pakistan, after years in hiding, neighbors remarked that the most unusual aspect of his compound was that its residents never put trash out for collection. Instead, bin Laden had all waste incinerated on site so as not to leave clues to his whereabouts. The absence of a waste stream aroused suspicion, just as the presence of particular items tell us about the habits of the consumers who generate a waste stream. Our trash is part of us, whether or not we choose to acknowledge it.

In the *Encyclopedia of Consumption and Waste*, you will read the perspectives of anthropologists, archaeologists, historians, philosophers, policy analysts, and sociologists, just to name a few. The interdisciplinary lens of the volume reveals the complexity of our relationship to the world of goods, services, and wastes. This is evident whether you read every entry alphabetically, or follow the listings of related entries from one to another. Contributing editor William Rathje initially planned the encyclopedia, apparent in the array of entries on garbage archaeology and his appendix "Garbology 101." I then became general editor, and readers may find evidence of my background as an environmental historian present in the organization of individual entries and the encyclopedia as a whole. Our goal was to bring together scholars working on waste from many perspectives, so that we all may better understand the dynamics of consumption and waste that affect our households, cities such as Shanghai, nations such as Brazil, the garbage patch growing in the Pacific, and the ecosystems around the world that we pollute every day. Entries on each of these topics await you. Whether you find this encyclopedia in a library or satiated an impulse to purchase it, we hope it encourages conversation about the patterns and consequences of our consumption.

Carl A. Zimring
General Editor

Chronology

600 B.C.E.: Construction is completed on the Cloaca Maxima sewage collection system in Rome.

1346 C.E.: The second pandemic of the bubonic plague begins. It is later concluded by scientists that the plague was caused by infected rats accidentally carried onboard ships traveling throughout Europe and the Middle East.

1349: King Edward III of England complains to the mayor of London in a letter, saying, "The streets and lanes through which people had to pass were foul with human faeces and the air of the city poisoned to the great danger of men passing, especially in this time of infectious disease."

1374: The first above-ground sewer in the city of Paris is constructed.

1555: In his book *De Re Metallica*, German doctor Georgius Agricola states that the environmental degradation brought on by mining excavation is only a temporary phenomenon.

1649: In an effort to protect navigating boats, the Japanese government enacts laws designed to prevent the dumping of trash into rivers and canals.

1657: Residents of the New York City borough of Manhattan are prohibited from throwing "any rubbish, filth, oyster shells, dead animals or anything like it" into the streets.

1690: The Rittenhouse Mill, the first paper mill established in the United States, begins operations near the city of Philadelphia.

1702: An outbreak of yellow fever in New York City results in the deaths of one-tenth of the city's population.

1750–73: The availability of imported goods into the U.S. market for personal consumption increases by 120 percent.

1790–1840: The percentage of Americans living in urban areas increases from 5.1 to 10.8 percent.

1800–50: The population of London nearly triples, leading to increased concerns over the city's sanitation system.

1827: Using electrolysis, chemists Hans Orsted and Frederich Wohler become the first people to isolate pure aluminum.

1834: In the West Virginia city of Charleston, local officials pass a law that sets penalties for the shooting of vultures; the law is passed due to the vultures' tendency to eat the city's garbage.

1848: The city of London establishes a centralized governing body called the Metropolitan Commission of Sewers, with reformer Edwin Chadwick selected to head the new organization.

1849: Walter Hunt invents the safety pin, significantly increasing the ease of the diaper-changing process.

1853: Condensed milk, an infant feeding alternative for mothers who either cannot afford a wet nurse or cannot nurse themselves, becomes available to U.S. consumers.

1860: The Argentine city of Buenos Aires establishes its first *quema* (burn) waste incineration system.

1866: Health conditions in New York City worsen to the point where officials compare to medieval London.

1872: The U.S. Congress passes the Mining Law, placing governance over 270 million acres of public domain lands that are potentially suitable for mining.

1874: The first waste incineration system is constructed in England.

1874: The world's first curbside recycling program is introduced in the city of Baltimore.

1895: City waste and human disease expert George Waring is appointed as New York City's street cleaning commissioner.

1900: The Japanese government passes the Waste Cleaning Act.

1900: The Japanese government passes the National Waste Disposal Law, requiring local municipalities to manage their own waste.

1904: In the metalworks area of the city of Chicago, Illinois, the first large-scale aluminum recycling program begins operation.

1904: King C. Gillette patents his safety razor kit.

1905: *Waste Trade Journal* publishes its first issue.

1913: The National Association of Waste Material Dealers is founded.

1916: The first Japanese draft furnace incinerator is constructed.

1918: The U.S. War Food Administration reports that, during World War I, American households threw away nearly 30 percent of food that was purchased for consumption.

1919: The U.S. Bureau of Mines is established as an agency under the U.S. Department of the Interior.

1921: The world's first textbook dealing with urban waste management, *Collection and Disposal of Municipal Refuse*, is published by civil engineers Rudolph Hering and Samuel Greeley.

1939: The chemical compound DDT is discovered and its use as an insecticide begins.

1941: Researchers release reports showing that over 20 percent of food served in mess halls to American soldiers is discarded.

1946–84: Dumped refrigerators with poorly made mechanical latches lead to the deaths of over 400 young children.

1947: Construction of the Fresh Kills Landfill, which would become the largest municipal waste dump in the world, is completed.

1948: The U.S. Congress passes the Federal Water Pollution Control Act, establishing the authority for the federal government to regulate water quality.

1950–70: The U.S. population rises by 30 percent, but total waste output for the country increases by 60 percent.

1950–2000: The percentage of people in sub-Saharan Africa living in urban areas increases from 15 to 42 percent.

1951: The number of "automobile graveyards" in the United States rises to 25,000.

1955: President Dwight Eisenhower signs the Air Pollution Control Act into law, providing federal funding for research into air pollution.

1958–72: The amount of beef the average American consumes increases from 80.5 to 115.9 pounds annually.

1958–98: The amount of concentration of carbon dioxide in the Earth's atmosphere increases from 316 to 369 ppmv.

1959: Procter & Gamble introduces the world's first disposable diaper.

1959: The first fully automated Japanese waste incineration machine is installed in the Sumiyoshi plant in the city of Osaka.

1962: American biologist Rachel Carson publishes *Silent Spring*, a heavily researched book on how the pesticide DDT is causing widespread environmental degradation.

1963: The U.S. Congress passes the Clean Air Act, the first piece of U.S. legislation to federally require the control of air pollution.

1964: U.S. President Lyndon B. Johnson signs the Highway Beautification Act into law.

1965: The Solid Waste Disposal Act is passed by the U.S. Congress.

1970: The United States' first Earth Day is celebrated nationwide.

1970: The U.S. Congress passes the Resource Recovery Act.

1971: The famous "Crying Indian" public service announcement begins to air on U.S. television stations as part of an effort to reduce pollution.

1972: The U.S. Congress passes the Clean Water Act, not only requiring the end of dangerous pollution practices, but also aiming to restore America's water quality to passable levels.

1972: The U.S. Congress passes the Marine Protection, Research, and Sanctuaries Act.

1972: The London Convention, an international environmental meeting with delegates from dozens of countries, is held.

1972: A team of researchers led by Mathis Wackernagel concludes that the Earth's ecosystems are at 85 percent of total sustainability, meaning that humans have consumed resources to the point where only 15 percent of sustainability remains. In 2008, that percentage would increase to 125 percent, meaning that humans have consumed resources beyond the Earth's total capacity.

1973: The Garbage Project, an in-depth analysis of consumers' garbage in the Arizona area, is launched at the University of Arizona by professor William Rathje.

1973: In an effort to curb the rising cost of beef, U.S. President Richard Nixon announces that a price ceiling will be placed on all beef products.

1973: The International Convention for the Prevention of Pollution From Ships is held.

1974: U.S. President Gerald Ford signs the Safe Drinking Water Act into law.

1976: U.S. President Gerald Ford signs the Toxic Substances Control Act into law.

1976: The Resource Conservation and Recovery Act is passed by the U.S. Congress.

1978: Residents of the New York neighborhood of Love Canal experience toxic waste seeping into their houses' basements, leading to the discovery of what some have called the worst toxic waste disaster in U.S. history.

1978: An explosion occurs at the Consol #9 coal mine in West Virginia, resulting in the deaths of more than 78 people.

1978: Deng Xiaoping rises to the top of leadership in the government of China. Xiaoping's reforms would significantly alter China's position toward economic modernization, forever changing the country's consumer culture.

1979: British social scientist Michael Thompson introduces rubbish theory, a philosophy that attempts to address how value is placed on material objects.

1980: The U.S. Congress passes the Infant Formula Act, forcing manufacturers of baby formula to meet certain nutritional requirements in their products.

1980: The Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund, is passed by Congress.

1980: As large, imposing landfills threaten to overrun the available living space of the small island nation of Japan, its government begins a shift toward incineration of garbage, investing funds into research. Over time, 99.9 percent of combustible waste produced in of Osaka will be destroyed using incineration methods.

1981: As pollution concerns stemming from industrial expansion continue to mount in Japan, representatives of one of the country's most prosperous industrial centers, Osaka, begin the Osaka Phoenix Project.

1984: Cairo, Egypt, founds the Cairo Cleansing and Beautification Authorities organization.

1984: An insecticide manufacturing plant in Bhopal, India, accidentally releases tons of toxic gas, resulting in the deaths of 15,000 to 20,000 residents who live in the neighborhoods surrounding the plant.

1987: The Garbage Project begins its excavation of landfills for the purpose of studying garbage. Over time, nearly 30,000 pounds of garbage are stored and analyzed.

1987: Japan's first waste incinerator is constructed in the port city of Tsuruga. Over time, the number of incinerators in the island nation will increase to over 1,500.

1987: The *Mobro 4000* barge makes several unsuccessful attempts to unload 3,168 tons of New York trash along Atlantic coast communities in the United States, Mexico, and Belize, before returning to Islip, NewYork.

1988: The Supreme Court rules in the case of *California v. Greenwood* that "the Fourth Amendment's protection against unwarranted search and seizure does not extend to one's trash."

1988–98: The number of municipal composting programs in the United States increases from 700 to 3,800.

1989: Curbside recycling is mandated in New York City.

1991: Turkey establishes a Ministry of Environment.

1991–2001: In a 10-year period, the production of waste in the densely populated Indian city of Mumbai increases by 50 percent.

1999: A gasoline pipeline in the state of Washington ruptures and breaks, spilling 236,000 gallons of gasoline into Hanna Creek and resulting in the deaths of three people.

1999: The European Union establishes the Landfill Directive with the purpose of reducing "negative effects on the environment, in particular the pollution of surface water, groundwater, soil and

air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from the landfilling of waste, during the whole life-cycle of the landfill."

1999–2008: The percentage of Chileans covered by Chile's sewage treatment system rises from 20 percent to 84 percent.

2000: An open dump landslide in the Philippines results in the deaths of nearly 200 people.

2001: Reports show that Nigeria consumes nearly one-third of all energy used by all sub-Saharan African nations.

2005: A survey released by a CBS Poll shows that 23 percent of Americans consume fast food every day.

2005: A study released by Global Issues shows that the wealthiest 20 percent of the world accounted for 76.6 percent of total private consumption, while the world's middle 60 percent consumed 21.9 percent, and the poorest 20 percent consumed only 1.5 percent. Furthermore, the study adds, the richest 20 percent consume 45 percent of all meat and fish, 58 percent of total energy, 84 percent of all paper, and own 87 percent of the world's vehicle fleet.

2005–06: During a two-year period, over 2.5 million cases of illegal dumping of garbage are reported in the United Kingdom.

2006: Researchers report that American consumers annually purchase a total of more than 57 billion liters of carbonated soft drinks, 31 billion liters of bottled water, 24 billion liters of beer, and 21 billion liters of milk.

2006: The 16th Nationwide Survey of Municipal Solid Waste Management in the United States is released, showing that Wyoming ranks 49th in terms of overall municipal solid waste production.

2007: San Francisco becomes the first city in the United States to place an outright ban on plastic grocery bags.

2007: The documentary film *Trashed* is released.

2008: A survey is released from the National Survey on Drug Use and Health (NSDUH) concluding that about 51 percent of Americans age 12 or older consume alcohol. Other data from the survey shows that 23 percent of people from the same group are binge drinkers, while 7 percent are heavy drinkers. Also, Asian Americans have the lowest alcohol consumption rate at 37 percent, and whites have the highest at 56 percent.

2008: The retailers Walmart, Target, and Toys "R" Us recall approximately 25 million toys that were made in China and found to contain dangerous levels of lead or other heavy metals.

2008: The Population Reference Bureau reports that "at least 50 percent" of the world's population resides in urban environments.

2008: The Environmental Protection Agency (EPA) reports that approximately 65 percent of U.S. trash comes from households. The report also states that an estimated 12.7 percent of all trash found in landfills is food scraps.

2009: The Chinese city of Beijing produces over 6.5 million tons of garbage per year.

2009: *No Impact Man*, a documentary featuring a New York City resident who experiments with dropping out of the mainstream consumer culture, is released.

2010: Researchers estimate that 95 percent of the food consumed by residents of Alaska comes from outside the state.

2010: Researchers report that the country of Uruguay leads the world in per capita beef consumption.

2010: The United Nations reports that approximately 1.8 million children worldwide die each year due to toxins found in drinking water.

2010: Reports are released showing that residents of the state of Connecticut produce, on average,

approximately five pounds of garbage per person per day.

2010: Researchers report that the Indian capital of Delhi produces approximately 7,000 tons of solid waste per day.

2010: The U.S. Environmental Protection Agency reports that Americans produce approximately 96 billion pounds of food waste annually, a result of discarding over 25 percent of prepared food.

2010: The World Health Organization reports that 1.6 million people die each year from waterborne diseases found in drinking water.

2010: Researchers estimate that the number of people worldwide who lack access to basic sanitation services is approximately 1 billion.

2010: American scientist Jared Diamond estimates that America's consumption of natural resources, combined with its output of wastes, is 32 times higher than in the developing world.

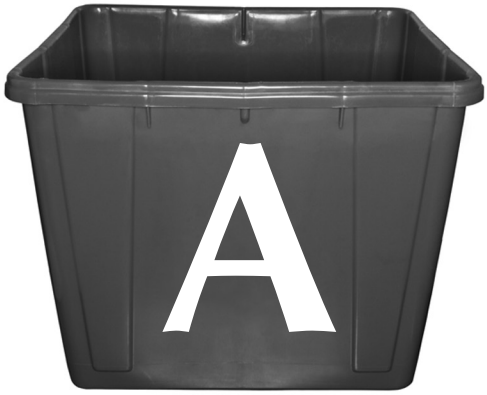
2011: Italy's Environmental Ministry enacts a ban on polythene shopping bags in an attempt to reduce plastic waste. The European Union's (EU) Commissioner for the Environment opens an online consultation to assess EU citizens' opinion of taxing or outright banning plastic shopping bags across the continent.

2011: The international terrorist Osama bin Laden is found and killed in a residential neighborhood in Abbottabad, Pakistan. Observers of his hiding place note the residents were unusual as they never put trash out for collection, opting instead to incinerate it within the walled compound.

2011: California announces more than 1 billion pounds of electronic waste collected have been recycled since the state enacted the United States' first e-waste law in 2005.

2011: India passes the E-Waste (Management and Handling) Rule, a law intended to make producers financially liable for the disposal management of e-wastes.

2012: The Netherlands' National Waste Management Plan (established in 2002) has a target goal of recovering 83 percent of the nation's waste this year.



Acid Rain

The term *acid rain* describes any from of precipitation containing high levels of sulfuric and nitric acids. All precipitation, including snow, fog, hail, and sleet, can be acidic. The terms *acid deposition* or *wet disposition* are frequently used as synonyms. This form of pollution has caused severe environmental problems in many parts of North America, Europe, and Asia. It affects mainly heavily industrialized regions and densely populated urban areas, but substantive amounts of gases causing acid precipitation can travel hundreds of miles before falling.

Causes and Formation

The formation of acid rain generally starts with the emission of sulfur dioxide and nitrogen oxide gases into the atmosphere. These substances react with the water molecules in clouds and become sulfuric and nitric acid. By the time they reach the ground again in the form of precipitation, they are highly acidic. The degree of acidity is measured on a pH scale, ranging from 0 to 14.

The number indicates the hydrogen ion concentration in kilograms per cubic meter, thus lower numbers represent greater acidity. In severe cases, the pH value of rain can be as low as 2 or 3. Some parts of western Europe and the eastern part of the United States suffer from this highly acidic rain. In certain areas, such as Los Angeles, California, or Whiteface Mountain, New York, acid fog causes much more damage, showing about 10 times higher degrees of acidity than rain.

Acid rain is mainly caused by human activities. The largest share of these pollutant gases come from the combustion of fossil fuels, such as oil and coal, used by electric power plants as well as by cars and other motor vehicles. Livestock production is another important factor. A much smaller amount comes from wildfires. Natural phenomena can also cause acid precipitations. Emissions from active volcanoes can lead to fog and rain with high degrees of acidity, making human settlement and vegetation impossible in surrounding areas. A small amount of those gases causing acid precipitation occurs naturally in wetlands and oceans.

Effects and Damage to Nature

Acid precipitation contaminates streams and lakes and damages fish and other aquatic life. It is especially harmful in areas where soil is thin or mainly composed of granite rock, since there are few natural filters to buffer the acidic components of

water. Acid precipitation further has the effect of dissolving aluminium from the soil, which aquatic organisms then absorb. Not all species can tolerate the same amount of acidity, and some are more vulnerable to increasing aluminium and lower pH values than others. Fish eggs are affected, as they will not hatch when the water is too polluted. Higher acidity can also kill adult aquatic organisms. As a result, there is reduced biodiversity in contaminated lakes and rivers, and some species have already been eliminated.

Acid precipitation causes great damage to many kinds of vegetation. It inhibits nitrogen fixation and leaches out nutrients from foliage. Trees can then become less tolerant to other outside influences, such as cold weather. High altitude forests are most affected, as they are more often immerged in contaminated clouds and fog, which are much more acidic than rain. Even though agricultural crops can be damaged, the harmful effects are counterbalanced by additional applications of lime and fertilizers that replace the nutrients. Some microorganisms are sensitive to changing degrees of acidity. Their enzymes are denatured, and they cannot survive. While toxic substances such as aluminium dissolve from the soil and enter the watershed (causing damage to marine life), useful and important nutrients, such as magnesium and calcium, are also leached away. This loss of nutrients especially affects sensitive plants. The addition of limestone helps stabilize the pH of soil—a method mainly used for agricultural soil.

Acid rain corrodes the surface of many buildings—mainly those made of limestone and marble. The acid rain reacts with calcium carbonate in the building materials and covers the surface with a white layer of gypsum. This light substance easily flakes off when it rains, uncovering the uneven and damaged surface below. It can affect either an entire structure or only small parts where the chemical reaction is more intense. The effect on sculptures can be very damaging, as the process mostly destroys the finely carved parts of the art piece. Acid precipitation erodes and damages many important historic buildings and cultural heritage sites. It can also increase the oxidation of certain materials, such as bronze and copper, which are often used for sculptures. Renovating damaged cultural heritage is very costly. The United Kingdom, for example, invested up to £10 million to repair the damage caused by acid rain to Westminster Abbey in London.

Solutions

There are two different approaches for dealing with the problem of acid rain. Some policy makers advocate the "cost-sharing" principle, meaning that all those countries affected by acid rain should contribute to the problem's solution collectively. Adherents of the "polluter pays" policy state that those who are responsible for pollution should pay for repairing the damage they caused.

Several new technical solutions such as flue gas desulfurization or the use of lime have been attempted in order to cut emissions. The car industry has also reacted by producing greater numbers of low-emission or high-fuel-efficiency vehicles in an attempt to emit less nitrogen oxide.

On the regulatory level, several national and international treaties and conventions attempt to regulate emissions and devise a system to handle the damage caused by toxic pollutants. Emissions trading is another possible solution that combines an institutional and a market-based approach, giving producers incentives to invest in new technologies to cut pollution. With the enactment of the 1990 Clean Air Act Amendment in the United States, the amount of pollution every producer is allowed to emit is regulated. A firm is given a certain number of emissions allowances. Those producers who decide to reduce pollution by installing environmentally friendly equipment can sell their extra units to other producers who are not able or not willing to cut emissions. This way, they recover the costs they previously invested in new environmentally friendly technologies.

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See Also: Clean Air Act; Emissions; Fuel; Gasoline; Pollution, Air.

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Adhesives

Adhesives are substances that can hold at least two materials together by surface attachment. They have been part of human history since 4000 B.C.E. Early adhesives were made from natural materials, such as tree sap, vegetables, tar, beeswax, or animal parts. Synthetic polymer adhesives began to be used around the 1900s. Glue is made from organic compounds, while adhesives are chemical-based. Glue is a by-product of the animal processing industry, such as milk and meat processing. While glue used to be made from old horses (leading to the expression "ready for the glue factory"), 21st-century glue is made from synthetic material or cow hoofs and bones. Adhesives are used in almost every facet of modern human life, including applications in envelopes, cardboard containers, carpeting, automotive trim, film, laminates, and composite materials. The adhesive polymer industry has become an essential part of consumer society.

The first adhesive patent was granted in Great Britain in the late 1700s for a fish-based glue. Synthetic glues were developed in the early 20th century, and technological advances continue into the 21st century. There are two types of adhesives: structural adhesives and nonstructural adhesives. Structural adhesives, such as those used on bridges, are expected to last the life of the product; while nonstructural adhesives, such as those used for pressure sensitive envelopes, are less permanent.

Disposal and Recycling Challenges

Adhesives have always been a challenge for the recycling industry. Successful recycling depends on the quantity and quality of material collected for processing and sent to end markets. In the past, commodity processing required municipal residents to soak labels off jars, remove plastic film windows from envelopes, and other preparatory steps in order to prevent contamination or adverse impacts on the operation of machinery. Manufacturers had to use highly toxic solvents to remove industrial adhesives, such as those used in electronic, automobile, and carpet components. These requirements caused many people to view recycling as inefficient, cumbersome, and time consuming. However, technological advances in commodity processing have improved so that only a few collected commodities cause problems.

The bane of municipal and industrial recycling processes continues to be pressure-sensitive or press-and-seal adhesives, which are increasingly used in products because of cost and convenience factors. The challenge being approached by mills is designing machinery to better handle adhesives, while manufacturers continue to work on environmentally and machine-friendly adhesive formulas or detachable adhesives. Until processing technology catches up with consumption of adhesive products, the best way to prevent damage to machinery and contamination is through education.

Recycling Process

Often, the public is not educated about the specifics of the recycling industry because it is believed that if it is not "easy," people will not recycle. This leads

Technological advances in adhesives removal have made paper recycling less cumbersome and toxic. However, pressure-sensitive adhesives, which are cheap and convenient, continue to cause millions of dollars in damage to pulping and sieving machinery.

the public to believe that recycling rules are arbitrary and that putting materials such as self-adhesive notes in with paper has an inconsequential impact, while continuing to soak labels off of products and remove staples, despite the fact that technology has been developed to address one problem but not the latter. However, when people understand how their actions impact the recycling process, they are more likely to keep contaminants out of the waste stream.

Adhesives cause problems when bales of sorted paper, including those containing adhesives, are fed into a processing machine that blends the paper with water and chemicals, creating a pulp. This pulp goes through several processing steps and is sieved through different sized metal grating. Anywhere along this process, paper containing adhesives can damage the machinery by clumping, quite literally gumming up the works. This damage costs several million dollars per year.

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See Also: Culture, Values, and Garbage; Post-Consumer Waste; Pre-Consumer Waste; Recyclable Products; Recycling Behaviors.

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Adorno, Theodor

The metaphors of garbage and waste exist throughout the postwar writings of German philosopher Theodor W. Adorno (1903–69), functioning in complex and often seemingly contradictory ways. A member of the Frankfurt school, Adorno's writings drew upon sociology, philosophy, and musicology and spanned the 20th century, including the modernism of the 1920s, the emergence of the cold war in the 1940s, and the student revolts of the 1960s. The majority of his work involved developing a critique of totality, the Enlightenment, capitalism, fascism, Stalinism, and the culture industry. For Adorno, the garbage of capitalist culture was pitched in opposition to the autonomous points of resistance he saw located in radical art, literature, and music.

Beliefs

The meanings Adorno allotted to both garbage and waste are neither straightforward nor interchangeable. Adorno argued that all culture after Auschwitz, including its critique, was garbage [*Müll*]. Or, in other words, that the sphere of "resurrected culture" (that which he saw as merely rehashing traditional values of truth, beauty, and goodness, as if the Holocaust had not happened) should be considered as mere refuse. At the same time, Adorno's critique of culture as garbage was also directly related to his condemnation of the trashy kitsch produced by capitalist culture.

Having fled Nazi Germany in 1938, Adorno lived in exile in the United States until 1953. The philosopher consequently experienced the janus-faced culture of the mid-20th century; the *Hochkultur* (high culture) of Germany versus the burgeoning U.S. culture industry and its soon-to-be all-consuming mass media. For him, the culture industry's production of lifestyle involved a problematic recycling of real culture, transforming aesthetics into commodities and muting any negative or critical potential the former might have had. According to Adorno, the culture industry dangerously sanctioned this demand for rubbish. He warned against capitalism's often ahistoric consciousness, which swept aside the past as garbage. He was critical of the logic of capitalist production, which he saw as relegating to the junk pile everything not in line with the most recent methods of industrial production. For Adorno, this also ultimately meant rubbishing what he thought of as life's valuable continuity. He argued that art had degenerated into culture by means of the entertainment industry, becoming confused with its own waste products as its aberrant influence grew. In correspondence with the German philosopher Walter

Benjamin, Adorno suggested that even rubbish could be subject to capitalist exchange value. At the same time, Adorno saw the communism of the Eastern Bloc as having transformed culture into rubbish as a means of control, and he accused Josef Stalin of throwing modernism's great heroes, such as Franz Kafka and Vincent Van Gogh, onto the rubbish heap.

On the other hand, and in keeping with this critique, Adorno suggested that people should address the "waste products" and "blind spots" of history so as to reclaim their radical potential. For him, the relationship between waste and memory was powerful. He believed that a history of waste and blindness was equivalent to a history of dissonant or negative elements. For Adorno, the modernist works of art that resisted being commodified and turned into capitalist garbage were those that managed to retain a negativity and autonomy. He suggested that it would be rewarding to investigate the piles of rubbish, detritus, and filth upon which the works of major artists appear to be erected and to which they still owed something of their character.

Analysis of Beckett

The complexity of waste as a figure in Adorno's thought is evident in his approach to Samuel Beckett's 1957 one-act play *Endgame*. For Adorno, *Endgame* presented culture after the destruction of culture with his protagonists literally living in history's trash cans. He argued that Beckett offered modernism as the obsolescence of the modern, presenting a philosophy simultaneously reduced to "culture-trash." Adorno's Beckett lays waste to culture, as the play depicts a world that, along with the continuity of tradition, has been thrown on the garbage heap. Beckett's play, like Adorno's postwar philosophy, pictures existence after catastrophe and the complete reification of the world. In the dialogue between Hamm and Clov (the play's two antiheroes), Adorno argues that thoughts become refuse—the day's leftovers—as humanity vegetates on a pile of ruins. For Adorno, Beckett's trash cans are the emblem of a culture restored after Auschwitz.

Adorno's perceptive reading of cultural production as a mode of recycling resonates with postmodernism's constant reappropriation of previous styles and ideas. Many scholars, such as Brian Neville and Johanne Villeneuve, who have explored the idea of cultural waste, have turned to Adorno's philosophy as a means of rethinking the semiological and epistemological conventions that underlie notions of waste, memory, and recycling.

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See Also: Capitalism; Commodification; Consumerism; Culture, Values, and Garbage; Garbage in Modern Thought; Germany.

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Aerosol Spray

Aerosol spray represents an inexpensive and convenient way to dispense a variety of liquids, including deodorants, insecticides, and paints. A dispensing system that creates an aerosol mist of liquid particles, aerosol spray uses a can or bottle that contains a liquid under pressure. Common in the United States since the 1940s, aerosol sprays use propellants to assist with the process of driving the payload out of the container. Chlorofluorocarbons (CFCs) were commonly used as propellants in aerosol sprays, but during the 1980s CFCs were found to have negative effects on the Earth's ozone layer. As a result,

in 1989, the Montreal Protocol on Substances That Deplete the Ozone Layer (Montreal Protocol) sought to phase out the use of CFCs and has been largely successful in doing so. Replacements for CFCs have been found, although these are often flammable. This, along with the sometimes nonbiodegradable nature of aerosol spray packaging, has led to concerns about the waste these products generate.

History

Aerosol sprays were conceptualized as early as the late 18th century, although it took almost 150 years for the concept to be realized. Atomizers were used throughout the 19th century to dispense paint, perfume, and other liquids using a hand-operated pump rather than stored gas. In 1926, a Norwegian chemist, Erik Rotheim, invented the first aerosol spray can. Rotheim's invention forced liquid contained in a canister out of a small hole, emerging as an aerosol or mist when the container's valve was opened. Rotheim sold his patent to a U.S. company for 100,000 Norwegian kroner, but it was not until 1939, when Julian S. Kahn received a patent for a disposable spray can, that aerosol sprays became commercially viable.

During World War II, the U.S. government sought a convenient means to combat the malaria-carrying mosquitoes besieging troops in the Pacific. Lyle Goodhue and William Sullivan, working for the U.S. Department of Agriculture (USDA), designed a refillable spray can, dubbed the "bug bomb," which was patented in 1943. Goodhue and Sullivan's small, portable can used liquefied gas to provide it with propellant qualities, permitting soldiers to spray the inside of tents with aerosol pesticide. After the conclusion of World War II, the USDA granted licenses to three companies to manufacture aerosols for commercial use, including Chase Products Company and Claire Manufacturing, which continue to manufacture aerosols to this day. Robert Abplanalp, owner of the New York–based Precision Valve Corporation, invented the crimp-on valve in 1949; this controlled the aerosol spray, further expediting the commercial viability of aerosol sprays.

Packaging and Propellants

Aerosol sprays proved immensely popular with consumers as a means of dispensing liquids. The liquid to be dispensed is stored in a can or bottle that contains a gas under pressure. When the consumer opens the valve, the liquid is forced out through a small hole, emerging as an aerosol mist. The gas expands inside the container as it drives the liquid out, thereby maintaining an even pressure. Once outside the container, droplets of propellant evaporate rapidly, leaving the payload suspended as very fine droplets or particles.

Most aerosol-spray containers are comprised of three primary parts: the can, valve, and actuator. The can is usually lacquered tinplate or aluminum and is often two or three separate pieces of metal crimped together. The valve determines the spray rate of the liquid and is usually crimped to the structure of the can. The actuator is the button that the user depresses to open the valve. The nozzle's shape and size control the spread of the aerosol spray and can sometimes be adjusted by the user. Aerosol spray containers used with highly viscous products, such as food spreads, thick shaving creams, and sealants, often use a piston barrier system, which assures separation of the product from the propellant, ensuring purity of the product. Certain pet-care, pharmaceutical, sun-care, and other products use a bag on valve (BOV) system, where the product is separated from the propellant by means of a laminated, hermetically sealed, multilayer pouch. The BOV system is popular because it extends the product's shelf life. Regardless of the system used, the pressurization makes cans used for aerosol sprays difficult to recycle and, as a result, they often end up in landfills.

Inside the pressurized can, the propellant exists as gas in vapor form, existing in balance with its bulk liquid at a pressure that is higher than atmospheric levels, but not dangerously high. From the 1940s through the 1980s, CFCs were most commonly used for the propellant in aerosol sprays. After CFCs were identified as a major source of ozone depletion, however, a number of nations met to pass the Montreal Protocol, which was an international treaty designed to phase out the use of CFCs and other ozone-damaging substances. To date, the Montreal Protocol has been ratified by 196 nations and is considered one of the most successful international environmental agreements. As a result of the Montreal Protocol, the Earth's ozone

layer is expected to recover fully by 2050. Aerosol sprays today use mixtures of volatile hydrocarbons, such as propane, n-butane, and isobutane, as well as dimethyl ether (DME) and methyl ethyl ether as propellants. While these do not harm Earth's ozone layer, all of these substances are flammable. This flammability requires additional safeguards during the production of aerosol sprays and limits the methods of disposal. Although aerosol sprays' packaging and propellants create waste, their convenience makes their continued popularity and prevalence likely.

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See Also: Biodegradable; Clean Air Act; Cleaning Products; Packaging and Product Containers; Pollution, Air.

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Africa, North

North Africa includes Algeria, Egypt, Libya, Morocco, Sudan, Tunisia, and western Sahara. The geopolitical distinction between these countries and the rest of Africa (sub-Saharan Africa) is due to the barrier of the vast Sahara Desert and the proximity of the northern region of the continent to the trade routes and colonizing activities of Mediterranean civilizations like the Phoenicians, Greeks, Romans, and Vandals. Since the 7th century, north Africa has been a significant part of the Arab and Islamic world. Arabic continues to be one of the official languages of every country in the region, and North Africa has a strong Muslim presence. The entire region was at one point under the control of the Ottoman Empire (with the exception of Morocco), and during the height of European imperialism, various parts of the region were under the control of the United Kingdom, Spain, Italy, or France. The cultural, political, and economic influences on north Africa's history have thus been complex and varied, but have served to increase the commonalities among the nations of the region and the differences between it and sub-Saharan Africa.

In the 21st century, Algeria, Libya, and Sudan are dependent on their oil and natural gas reserves; Tunisia on tourism; Egypt on tourism and the strongest industrial sector in the region; and Morocco on phosphate mines and farming. North Africa has been one of the regions noticeably affected by global climate change, with record heat reported. Western Sahara is a disputed territory, claimed by both Morocco and the Sahrawi Arab Democratic Republic (SADR), the government of which operates in exile from Algeria, with that host country's support. SADR is recognized by the African Union, while Morocco's claim is recognized by most of the Arab world, again highlighting the transcontinental influences of the region.

Water Crisis

Sudan and Tunisia are among the countries most impacted by the worldwide freshwater crisis, with 12.3 million and 2.1 million people, respectively, whose sole water source is contaminated. Algeria and Egypt are among the countries with the most significant water deficits in the world, leading to overpumping and a lowering of the water table. Subsequent grain shortages require the importation of wheat and other basic staples. Morocco's water problems are exacerbated by a denser population, considerable population growth, and the seasonal influx of tourists in the summer months. The treatment of water and wastewater in north Africa is thus a critical issue germane not only to environmental concerns and long-term safety and welfare, but also to current ongoing crises of human survival.

Wastewater treatment removes contaminants from wastewater originating both from households and from effluents (sewers and other runoff). The by-products are environmentally safe fluids

People living along the canals in El-Gededa om El-Resh and El-Seds in Egypt's eastern El-Sharkia province used to throw their garbage and sewage into open canals. After USAID worked with Egypt's government to address environmental issues related to agricultural irrigation, canals passing through residential areas were covered and protected from this garbage and sewage problem. Municipal solid waste collection is problematic throughout north Africa, where urbanization is increasing and collection efficiency is poor.

and solids; the solids can be disposed of or turned into fertilizer, while the fluids are returned to the environment. Technological advances now permit treated wastewater to be purified back into drinking water. Wastewater treatment of any sort, however, is expensive to set up, with newer technologies even more so.

Rapid population expansion can result in an expensive arms race between the wastewater and its treatment facilities, particularly as—in many parts of the world—the per capita use of water is steadily increasing. In 2010, only Singapore produced drinking water from wastewater on a large scale. It may be decades before north Africa can follow, without outside financial intervention.

Further, water problems are exacerbated in the region because of a lack of sanitary landfills, insufficient municipal solid waste management, and a lax legal environment for overseeing industry and modern agriculture. Some rural areas do not have sewage networks or have failed to repair broken-down wastewater treatment plants. Urban wastewater and municipal solid waste are major sources of pollution in north Africa. Where sewage networks are lacking, wastewater is disposed of in septic tanks and may wind up either on the seashore, poured into valley courses, or deposited on open land. Most north African wastewater treatment plants were designed only for secondary wastewater treatment (treating it to a level of quality suitable for agricultural purposes, but still far from clean). When problems arise with these plants, the quality of the discharge drops to considerably below that level. Many households are improperly connected to their wastewater systems, leading to large amounts of above-ground runoff, especially near urban areas.

Lower-tech, lower-cost solutions include water treatment systems like solar-powered distillation to produce drinking water and desalination to harvest seawater and turn it into freshwater usable for either drinking or irrigation. While overexploitation of groundwater has dire consequences, it is politically unpopular to slow it down or reduce it because limiting the amount of groundwater available for crop irrigation can result in crop and farm failures in the short term, even though permitting it to continue will lead to crop failures in the long term.

Wastewater Irrigation

Because of the increasing demand for fresh water, there has been significant interest in reusing wastewater in agriculture in order to free up more clean freshwater for human consumption. Wastewater irrigation conserves freshwater, presents a low-cost method for sanitary disposal of urban wastewater, reduces the pollution of waterways, provides a water supply for farmers, and provides crops with nutrients, reducing the need for other fertilizers (especially artificial fertilizers), which can damage soil and water quality. Treated wastewater is used extensively for irrigation in Israel and has seen increased use in Morocco—one of the north African countries with the necessary capital for extensive wastewater treatment facilities. Wastewater for agricultural uses still needs to be treated to a reasonable microbiological standard, but can result in increased crop yields of as much as 25 percent.

Morocco operates 39 urban wastewater treatment plants and 23 in rural communities. Approximately 900,000 people of Morocco's population of about 13.5 million are served by a wastewater treatment plant. Reuse of wastewater for irrigation has been somewhat restricted by the fact that not all of the plants treat water to the necessary level of cleanliness, which could result in contamination of crops. Morocco's water pollution problems have been steadily increasing since the 1960s, and the present cost of damage caused by polluted water exceeds 1 percent of the country's gross domestic product (GDP), making it one of the most water-polluted countries in the world from a financial perspective. Most of north Africa has only ill-defined standards for wastewater treatment, which are often overlooked. Funding is available from the European Investment Bank, the World Bank, the United Nations, and the U.S. Agency for International Development for developing systems of wastewater reuse, including raising the standards of treatment plants.

The potential dangers of wastewater irrigation include the contamination of groundwater through nitrates; the build up in the soil of heavy metals and other chemical pollutants; the establishment of disease vectors; excess growth of algae and other vegetation in wastewater-carrying canals; and health risks to workers with prolonged contact with untreated wastewater or to consumers of fresh produce irrigated with disease-carrying water. These problems can be exacerbated by a bureaucracy and workforce unfamiliar with the risks and the methods for mitigating them, a lack of information on cost-effective wastewater treatment, a lack of local infrastructure for developing the proper technical specifications for such treatment, and farmers who are not sufficiently aware of the appropriate procedures to reduce the health risks associated with the use of wastewater. Theoretically, technical support in these areas could be offered by outside agencies. Morocco participates in the MEDAWARE project, a European-Mediterranean partnership for developing water management and wastewater policy solutions.

In many parts of north Africa, farmers without sufficient access to other water sources have resorted to using untreated wastewater for irrigation, which carries all of the above risks and a significantly elevated health risk both to farmworkers and consumers. Wastewater contains both industrial contaminants and biological contaminants (such as bacteria, eggs, and larvae) from sewage, both of which can be passed on to crops, especially dangerous in those consumed raw. Washing is not always sufficient to reduce this risk, particularly in countries where the water used for such washing cannot be depended upon for cleanliness.

Some farmers mitigate risk by using wastewater only for crops that will not be consumed (such as cotton) or that will be heavily processed before consumption (such as cereals, grains, and soybeans). This use can still pass contaminants into the soil and presents a health risk to workers. Algeria, for example, suffered a food poisoning epidemic in the summer of 2010 as a result of insufficiently treated (possibly untreated) wastewater used to irrigate watermelon.

In July 2010, the World Bank approved the Northern Tunis Wastewater Project, allocating $8.03 million to build a submarine outfall to reduce the environmental consequences of treated wastewater discharge into the Gulf of Tunis. The completed project will help farmers use treated wastewater for agricultural purposes. The remainder of the discharge will go through an underwater outfall into the Mediterranean Sea, and systems will be greatly enhanced to monitor discharge quality issues and increase Tunisia's wastewater treatment capacity, which—like

the rest of the region—is far behind demand. Ideally, the project will see significant environmental, economic, and human health gains, and it will reduce Tunisia's dependence on foreign food imports as well as the possibility of a public health epidemic caused by irrigating with untreated wastewater.

Other Forms of Waste

Throughout north Africa, there are problems with municipal solid waste collection. While quality varies from area to area, efficiency is typically low, and often the waste is deposited in landfills without any sanitary measures taken. Some landfills are even located directly at the waterfront, polluting the sea through leaching. Sometimes, waste is merely deposited on a vacant lot or otherwise unused land by waste removal trucks. The increased urbanization of north Africa and general population growth have greatly increased the volume not only of household waste, but also of construction and demolition waste, and there are usually few controls or plans dealing with handling such wastes, leading to widespread uncontrolled and unmanaged dump sites. Remedying this situation is not a budget priority in any north African country, and the capital needed to begin a methodical waste collection management system is significant. Libya, for instance, did not even include municipal solid waste management in the National Physical Plan until 2000, despite addressing matters in and allocating monies for other urban utilities. Often, urban solid waste collection is more efficient than in rural areas, but this is not always the case.

The legal frameworks of north African countries often fail to address issues related to the disposal of poisonous, toxic, or household waste, as well as similar issues such as the correct storage and handling procedures for poisons, pesticides, and herbicides. The law lags behind the technology in these respects, since apart from Egypt, the area is relatively new to industrialization and has been plagued with social, political, and economic concerns that may have made such lawmaking seem a luxury easily put off. Egypt is rather more advanced in this area and initiated a 10-year program for Integrated Solid Waste Management in 2000, which addresses municipal, agricultural, healthcare, construction, and demolition wastes as the top priorities, followed by industrial waste, waste generated from clearing drainage canals, and municipal wastewater sludge as secondary priorities, as well as adopting the "polluter pays" principle. The program laid out a comprehensive legal framework for waste management in Egypt and initiated groundwater and soil condition studies to inform the subsequent 10-year plan. Egypt had been ahead of the region in the 20th century as well, finally adopting regulations specific to hazardous waste in the 1990s, while most other north African countries have failed to do so even in the 21st century.

Even in Egypt, as in the rest of north Africa, there is a considerable gap between the amount of waste generated and the amount of waste disposed of at disposal sites. The developed world considers it an aberration if these amounts do not approach identicality. In north Africa, scavengers pick over the waste for reusable materials, and some waste is simply never collected. It is difficult, however, for record keepers to know to what cause to ascribe the "missing" waste, which makes efficiency studies problematic.

Unlike in the more developed parts of the world, solid waste in north Africa is usually between one-half and two-thirds organic waste (two to three times as much as in the United States), with plastic, paper, glass, and metals together making up about one-quarter of the waste by weight. Rural areas dispose of much less solid waste because so much of what is disposed of in cities is likely to be reused in the country as fertilizer or animal feed. In Egypt, Morocco, and Tunisia, in particular, the food waste of tourists in urban areas is a significant contributor to municipal waste.

Sanitary landfills are in their infancy in north Africa. In most areas, there is insufficient regulation defining or overseeing proper landfill management. Laws may even be limited to their minimal demands of banning the burning of waste and the placement of organic waste too near to waterways. What regulations exist are frequently bent or broken, sometimes out of ignorance or financial inability to comply.

Energy Sources

Hydrocarbons are the primary source of energy for north Africa. Algeria and Libya are both members of the Organization of Petroleum Exporting Countries (OPEC). Tunisia and Morocco are less

rich in oil, but still produce enough of it to depend upon it as a main source of energy. However, as oil reserves run low, the possibility of nuclear power in the future has been raised. Every north African country, barring Western Sahara, has worked on developing nuclear capabilities, often with Western support—especially from France. While the words "nuclear north Africa" have raised concerns about the development of nuclear weaponry in a historically volatile region, it seems that the region's interest in nuclear technology is purely related to the need for post-oil energy sources. Nuclear power plants could efficiently power seawater desalination plants to alleviate the water crisis, and the adoption of nuclear power would increase economic ties to Western corporations.

In 2007, Egypt announced plans to build nuclear reactors to meet its rising energy demands. Algeria, meanwhile, has pursued plans to build a nuclear power station by 2020 and has the advantage of considerable uranium deposits, though it had no capacity for enriching uranium as of 2010. Libya has negotiated with Russia for assistance in building a civilian nuclear power plant as well.

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See Also: Africa, Sub-Saharan; Cairo, Egypt; Developing Countries; Iran; Middle East; Pollution, Water; Saudi Arabia; Sewage; Sewage Treatment.

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Africa, Sub-Saharan

Sub-Saharan Africa consists of four major regions in Africa: west, east, central, and southern Africa. About 48 independent countries exist within the region. The term *sub-Saharan Africa* is usually used to depict the geographical area of the African continent that lies south of the Sahara Desert, or those African countries that are located south of the Sahara. Some say it excludes the Sahel and the Horn of Africa in the north. The region is one of the poorest in the world and is characterized by low economic opportunities, unstable government and government policies, poorly developed social and technological structures, and unplanned and expanding urban centers.

The region is also characterized by high population growth rates, comparatively high fertility rates, and a youthful population. The region's urban population was 15 percent in 1950, 42 percent in 2000, and it was projected that by 2020, the majority of the population will live in urban areas. Sub-Saharan Africa has one of the world's fastest-growing populations, increasing at about 2.8 percent per year, and it is expected to be home to over 1 billion people by 2025. While in the first half of the 20th century urbanization was predominantly confined to countries that had the highest levels of per capita income, in the more recent past, the most visible changes in urbanization have occurred and will likely continue to occur in middle- and low-income countries like those in sub-Saharan Africa.

Consumption Patterns

The region has witnessed a decline in agricultural output since the 1970s and relies heavily on importation to feed its growing population. The patterns of consumption have tilted toward imported foods, including livestock (such as frozen foods and dairy) and staple foods (such as rice). This development has raised the consumption of mostly high-waste-generating imported food and has also led to increasing numbers of fast food restaurants. The volume of waste generation among fast food operators within the region is high, with very passive or no government regulation.

According to 2004 United Nations Economic Programme (UNEP) reports, countries in sub-Saha-

ran Africa are facing serious problems related to natural resource management and environmental pollution owing to rapid growth in urbanization and industrialization. High consumption levels and a propensity to consume are putting a strain on the environment. However, excessive and indiscriminate consumption of resources is not limited to urban people; a disproportionately growing number of rural dwellers in sub-Saharan Africa engage in arbitrary consumption of resources such as deforestation and bush burnings. But the patterns and trends mark the difference. The contribution of urban and rural activities to harmful consumption of resources is a critical factor.

Consumption is clearly an essential property of human settlements. In industrialized countries, consumption of resources will mainly continue in the pursuit of a better of life, while in developing countries, such as sub-Saharan Africa, consumption is primarily driven by the desire to meet basic needs, increase economic growth, and sustain the development process. In economic terms, higher consumption levels lead to higher investment, which further leads to higher per capita income in the long run. Consumption will arguably contribute to human development when it enlarges the capabilities and enriches the lives of people without adversely affecting the well-being of others. Consumption becomes a positive factor in the development process when it is done in a sustainable manner. But the links between consumption and development are often broken. When they are, consumption becomes inimical to human and environmental development. The consumption pattern of the early 21st century is undermining the environmental resource base. If the patterns of consumption in sub-Saharan Africa are not changed, the problems of unsustainable and excessive consumption of resources and human development will worsen. Therefore, the real issue is not consumption itself, but rather its patterns and effects, including emissions and wastes that pollute the Earth and destroy ecosystems, and deplete and degrade renewable resources, undermining livelihoods and future development.

The current pattern of resource consumption in sub-Saharan Africa is overexploiting the natural resource base and stretching the carrying capacity of ecosystems that provide them to a point that they could collapse long before the world runs out of nonrenewable resources. Meanwhile, current consumption patterns do not show any prospect of abatement, threatening the health and livelihood of future generations. Pollution, resource depletion, energy consumption, increasing waste generation, and biodiversity and landscape destruction, which appear to be unsustainable by any standard, constitute the features of many consumption patterns in sub-Saharan Africa. Land conversion associated with both urbanization and tourism shoreline development is also noticeable.

The production and consumption of commodities requires the extraction and use of natural resources (such as wood, ore, fossil fuels, and water). It also requires the creation of factories and factory complexes whose operation creates toxic by-products, while the use of commodities themselves (such as automobiles) creates pollution. High consumption levels can never be separated from increasing volumes of waste. Excessive consumption in sub-Saharan Africa has brought about a deep concern for waste management as increasing volumes of waste are generated by urban areas.

The current conditions and trends of natural resources consumption in sub-Saharan Africa involve three critical areas: (1) energy and transport, (2) water, and (3) forest-based and mineral resources. These consumption activities provide clues and insights into the current consumption patterns of resources and prospects for the future.

Energy

Energy consumption in sub-Saharan Africa varies dramatically, with noncommercial fuels, such as wood and animal waste, dominating fuel consumption. The use of wood for fuel is predominant in both rural and urban locations, accounting for approximately 70 percent of total energy use and 90 percent of household energy use. Africa is the world's largest consumer of biomass energy (energy from sources like firewood, agricultural residues, animal wastes, and charcoal), calculated as a percentage of overall energy consumption. Nigeria consistently leads sub-Saharan Africa in commercial energy consumption. In 2001, Nigeria consumed 0.92 quadrillion Btu (quads), which represented 32 percent of all energy consumed in the region. Of the remain-

ing countries, Zimbabwe registered the next highest level with 0.24 quads of energy consumed, and Ghana consumed 0.17 quads. These numbers are generally higher than most of sub-Saharan Africa, which averaged 0.06 quads in 2001. Although domestic demand for energy consumption in sub-Saharan Africa is growing rapidly, consumption levels remain well below world average.

The global primary energy consumption is rising by more than 3 percent annually, and most of this consumption takes place in human settlements. There are, however, wide variations in per capita energy use in different regions of the world; on average, the energy used by a person in a developed country is about nine times that of a person in a developing country. Large disparities also exist among developing countries; for example, the annual per capita consumption of modern forms of energy in sub-Saharan Africa is less than half the average of developed countries. Similar disparity exists within the countries of sub-Saharan Africa, as well as between the rural and urban poor and the higher income groups. Several factors contribute to this disparity in energy consumption: the level of urbanization, economic activity, and living standards. With rapid urbanization in low- and middle-income countries, this scenario is, however, changing fast. A World Bank study estimated that the energy demand in these countries is expected to rise to parity with Organisation for Economic Co-operation and Development (OECD) demand by 2015. Sub-Saharan Africa has a great potential for higher consumption of energy, with urbanization and motorization as the main contributing factors.

Transport

The rapid growth in demand in the energy sector in sub-Saharan Africa is taking place amid grossly inefficient energy use in the transport sector, households, and construction, which, together, account for most of the energy use in human population. The transport sector is the largest single consumer of commercial energy in human settlements, accounting for nearly half of all petroleum consumption. In sub-Saharan Africa, it accounts for nearly 80 percent of all commercial energy used. The key factors that contribute to inefficient energy use in the transport sector are the growing road congestion in urban areas resulting from urban growth, increasing dependence on cars, and vehicles with poor fuel efficiency coupled with poor vehicle and road maintenance in developing countries.

In households, considerable scope exists for efficiency improvements in common cooking, lighting, and appliance technologies. Vast amounts of energy are wasted in traditional cookstoves still in common use in rural areas of the developing world. The technology is already available for energy-efficient stoves, refrigerators, and lighting appliances, such as compact fluorescent lamps. Building insulation can reduce energy use by three-quarters, but its diffusion is slow, mainly because of higher initial cost to the consumer. Energy production and use, in almost every form, generates varying degrees of environmental externalities that affect human health, ecological stability, and economic development. The wide-scale use of fuel wood in Africa is contributing to deforestation and soil erosion. Also, the extensive use of biomass in traditional stoves exposes the users—mainly women and children—to high levels of indoor pollution. Transport-related air pollution is already threatening the health of some 300–400 million city dwellers in the region. If current trends continue, by 2015, transport-related air pollution in many large cities of the developing world will be much worse than projected levels for major cities in industrialized countries with a much higher level of motorization.

Another major characteristic of unsustainable energy consumption in sub-Saharan Africa is gas flaring. The flaring of natural gas in Nigeria, Angola, Cameroon, and Gabon has proven to be a significant source of carbon emissions in sub-Saharan Africa. In the process of oil production, natural gas is released. Because gas infrastructure in sub-Saharan Africa is extremely limited, this "associated" gas is often burned off, or "flared," rather than captured for use. Not only does this waste a potentially valuable energy source—the World Bank estimates that every day Africa flares gas equivalent to 12 times the energy that the continent uses—but it also releases carbon dioxide directly into the atmosphere. However, Nigeria—the major player in gas flaring—is working on developing a gas-to-liquids industry and expanding its liquefied natural gas trade to reduce

flaring. The government has attempted to terminate all gas flaring, with heavy fines for companies that do not comply. However, this goal is far from being realized as high magnitudes of gas are wasted through flaring.

Water

Freshwater is a finite resource, which has to meet ever-increasing demands from competing users: agriculture, industry, and the domestic sector. The availability of freshwater is decreasing in many parts of Africa, notably in north Africa, the Sahel, and the Kalahari-Namib regions of sub-Saharan Africa. Some 80 countries with about 40 percent of the world's population are facing acute to chronic water scarcity. With rapid urbanization, many cities are also facing water scarcity. In sub-Saharan Africa, more than 300 cities face water shortages, with 100 in acute distress at an estimated cost of $14 billion in lost economic output each year. Excessive groundwater extraction and consumption in many cities in sub-Saharan Africa has caused saline intrusion and ground subsidence. According to the Nigeria Demographic Health Survey, 42.6 percent of its population in 2008 drew water from an unimproved source. In an attempt to have access to improved sources of water, many tube wells or boreholes have been dug. The implication of this activity is arbitrary degradation of the environment.

In developing countries, close to 85 percent of water is allocated to agriculture, 10 percent to industry, and only about 5 percent for domestic use. Less than 45 percent of the water for agriculture actually reaches the crops. In addition, cities in developing countries are losing between 30 and 60 percent of water—produced and treated at high cost for domestic use—through leakage from poorly maintained water supply systems before it reaches the intended consumers. There is also the need to put in place measures to promote more efficient use of water resources, reduce losses and wasteful use, and ensure equitable distribution among different uses and users for the present and future generations. There is also an important equity issue associated with water use, particularly in urban areas. The urban poor in developing countries almost always have to rely on private water vendors and end up paying a very high price for their water, often several times more than other affluent neighbors who have water piped into their homes. Thus the poor, in effect, subsidize water services for the more affluent and continue to suffer water scarcity and a heavy burden of healthcare. Inequitable pricing of water also leads to profligate use and wastage of this precious resource by the domestic sector and, to a lesser extent, the industrial sector.

Forest-Based and Mineral Resources

Sub-Saharan Africa has suffered the worst deforestation, with the forest cover reduced to 8 percent. The per capita availability of forests in developing countries is now about half of that in industrialized countries. Firewood accounts for more than half of the world's demand for wood. In African countries, biomass is the key source of energy, accounting for 50–90 percent of the total national energy supply. In Sudan, between 1962 and 1980, wood fuel consumption contributed to 92 percent of the 21,125 square miles of deforested areas. Zimbabwe's forests are reduced by 1.5 percent per year, with a growing fuel wood deficit and implications for women who gather fuel wood. In Nigeria, for instance, the livelihood of some 40 million of the country's indigenous people, many of them women, depends on access to fuel wood. Despite widespread deforestation in large parts of the developing world, the forest-products industry continues to thrive, with a global annual turnover of $330 billion. The annual demand for industrial wood is estimated to increase from 1.6 billion cubic meters to 1.9 billion by 2010, driven by increases in population and rising living standards. Industrial logging has also played an important role in the destruction of primary rain forests in central Africa.

In the case of mineral resources, central Africa is home to one of the world's largest rainforests and serves as one of the world's most important carbon sinks. Carbon sinks capture carbon dioxide from the atmosphere, thus reducing global carbon dioxide levels. Deforestation is one of the most pressing environmental problems faced by almost all sub-Saharan African nations, with one of the primary causes of deforestation being wood utilization for fuel. Many sub-Saharan countries have had over three-quarters of their forest cover depleted, and it

is estimated that if current trends continue, many areas—especially that of the Sudan-Sahelian belt—will experience a severe shortage of fuel wood by 2025. Deforestation also has negative implications for the local environment, including increased erosion and loss of biodiversity. The highest rates of deforestation occur in areas with large growing populations, such as the East African Highlands and the Sahel.

The harvesting of wood for use as fuel also has contributed to the problem of desertification. *Desertification* is the term used to describe the loss of soil fertility and structure to the extent that its ability to support plant life is severely compromised. In sub-Saharan Africa, where desertification has its greatest impact, forest areas are often cleared in order to harvest fuel wood and for agricultural use. Traditional farming practices, which tend to be inefficient and land intensive, significantly degrade scarce arable land—the single most important natural resource in sub-Saharan Africa. Desertification can lead to downstream flooding, reduced water quality, and sedimentation in rivers and lakes. It also can lead to dust storms, air pollution, and health problems, such as respiratory illnesses and allergies.

At the World Summit for Sustainable Development, the United States joined forces with the governments of Cameroon, the Central African Republic, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, and the Republic of Congo, along with multilateral donors to promote economic development in the Congo River basin through natural resource conservation programs. The program creates a network of parks and protected areas, well-managed forestry concessions, and communities that depend upon the conservation of the forest and wildlife resources in the Congo River basin. The United States alone planned to invest $53 million in this project. However, this plausible program on environmental sustainability has not yielded any appreciative change in people's attitude toward deforestation because of the complexities of the changing processes involved.

Urban Waste

Waste generation, both domestic and industrial, continues to increase worldwide in tandem with growth in consumption. In developed countries, per capita waste generation increased nearly threefold since the 1980s, reaching a level five to six times higher than that in developing countries. With increases in populations and living standards, waste generation in developing countries is also increasing rapidly and may double in volume within a decade. If current trends continue, according to some estimates, the world may see a fivefold increase in waste generation by 2025.

Urban areas not only concentrate consumption of resources, but also generate much of the domestic waste. Most city governments are facing mounting problems with the collection and disposal of wastes. In high-income countries, the problems usually center on the difficulties of disposing the large quantities of solid wastes generated by households and businesses. Land filling, the most widely practiced disposal method in these countries, is becoming increasingly costly because of land scarcity and rising transportation costs. In developing countries, many city authorities are unable to collect and transport more than one-third of the solid waste generated because of limited municipal budgets. The rising cost of land filling and the need to conserve resources have prompted most industrial countries to focus increasingly on recycling and reuse of both municipal and industrial wastes. In developing countries in general, and sub-Saharan Africa in particular, recycling is driven by the need for low-cost materials for industry, high levels of underemployment, and the low purchasing power of large segments of the population. Many cities in developing countries have developed extensive waste economies.

Agricultural Waste

In sub-Saharan Africa, increasing uses of agrochemicals in intensive farming practices have contaminated potable water resources to a level hazardous to health. Poor solid waste disposal affects all three environmental media. Air pollution from combustion products, illegally dumped hazardous wastes, and other gaseous products of waste decomposition have a significant effect not only on the local environment, but also on a global scale, contributing to the greenhouse effect and causing acidification of the environment. The

pollution of water courses, both surface and subsurface, by decomposing wastes is also a problem, especially where it is ultimately used as a potable supply by communities. Increasing rates of waste generation in developing countries are threatening the environment. Countries in sub-Saharan Africa have not been able to develop effective and holistic approaches to waste management: mainly as a result of, a lack of infrastructure for waste management, lack of access to and adoption of appropriate technology to manage waste, widespread illegal dump sites, and limited presence of formal systems to sort and recycle waste. Developed countries are successfully managing waste through recycling systems and reuse of both domestic and industrial waste. The challenge for sub-Saharan Africa is turning the ever-increasing waste over to effective and adequate management.

In conclusion, countries in sub-Saharan Africa portend high consumption patterns of natural resources because of their growing population and poor waste management systems. The unprecedented increase in human population, with prospects for further increase, raises questions on the capability and potential of the region to maintain the current patterns in consumption levels without impinging on the sustainability of resources and environment. Consumption and production of waste will go on at an ever-increasing pace. Many countries in sub-Saharan Africa are finding it rigorously difficult to cope with the environmental challenges posed by unsustainable use of resources and mounting waste creation.

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See Also: Africa, North; Overconsumption; South Africa; Sustainable Development.

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Air Filters

Particulate air filters remove solid particulates like mold, pollen, dust, and bacteria from the air. Typically they are composed of fibrous materials that are permeable by air but trap the particulates. Depending on the usage for which they are intended, filters may include a chemical component, which removes or neutralizes contaminants, or they may use a static electric charge to actively attract particles rather than simply passively catching them. Air filters have two types of environmental ramifications: they are used to improve air quality and their construction and disposal have environmental consequences.

Use and Production

Air filters are used in vehicles to both filter the air for the passenger compartment and prevent the entrance into an engine's cylinders of abrasive particulates that will contaminate the oil and contribute to mechanical wear and tear. Both types are usually made of pleated paper, sometimes felt. Ford introduced a new long-life filter system for engines in 2003 that uses foam instead of paper: these filters are placed in the bumper of the car with a stated

150,000-mile service interval. But apart from the use of these filters in the Ford Focus, nearly all engine air filters are made with pleated paper.

The paper used for filters is called "filter paper" and is similar to the paper used for coffee filters and tea bags. The material, usually made with high-cellulose bleached wood pulp, called "dissolving pulp," may be treated with chemical reagents and impregnated to increase moisture resistance before being pleated. It is semipermeable and placed perpendicular to the expected airflow, and many heavy-duty filters may be rinsed periodically in order to extend their life.

Dissolving pulp is made from pulpwood (timber grown specifically for paper production). Most pulpwood forests are reforested as standard practice, making them a renewable resource. Pulpwood can also be harvested from mixed forests, in which the better-quality trees are used for lumber production, while pulpwood is made from the four types of trees inferior for lumber: open-grown trees, which have heavy branches low on the trunk; dead or diseased trees; treetops; and trees too small for logging. Salvage cuts after natural disasters are often used for pulpwood. Typical tree varieties used for dissolving pulp include aspen, paper bird, red maple, balsam fir, jack pine, and white spruce, all of which have high cellulose content.

Particulate air filters are used to filter home and automotive systems from mold, bacteria, pollen, and dust. While reusable filters last longer and don't clog landfills, they are more expensive and difficult to clean properly, so disposable filters are more common.

Health Effects

On the face of it, the production of air filters is largely environmentally friendly. The bleaching, however, can be considered problematic. Whiteness is considered desirable in most filters because it makes it easy to visually ascertain how dirty the filter has become. Various chemicals are used to reduce the chromophores (color-causing substances) in the pulp, including chlorine dioxide, hydrogen peroxide, sodium dithionite, magnesium salts, and sodium silicate. Ozone is sometimes promoted as an oxidizing agent for bleaching because it can achieve results without any chlorine (in products designated "totally chlorine free") or without any elemental chlorine (in products designated "elemental chlorine free"). The main way in which bleaching pulp can damage the environment is through the release of materials into waterways, which are usually located near pulp mills because significant amounts of water are required for their operation. The substances released include chlorinated dioxins, which are recognized as a persistent environmental pollutant with significant human health effects. Most human exposure to dioxins is through food because they accumulate in the food chain through the fatty tissues of animals.

Recycling and Cleaning

Further, while the production of the filter uses a renewable resource, it is still a wasted resource if the filter is simply thrown away, particularly if it is not designed to be used for a long period of time. Remedies to this issue include recycling and cleaning. Cleanable air filters are more expensive than disposable ones, but they last longer. On the other hand, their maximum efficacy is considerably lower than disposable air filters because there is a tug-of-war between permeability and ease of cleaning; the smaller the particles a filter can effectively capture,

the harder it is to clean it. It is particularly difficult to find an effective, reusable air filter for household antiallergen use, for instance, and claims of efficacy by manufacturers are often wildly exaggerated.

Recycling air filters, on the other hand, is often possible through specialized services. They can generally not be recycled as ordinary paper, depending on the use to which they were put, but services exist that exchange clean filters for used ones in order to recycle them.

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See Also: Paper Products; Pollution, Air; Recyclable Products; Recycling.

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Alabama

A Deep South state, Alabama is bordered by Tennessee, Georgia, Florida, Mississippi, and the Gulf of Mexico. The state has the second-largest inland waterway system in the country, with numerous rivers and creeks. The 2010 population was 4,779,736. The economy has become more diversified since World War II, with a gradual transition from agriculture to expanded mineral extraction, technology, and heavy manufacturing sectors, as well as the establishment of numerous military installations providing government jobs. Nevertheless, the state has often suffered from economic trouble, and in 2010, unemployment approached 9 percent. It was one of the states impacted by the 2010 BP oil catastrophe in the Gulf of Mexico.

Energy Consumption

Alabama ranks 15th in the country of carbon dioxide (CO_2)-polluting states, producing about 31 tons of CO_2 per resident per year, and it ranks highest in per capita energy usage. About half of the state's energy consumption is due to the industrial sector. It also ranks fourth-highest in per capita gasoline consumption. The state has considerable natural gas and coal resources, which encourage its dependence on fossil fuels, though the plentiful rivers also have untapped hydroelectric potential, and many of the state's regions are perfectly suited to growing switchgrass for biofuel.

Waste Disposal

The Land Division of the Alabama Department of Environmental Management administers the state's waste management and remediation programs, with primary jurisdiction over the disposal of solid and hazardous waste and the remediation of contaminated sites. Specific major programs within the Land Division include hazardous waste, solid waste, remediation, scrap tire, and brownfields/voluntary cleanup. The state's rules for hazardous waste disposal follow those of the federal government, and the delegable portion of the federal Resource Conservation and Recovery Act is administered by the Land Division. The Land Division designates permitted landfills in the construction/demolition, industrial, and municipal waste categories, and it investigates illegal solid waste disposal sites and complaints regarding waste disposal.

The brownfields/voluntary cleanup program is set up to redevelop brownfield sites in Alabama. Brownfields are properties whose redevelopment or reuse may be complicated by the presence of hazardous substances, pollutants, or contaminants. Their safe redevelopment and remediation is intended to create jobs or to increase public space without doing so at the expense of greenfields. The program assists local governments and nonprofit organizations with the assessment, cleanup, and redevelopment of such sites.

Emelle Landfill

Emelle, Alabama, in Sumter County (on the Mississippi border), is home to the country's largest hazardous-waste landfill. A young, tiny town, Emelle had

a population of only 31 (79 percent African American) as of the 2000 census, and it was not incorporated until the 1980s, despite continuous population since the previous century. The landfill is owned by Chemical Waste Management, Inc. (CWM), which has been accused of and used as a textbook example of environmental racism (the practice of shunting waste, especially hazardous waste, to areas populated by African American, Native American, and other minority communities). The CWM landfill was purchased in 1978 and the site has become the depository for approximately 6 million tons of waste. It is located near the top of the Eutaw Aquifer, which supplies water to much of Alabama. This part of the state is poor—about one-third of the residents live below the poverty level—and almost entirely African American, being located in the Black Belt soil region. Political considerations may have been involved in the landfill's inception, as one of the original owners was the son-in-law of former Alabama governor and presidential candidate George Wallace, a noted racist. Resource Industries later sued CWM for fraud and misrepresentation, winning an award of $91 million, though the general public of Alabama and Sumter County received nothing.

The landfill was supported by local governments, as it was extremely profitable for the impoverished county (generating tens of millions of dollars in fees), but it attracted considerable opposition from activists, other Alabamans, and regulatory agencies. The company countered that it created local jobs. The landfill, originally 300 acres, expanded over time to 2,700 acres. Between 1984 and 1987, about 40 percent of the toxic waste in the entire country was brought to Emelle from the many businesses and other customers that CWM serves.

Federal regulations and a new state tax slowed the growth of the landfill in the 1990s, and as of 2010, only about 120,000 tons a year are added to the landfill, down from a peak of 800,000 tons. Problems at the site have included a cloud of acidic vapor released in 1984, a fire in 1985 requiring the evacuation of hundreds of workers, and at least one spill of liquid waste onto adjacent land without any contingency plans implemented or authorities notified. Activist groups opposing the landfill have included Greenpeace, the Sierra Club, Sumter Countians Organized for the Protection of the Environment (SCOPE), and Alabamians for a Clean Environment (ACE). ACE is primarily credited with attracting the attention of national organizations and activist groups. Meanwhile, the local Sumter County media portrayed landfill opponents as hippie holdovers out of touch with the economic realities of their hometowns and played up the fact that while most of Sumter County is black, most of the activists, especially those interviewed on television, were white. Emelle is an even smaller town than it once was, hundreds of landfill jobs having been eliminated since the early 1990s when operations were at their peak. Supporters of the landfill point out that Emelle now suffers from the worst of both worlds: the landfill is still there, still as much a danger as before, but now provides fewer jobs for the public and fewer taxes for the county.

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See Also: Economics of Waste Collection and Disposal, U.S.; Landfills, Modern; Mississippi; Politics of Waste; Race and Garbage; Tennessee; Toxic Wastes; United States.

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Alaska

Alaska is often referred to as the "last frontier" of the United States. The largest of the United States by area, with 663,268 square miles, Alaska only has 710,231 residents, making it the fourth-smallest state in terms of population. Scale and distance shape both consumption and waste management practices in the state, with residents paying among the highest prices within the United States for commodities. Recyclables collected within the state are shipped through the Port of Tacoma for processing

and sale, and the array of communities scattered across the state rely on landfills and incineration, depending on the size and remoteness of the settlement. Unique characteristics of Alaska include its marketing to outsiders, which has billed it as the "vacation of a lifetime." The influx of tourists, particularly to southeast Alaska during the summer season, presents challenges of waste management. Similarly, the resources available in Alaska, particularly oil and gas, continue to be central to key questions of climate change, science, public policy, consumption, and international affairs. The arctic and subarctic environments of Alaska present several challenges in terms of consumption, waste collection, and disposal.

While Alaska has a low population per square mile, the remoteness of many areas, including the state capital, presents limited options for local disposal of waste. In terms of consumption, Alaska is a state of ironies where, although there are many natural resources available and a tradition of independent living, there is heavy reliance upon outside sources of consumptive goods. This irony is perhaps no greater than in the context of fossil fuels, including the iconic Alaska pipeline and the controversial utilization of the Arctic National Wildlife Refuge. The isolation of Alaska brings with it high costs of gasoline and heating oil. This discrepancy is particularly marked between rural and urban areas of Alaska.

The higher price of oil in Alaska has contributed to increased prices in store-bought foods. Alaskans boast the highest consumption of subsistence resources in the United States. Subsistence resources utilization is much higher in rural than urban areas. There is, at the same time, a heavy dependence on imported foods. It is estimated that 95 percent of the food consumed by Alaskans, on average, comes from outside the state. Although urban Alaska residents pay a premium in relation to the "lower 48," the price in rural areas can be two or even three times the cost of goods in the "lower 48."

Transfer Stations

Transfer stations in Fairbanks have been a source of wealth for some. These transfer stations are places of exchange wherein individuals will dispose of items they no longer want, including building materials, functional electronics, or even a baby's crib. At these locations, individuals not only seek to get rid of their unwanted goods, but also very deliberately place some of their goods where they can easily be accessed by people scavenging for resources. Humans are not alone in scavenging for resources in waste as ravens, arctic foxes, and bears have all been reported as frequent users of waste in different parts of Alaska. Individuals will scavenge resources that they can reuse personally or to salvage for resale either in whole or for their component parts. For example, some individuals patrol different transfer stations to salvage the copper wire from working electronic devices in order to sell the copper.

Recycling and Toxic Waste

The relative isolation of Alaska presents challenges in developing programs to deal with different types of waste. Urban areas have different capacities to deal with recyclable materials. For example, although there are drop-off locations for recycling in Fairbanks, there was no pick-up program designed for recycling as of 2010; both Anchorage and Juneau have more thorough recycling programs. At the end of 2010, a community recycling center and education facility opened on the Palmer-Wasilla Highway. Built to LEED Gold Standard specifications, the facility serves the rapidly growing Matanuska-Susitna Valley north of Anchorage. There are very few locations for recycling and very little has been implemented in terms of recycling programs in rural Alaska.

Rural communities utilize a hub system wherein a centralized town with aviation capacity serves as the centralized distribution point for consumable goods from Anchorage. A 2010 initiative in Nome is beginning the process of using the plane's return trip to Anchorage to ship electronic, potentially toxic waste back from Nome and surrounding communities. Initiatives such as this have the potential to prevent the creation of new Superfund sites in rural Alaska. Previous disposal of toxic waste from households, military, and industry present serious health issues, particularly in rural Alaska.

Human Waste

In terms of human waste, the Alaskan outhouse is a primary—if not sole—option for many who live

in "dry-cabins," or those without running water. Alaskan outhouses take a myriad of forms, including sanitary, closed-structure, or open-pit. This can have severe consequences during the spring when thawing occurs, resulting in large quantities of water on the landscape. In some areas, this water can lead to overflowing in outhouses and hence potential sanitation issues, including water pollution. This issue can be further compounded by the fact that much of this water can remain stagnant in certain areas. In some instances, rural and urban residents without access to indoor plumbing or limited access to indoor plumbing use "honeybuckets" in order to deal with human waste. This method of disposal offers the benefit of not having to venture outside, but involves the collection of human waste in an inside bucket, which is then later disposed of in garbage or placed outside in order to freeze during the wintertime.

Fuel

Several efforts are underway in Alaska to decrease the overall reliance on outside sources of fuel and food. In order to limit the amount of heating oil consumed in newly constructed housing, architects and organizations such as the Cold Climate Housing Research Center are working to incorporate energy efficient design elements in new construction and house retrofitting. In other areas, cities, towns, and organizations are exploring alternatives to fossil fuels, including wind and geothermal power.

Tourism

While there is heavy reliance in Alaska on natural resource exploitation, the tourist industry also plays a large role in Alaska's economy. The impacts of tourism are more noticeable in certain regions than others. On typical summer days in downtown Juneau, multiple cruise ships transport tourists through the famed Inside Passage and along the Northwest Coast.

Tourists from all over the world utilize these cruise ships and rush into ports of call en route to or from Anchorage. These cruise ships must also dispose of their waste products, and this has raised controversy as to how to best dispose of waste en route. The greater length of time these ships carry additional weight, the more fuel they burn.

Alaska is still aptly referred to as the "last frontier" as its unique positioning offers both challenges and opportunities for cost and environmentally effective means of dealing with challenges of consumption and waste production and utilization. The relative isolation of not only the state, but also rural communities and urban centers, may point to unique circumstances (such as high costs of transportation leading to price premiums on food and fuel) wherein the most cost-effective solutions involve tight cycling of energy and waste so that Alaskans may confront issues of waste and consumption in their own backyard. To describe Alaska as a "state removed" does not address the reality that the state will continue to grapple with its connections to not only the "lower 48," but also the global economy, as much-needed tourist dollars continue to flow into the state, bringing with them benefits and challenges.

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See Also: Dumpster-Diving; Food Consumption; Gasoline; Grocery Stores; Human Waste; NIMBY (Not in My Backyard); Ocean Disposal; Public Health; Recycling; Recycling Behaviors; Supermarkets; Sustainable Development; Sustainable Waste Management; Toxic Wastes; Trash to Cash.

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Alcohol Consumption Surveys

Alcohol consumption can be both beneficial and harmful to human health. In the 20th century, moderate drinking was associated with a lower risk of cardiovascular disease. However, recent trends have shown alcohol consumption to be one of the leading causes of death and poor health in the United States. According to the World Health Organization (WHO), the United States has the second-highest level of alcohol consumption after Europe. It had peaked in the 1980s, and after a slight reduction in the next decade, it has remained stable since 2000.

Statistics

Alcohol consumption surveys have been structured to collect and report information regarding alcohol consumption in the U.S. population. The National Survey on Drug Use and Health (NSDUH) conducts surveys on drug and alcohol consumption of U.S. consumers from different demographic (such as age, gender, race/ethnicity, education, and employment), geographic, and other variables. A 2008 survey report shows that 51.6 percent, or about 129 million Americans age 12 and older, consume alcohol. Approximately 23 percent of those groups are binge drinkers (with blood alcohol concentration 0.08 grams or above), and 7 percent are heavy drinkers (those who consume an average of more than two drinks per day). Of all ethnicities, white Americans have the highest (56 percent), and Asian Americans have the lowest (37 percent) percentage of self-reported alcohol use. These survey statistics also provide information about alcohol-related deaths, injuries, and other health problems.

Underage drinking continues to prevail in the United States. The percentage of male and female drinkers ages 12 to 17 is similar, at 14–15 percent. However, in the age group of 18–25, the percentage of male drinkers (64 percent) is higher than that of females (58 percent). A number of national surveys have confirmed that three-fourths of 12th graders, more than two-thirds of 10th graders, and about two in every five 8th graders have consumed alcohol. According to a survey by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), each year, approximately 5,000 people under the age of 21 die of alcohol-related causes. This statistic includes approximately 1,900 deaths from car crashes, 1,600 deaths from homicide, 300 deaths from suicide, and hundreds from other injuries such as falls, burns, and drowning. Data from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) show that teens who drank alcohol at an early age were at greater risk of developing alcohol dependence in adulthood.

Beyond the NIAAA's national-level surveys, many online and off-line surveys have been conducted in colleges and universities to learn about alcohol consumption among college-level students and the implications on campuses. These surveys include questions regarding campus culture, alcohol control policies, enforcement policies, availabilities, pricing, marketing, and special promotions of alcohol. They provide valuable information for the authorities to intervene to prevent drinking and alcohol-related consequences among students. The data further showed that the students who drank at "non-extreme" levels and not in the "high risk" group were harmed the most.

Some of the problems related to alcohol consumption as reported by the college students are missing classes, poor performance on tests, being injured, having arguments or fights, having trouble with authorities, getting arrested, damaging property, sexual assault, and drunk driving. The availability and effectiveness of appropriate programs and laws, such as "No drinking and driving," was shown to save the lives of underage drinkers, adults, and the people around them. The percentage of people 12 and older driving under the influence of alcohol dropped from 14 percent in 2002 to 12 percent in 2008.

Truth in Garbage

There is a considerable difference between the survey results and the true alcohol consumption in the adult population, as well as in underage drinkers on college campuses. According to William Rathje, an eminent garbologist, alcohol consumption is typically underreported by 40 to 60 percent. During surveys, people are not always truthful about how much alcohol they consume on a regular basis because they might be perceived wrongly or because

Alcohol consumption surveys, particularly among underage drinkers, are usually inaccurate by a wide margin. Counting beer or wine bottles in household garbage or campus dumpsters is the most reliable method of estimating actual alcohol consumption.

they are not aware of their drinking patterns. Looking through a household's garbage for beer cans and wine bottles is found to be a more reliable method in accounting for actual alcohol consumption. Similarly, true data for underage drinking in college campuses may be found by locating the number of beer cans discarded in trash bins in residence halls for freshmen and sophomores. Hence, alcohol consumption surveys and garbology are complementary tools in finding the true extent of alcohol consumption.

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See Also: Consumption Patterns; Culture, Values, and Garbage; Garbage Project; Garbology; Public Health; Supermarkets; Surveys and Information Bias; Zero Waste.

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Aluminum

A rare and precious metal just 150 years ago, aluminum is now a nearly ubiquitous element in consumer goods, cars, power lines, airplanes, and computers. Although aluminum is the most abundant metal in the Earth's crust, the process of extracting it from ore consumes extensive amounts of soil, water, and energy. Aluminum's physical qualities, particularly its shine, light weight, malleability, and versatility, make it attractive to artisans, industrialists, and artists, for whom it is a key ingredient in wiring, jet aircraft, cookware, sculpture, and antiperspirant, among other products. A great deal of the world's aluminum still comes from bauxite ore. Since the 1960s, however, recycling has become an equally important source. In the 21st century, while some people prize aluminum as a sustainable, reusable resource, others denigrate it for the high ecological impact of its production.

History

Throughout antiquity, people used alum as an astringent and as an ingredient in ceramics. It was not until 1807, however, that Sir Humphrey Davy proposed that alum contained a base metal, which he called "aluminum." In 1827, chemists Hans Orsted and Frederich Wohler isolated pure aluminum for the first time using electrolysis, but the process was slow and costly. In the mid-19th century, pure aluminum was considered as precious and rare as gold or silver. This notion changed in the 1880s, when chemists Charles Martin Hall and Paul Héroult, working independently in the United States and France, perfected a quicker and more efficient process of electrolyzing aluminum. The Hall-Héroult process ushered the transition of aluminum from precious metal to industrial element, and it remains a primary method in aluminum extraction.

Mining

Most aluminum in the Earth's crust resides in bauxite. Bauxite occurs naturally throughout most of the globe, but a great deal of the world's supply lies in developing areas, including Jamaica, Guinea, Brazil, China, and India. For people in these countries, bauxite mining presents a potential path to employment and economic development, but the benefits of mining have come with social and environmental costs.

Bauxite mining is an open-pit process, which means that topsoil and vegetation must be removed in order to obtain ore. The refining process requires the use of caustic sodium hydroxide, which yields valuable aluminum oxide and an alkaline toxic waste. This alkaline waste, known as "red mud," has some industrial applications, but it has also been a source of groundwater contamination in bauxite mining countries.

Both the refining process and the subsequent electrolysis by the Hall-Héroult process consume tremendous amounts of electricity. To provide this energy, governments and mining interests have built hydroelectric dams near bauxite sources. Even though they may provide local people with cheaper sources of power, dams are not always popular.

In the Indian state of Orissa, for example, ethnographers and activists contend that the aluminum industry and its dams have led to the displacement of thousands of *adivasi*, or "tribal," groups. They suggest that the forced relocation of people who live in bauxite-rich regions presents an economic and ecological burden that outweighs the benefits of aluminum extraction.

Recycling

Though bauxite mining remains a primary source of aluminum, industry leaders and environmentalists now recognize that it may be cheaper and more energy efficient to obtain aluminum by recycling. Aluminum is 100 percent recoverable, meaning it can be recast without any loss of its prized shine and malleability. Aluminum has a low melting point relative to other commonly used metals (about 600 degrees Celsius, or 1,200 degrees Fahrenheit). When heated, aluminum liquefies, leaving a small amount of waste product, called "dross." This dross can be further refined to recover pure aluminum.

The collection, recycling, and recasting of metals is not a new process, but the era of modern aluminum recycling did not begin until after the Hall-Héroult process made industrial aluminum production possible. The first large-scale alumi-

num recyclers sprang up in the metalworks of Chicago, Illinois, in 1904. During World War II, recycling in Chicago and other parts of the United States boomed as the military searched for cheap and quick sources of aluminum and other materials for weapons production.

A watershed moment in the history of recycling was the introduction, in 1964, of the aluminum beverage can. The aluminum can was a light, cheap, recyclable vessel that quickly became an industry standard. By the 1970s, can collecting had become commonplace, and by the 1990s, municipal recycling programs were established throughout the United States and Europe.

Aluminum remains one of the most commonly recycled materials in the world, and scrap aluminum has become a globally traded commodity. Although prices for aluminum are notoriously volatile, the recycling industry has grown consistently since the 1960s.

Economists and environmentalists alike celebrate the reductions in environmental impact and energy consumption that come from recycling aluminum instead of refining it from bauxite ore, but aluminum recycling also can have negative impacts on the environment and human health. As in mining, these impacts are not evenly distributed across the population.

Consider the example of Chicago, where residents of the low-income and largely African American neighborhoods located near aluminum smelting plants complain that local air quality has diminished. They point out that rates of asthma are higher in their neighborhoods than in others. Furthermore, the dominance of for-profit waste management firms in the recycling industry has meant that most of the economic benefits of aluminum recycling go to companies, rather than to people in the Chicago communities where homes and apartments are surrounded by can drops, aluminum smelters, and landfills. Chicago's recycling business has expanded over the past few decades, but low-income families still tend to bear the health burdens of recycling. Occupational hazards related to aluminum recycling include exposure to particulates and toxic fumes from plants and chronic and acute injury from sorting, hauling, and casting.

Informal and Alternative Uses

Around the globe, a robust informal economy for salvaged aluminum exists parallel to the industrial recycling industry. Scavengers and trash pickers recover aluminum in the form of cans, siding, wiring, alloy wheels, and other automobile parts, selling by the pound or kilogram to large brokers, who in turn sell in bulk to international traders. Since they deal in small quantities, informal scavengers frequently bear the economic impact of aluminum's price volatility. For example, many small-scale dealers and traders lost their livelihoods when aluminum prices plummeted after the 2008 global financial crisis.

An alternative to market-based aluminum recycling is artisanal recycling in which sculptors and cottage industrialists produce new items from found or purchased scrap aluminum. Aluminum's low melting point makes it an ideal metal for home foundries. Using homemade furnaces, artisanal recyclers design and build decorative and functional artwork, household utensils, and hardware.

Perhaps more than any other periodic element, aluminum encapsulates the promises and pitfalls of an age in which lightweight metals seem indispensable and when generalized concern with the problem of waste has led to the embrace of recycling. Aluminum's global circulation, moving from consumer products to dumps and back again, makes it a material bridge between poor and rich around the world.

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See Also: Illinois; Mineral Waste; Packaging and Product Containers; Recyclable Products; Recycling; Street Scavenging and Trash Picking.

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Anaerobic Digestion

Anaerobic digestion (AD) is a form of waste treatment that involves the controlled decomposition of biodegradable and organic wastes. The main outputs of AD are methane, which is considered a renewable form of energy, and a possible fertilizer rich in nitrogen, known as "digestate." Consequently, AD has played a significant role throughout the world as an alternative to the open dump, modern landfill, or incinerator, all of which represent waste treatment systems with considerably greater environmental risks. More recently, European and American governments have developed policy initiatives to promote AD as both a replacement for landfills and a possible solution to global climate change. But there are differences of opinion concerning how AD is best designed and implemented, which ultimately reflect different ideologies of sustainable development.

Digestion Process

AD is also the name of the process of biological decomposition that occurs outside the presence of oxygen due to the activity of microorganisms. There are four stages to the process, as complex organic polymers are gradually broken down into their basic constituents; they include hydrolysis, acidogenesis, acetogenesis, and methanogenesis. Though this process occurs naturally, it is actually rather sensitive. It is ideal for anaerobic digestion to occur within landfills in order to increase decomposition and ultimately create more capacity, but there need to be sufficient conditions to promote microbe colonies, including the right pH, a digestible substrate, and an adequate temperature. Increasingly, landfills are tapped for their biogas, which also contains methane, albeit in smaller proportions than in naturally occurring biogas. However, landfills are not designed to provide easy access to the waste they contain. In this way, they resemble the simplest form of anaerobic digester, a batch system. In these contexts, waste material is sealed off and breaks down undisturbed. Other digesters are designed to promote more control over the process, although this is difficult to achieve.

Steel anaerobic digestion towers in Germany. The Clement plant, built in 1976, processes over 400 million cubic meters of purified wastewater per year. Heavy rain and floods risk the discharge of untreated wastewater into the Rhine, as occurred in 1981 and 1995.

Digesters can be designed in a variety of ways, depending on how the process is maintained, at what temperature it occurs, and the kind of feedstock it is meant for. When digesters are developed independently from landfills—typically contained within steel, cylindrical vessels—they can be harnessed continually and predictably. The benefit of continual mixing is better gas production in addition to the ability to add material to alter the pH to a more optimal level; for example, adding basic compounds to lower acidity. Similar advantages come from heating digesters, so that the microorganisms that power them are the more efficient thermophilic variety, rather than mesophilic. Overall, the digestion process must sustain a relative chemical balance between stages of fermentation so that none of the microbes overwhelm the others. One common problem involves the overproduction of volatile fatty acids, or VFAs, which are the product of the acidogenesis stage and can disrupt the pH necessary to maintain later stages. One way of dealing with such complications is through a multistage digester, which allows for a more sustained, controlled process by separating the four stages into particular tanks, each corresponding to the microbial populations involved in the process.

Uses

The inputs to AD are divided into three categories: high solids that are dry, high solids that are wet, and low solids. Of the three, high-solid feedstocks that are wet require considerably more energy to transport and process. Some of the earliest AD plants

were used for sewage treatment in 19th-century England and India. Development organizations and aid workers have helped to promote the spread of basic AD techniques in rural areas of China, India, and other developing countries. In these contexts, AD is used primarily on farms, enabling households to make more productive and sanitary use of their animal wastes while providing a free source of fuel for heat and cooking. On an industrial scale, farmers increasingly turn to AD if they are "going organic" or simply attempting to reduce their reliance on the purchase of expensive, fossil-fuel-based fertilizers and energy sources. After the energy crisis of the 1970s, people returned to AD as a possible method of conserving and producing energy with wastes within and beyond the farm.

In the 21st century, AD has received increasing government support in the United States, Europe, and elsewhere as a sustainable alternative to more established waste disposal methods. In Germany, for example, AD has been promoted on a large scale through feed-in tariff programs, which guarantee developers a premium price for their energy. Controversially, these digesters typically codigest biological wastes with energy crops, such as corn, which are grown expressly to serve as catalysts for the digestion process and improve energy production overall. AD has been preferred, in particular, as a means of addressing directives from the European Union that require biodegradable waste materials to be diverted from landfills in proportionally greater amounts, leading ideally to a zero waste future. Food and green wastes, in particular, have been targeted as potential inputs for municipally run AD facilities. It is up for debate, however, to what extent large, centralized AD facilities can remain sustainable if they are drawing wastes from farther and farther distances and, presumably, requiring more fossil fuels to do so. Similar questions can be raised about whether electricity or heat is the more efficient application of AD-derived methane. As models of AD as a system of energy production draw more interest and investment, furthermore, smaller-scale, farm-based models may lose favor among regulators.

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See Also: Landfills, Modern; Methane; Microorganisms.

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Appliances, Kitchen

The consumer durable goods used every day in food processing, preparation, and storage may often go overlooked in the story of waste and garbage. They often outlast their owners, transferring hand to hand several times over their life cycle. In many cases, it is not known how long they can last, given that working exemplars of several species have passed the century mark. However, in most cases, they are a central node in the production of waste at the household level.

Status

The abandoned, deadly refrigerator waiting in the dump to lure the unwary child is a familiar trope of urban legend. In fact, nearly 400 children died in old-style refrigerators, with mechanical latches, from roughly 1946 to 1984. This occurred despite legislation, community action, and the introduction of a technology (magnetic strips) designed to prevent the problem. The reason children continued to die in cast-off refrigerators and freezers for a quarter century after federal legislation was passed in 1956 is because of the unique status of kitchen appliances among waste items—in a very disposable society, they tend to last a very long time.

Kitchen appliances occupy a nebulous status between furniture and infrastructure, which is reflected in the variance of laws concerning occupancy of property and the rental or sales agreements accompanying transfer of property. They fall under the title of "amenities" and, often, landlords

are not required to supply them, but are required to maintain them if present. This could mean that a 60-year-old stove is still in regular usage. When selling a home, the picture becomes even less clear, and appliance disposal or provision is dominated more by cultural convention and maintaining goodwill than by law. At times, sellers who wish to retain their appliances when they transfer the property are encouraged to write them into an exclusion rider just in case of controversy. Appliances, and the disposal thereof, can change status when affixed to real property; thus built-in appliances are generally considered fixtures and belong with the house during transfer, while a refrigerator that one simply unplugs remains personal property and leaves with the departing resident.

A good example of the limbo-like state many kitchen appliances inhabit is given by the garbage disposal, an item which, while an add-on to the basic utility of a sink, is nonetheless unlikely to be transferred from one home to another. It is a key player in the processing of food remains into waste, and it is also a controversial partner with sewage lines in the removal of waste from the home. The disposal of too much grease can clog the lines, while grinding bones or corn husks and other tough materials can render it inoperable. The use of potable water to transport food waste out of the household has been interpreted as a waste of a resource and as a possible danger to old, overwhelmed wastewater treatment plants. Many green information sources stress the alternative of composting or simply sending food waste to landfills via regular trash pickup. In these scenarios, the decomposing food wastes can be returned to utility; in the first through fertilizing household soil, and in the second as a possible source for biogas.

Life Cycles

In any given kitchen, there can be a mix of appliances from various periods, all with distinct life cycles. There are about 600 million appliances in existence, and the Association of Home Appliances Manufacturers states that a majority of them are not disposed of by their original owners, but are sold, traded in, left behind in a move, or given away two or three times over. According to the trade group, the actual lifetime of many appliances is difficult to estimate, but it can easily be 10–20 years, and maybe twice that. "Ask Heloise" is a newspaper and online helpful household hints column, and Heloise ran a contest for the oldest working appliance. The results were that among smaller appliances, like toasters and clothes irons, some were still working after 100 years! Larger categories included gas stoves from 1924 to 1929 that were still in use and a refrigerator from 1929 that was still in working order. A. P. Wagner, an appliance repair company that has been in business since 1928, held a video contest for oldest refrigerator, and the winner had a working ice box from the early 1900s, while a runner-up had a 1918 Kelvinator mechanical refrigerator converted from an ice box and still housed within the wooden cabinetry.

Hazardous Materials

One aspect many appliances have in common with respect to disposal is that they contain materials classified as hazardous waste. Older refrigerators contain chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFCs), both of which are ozone depleters and contribute to greenhouse gases and climate change. According to the Environmental Protection Agency, any refrigerator manufactured prior to 1995 contains CFCs in the refrigerant, and until 2005, they were manufactured using a foam containing HCFCs. Any appliance with switches and relays made before 2000 may contain mercury, and there are also polychlorinated biphenyls (PCBs) to be considered. Unfortunately, with respect to disposal, there are no perfect choices, as resale just transfers the problem to consumers and societies less able to bear the burden of expensive energy consumption and proper disposal. Recycling recovers many of the components, but in the process they generally release the foams containing HCFCs. Finally, simple disposal leaves them intact and nonbiodegradable, complete with dangerous components, in landfills.

Luckily, many working kitchen appliances buck the need for novelty to become cherished hand-me-downs. Nostalgia for their style can inspire retro recreations, like the Waring 60th Anniversary blender in chrome or the 1950s Easter-egg pastels of the KitchenAid mixer. This call and response of design across the decades helps to add luster to

the concept of heirloom kitchen appliances, further ensuring their survival in homes. It also helps that the mechanics and design have changed little; KitchenAid attachments from the early 20th century still fit models from 100 years later. Being able to use a grandmother's kitchen appliance can also be a connection to the past, reaffirming foodways and family histories.

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See Also: Consumerism; Culture, Values, and Garbage; Home Appliances; Recycled Content.

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Archaeological Techniques, Modern Day

Archaeology is the study of past human behavior through the objects and sites left behind by ancient people. Archaeologists use a variety of techniques to study artifacts, the contexts in which they are found, and even the landscape itself.

Archaeology is most commonly associated with excavation. In ancient times, people often utilized parts of existing buildings for new construction so that a site would build up over time. Plant growth and windblown soil also would cover the underlying remains. Excavation is the process of removing those layers of accumulated soil and fallen debris to reveal sequences of ancient activity areas.

Tools and Techniques

Excavation tools include not only small handheld trowels and dental picks, but also backhoes and heavy equipment that—in skilled hands—can be very effective in removing tons of overlying debris. Three-dimensional recording of excavated features is achieved through electronic theodolites (also known as total stations) or global-positioning systems (GPS). Researchers frequently integrate these field measurements with Geographic Information Systems (GIS) to build databases of artifacts and their contexts.

Large-scale excavations are time consuming and generally expensive to carry out, so other techniques have been developed for assessing a site's age and contents. These include coring, which involves drilling a narrow-diameter shaft to recover a sample of an ancient site's layers, and "shovel-testing" in which archaeologists scoop up representative samples from the upper layers of a site.

Systematic reconnaissance techniques enable excavated areas to be placed into the larger landscape context. Pedestrian survey is a method in which teams of people walk over terrain to identify artifacts and features that are still visible on the ground. Buried remains also can be found through a variety of remote sensing techniques, including magnetic gradiometry, electrical resistivity, and ground-penetrating radar. Other advanced approaches include the use of satellite data to detect buried remains. The use of older, declassified military images, such as CORONA, can be particularly valuable for parts of the world where population growth or warfare has resulted in logistical constraints on site access.

Data and Analysis

Archaeological data management includes the recording of many types of information, from artifact types to landscape conditions. Pottery and stone tools are classified and organized in ways that will help them be compared with similar materials from neighboring sites to understand patterns of human activity over time. Ancient remains are dated by a variety of techniques. Radiocarbon dating is suitable for organic materials that are less than 50,000 years old, while dendrochronology is utilized to assess the age of wooden beams through the study of the patterns of tree rings. There are also techniques that measure changes in object energy over time, such as thermoluminescence for baked-clay objects and optically stimulated luminescence for sediments.

Studies of ancient food remains provide information about changes in human relationships to the

environment, including the adoption of agriculture starting 10,000–12,000 years ago. Plant remains, such as seeds, often are preserved by charring in ancient cooking fires. These and other small remains can be recovered through flotation, which is a technique for washing dirt to release small organic fragments that float to the surface of the water.

In addition to studying the visible portions of plants, archaeologists evaluate nearly invisible plant residues such as pollen (often preserved in lake sediments as well as in archaeological sites) and phytoliths (silicate casts of plant cells). Archaeologists also study bones and other animal remains, both those species that were eaten and those that lived in the surrounding environment. The remains of commensal animals such as mice, rats, and dogs also can reveal patterns of migration as seen in the Pacific Islands and elsewhere.

Artifacts can be subjected to laboratory techniques to learn more about ancient technology. Chemical analysis and geological sourcing can pinpoint the origins of artifacts and raw materials to provide information about ancient trade routes. Vessels sometimes hold the preserved residues of contents such as wine and dairy products. Stone tools also can preserve the residue of blood along their cutting edges as well as marks indicative of cutting fibers or bone.

High-resolution scanning electron microscopy (SEM) can show detailed traces of use-wear as well as the analysis of production, such as the laborious perforation techniques utilized to make stone beads in ancient times. Other increasingly common techniques utilized for the study of durable artifacts include X-ray diffraction, X-ray fluorescence, instrumental neutron activation analysis (INAA), and inductively coupled plasma mass spectrometry (ICP-MS). These technologies are becoming increasingly portable, which enables researchers to analyze objects on the spot instead of having to export objects from their country of origin—an advantageous system because removal of archaeological remains from their home countries can be a politically sensitive issue.

Human Remains

The study of human burials and skeletal remains provides information about both biology and society. From bones, researchers can determine the sex, age of death, and general health of each ancient individual. Skeletons also sometimes preserve markers of the manner of death, whether through violence-associated trauma or through lengthy illnesses, such as tuberculosis, which leave distinctive physical scars. The skeleton also serves as a record of lifelong processes of energy expenditure as seen in the muscle attachments on limb bones, strain on extremities, and evidence of arthritis. Farmers, porters, and those who kneeled to grind grain for long hours all had different stresses on the body.

Teeth, a particularly durable part of the skeleton, offer a wealth of information about ancient activities, diet, and health as they preserve a record of what the individual ate over the lifetime. Strontium and oxygen-isotope analysis can show whether individuals moved from the coast inland, or even from one altitude zone to another. Teeth show that the earliest food-producing people (10,000–12,000 years ago) actually had worse dental health than their predecessors.

These early farmers suffered accelerated tooth wear from ingesting grit along with their foodgrains and had an increased number of dental caries because of their starchy, plant-heavy diet. When combined with skeletal markers of age and sex, archaeologists can evaluate associated social changes such as gender differences in tasks and in access to new foods.

The study of ancient DNA from human skeletal remains is being used to address questions of ancient migrations and social relationships within groups; for example, whether women or men moved from their ancestral homes after marriage. Whole human bodies are occasionally preserved either in exceptionally wet conditions (such as bog bodies of northern Europe), in glaciers and other frozen environments (such as the Italian Bronze Age man known as Otzi), or through processes of mummification as seen in Egypt, China, and South America. However, prior to conducting research on burial populations, archaeologists should be mindful of descendant populations who may object to studies of human remains and whose wishes are legally protected through legislation such as the 1990 U.S. Native American Graves Protection and Repatriation Act.

Specialized Fields

Several specialized fields of archaeology have emerged since the 1970s. Underwater archaeology focuses on the study of ancient ships as well as docks, bridges, and other submerged human-made features. Underwater archaeologists use SCUBA gear and—when the water is very deep—robots for the recovery of ancient items. Underwater archaeology is particularly useful for understanding ancient trade routes; for example, when shipwrecks are found with intact cargoes. High-altitude archaeology is another form of specialized inquiry, which has resulted in the recovery of ancient mummies from virtually inaccessible locations in the Himalayas and the Andes.

Ethnoarchaeology consists of interviewing and observing contemporary people who practice low-tech methods of manufacturing pottery, metal objects, baskets, and other crafts. Researchers examine the whole process of craft production, including the acquisition of raw materials and the social relations of the production process. Factors of apprenticeship and gendered task specialization are an integral component of production, which can also be modeled for the past.

Archaeologists also conduct experimental replications to learn about the skills and techniques required of ancient people. Experimental archaeology includes making stone tools and using them for woodworking and butchery; replicating the early trial-and-error processes of ancient metalworking; or building structures that mimic those found in the archaeological record. Sometimes, those experimental structures are left to decay naturally so that archaeologists can observe the slow degradation that eventually produces an archaeological site, and sometimes the structures are deliberately destroyed through fire or other processes to understand how the archaeological record is physically created.

Finally, conservation is an integral part of archaeological management. Sophisticated techniques of chemical analysis are used to simultaneously study and preserve ancient wall paintings; fragile objects, such as baskets; and unstable objects, such as metals that are subject to rapid oxidation and decay once they are removed from their buried environments.

Modern archaeological techniques are useful for not only building a picture of the past but also making projections about the future. Because of the long-term relationship of humans to the environment, archaeologists are now contributing information about the history of human-induced climate change that is increasingly featured in current debates about global warming.

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See Also: Archaeology of Garbage; Dating of Garbage Deposition; Funerals/Corpses; Garbology; History of Consumption and Waste, Ancient World; Human Waste.

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Archaeology of Garbage

The field of archaeology involves the scientific study of the remains and artifacts left behind by past societies and cultures. These materials are recovered and interpreted to reconstruct the structure and behaviors of past societies. Contemporary archaeology is a subfield of archaeological research that focuses on current society or the very recent past. The archaeology of garbage, or "garbology," as it has become known, involves literally applying archaeological methods to analyzing modern society's waste.

Why Study Garbage?

Archaeologists have realized the value in studying refuse for decades. When uncovering information about a vanished society, especially one with few material goods, the garbage mounds, middens, or refuse pits often offer the richest information about the people who made them. The garbage people leave behind is not only proof humans once occupied a space but it also provides unbiased factual data on how people lived: what they ate, what they

made, and how they acted. When reconstructing past civilizations, archaeologists often rely on subjective writings and records left behind. Carvings on temples and tombs glorify leaders and speak to how they want to be remembered (not necessarily how they actually behaved). Contemporary anthropologists and ethnographers often rely on recent interviews, surveys, and observations to analyze contemporary behavior. Unfortunately, human memory is unreliable. People tend to remember things the way they wish to, consciously or unconsciously applying personal bias to what is recorded. When surveyed about household behavior, individuals may overestimate good behaviors (such as eating vegetables) and underreport bad behaviors (such as drinking alcohol). There may also be a desire to please the person conducting the interview. Subjects may give the answers they think the interviewer is looking for, rather than answering factually.

History of Garbage Studies (Garbology)

There have been a number of attempts to systematically study contemporary garbage to answer specific questions. In the earliest decades of the 20th century, two civil engineers, Rudolph Hering and Samuel Greeley, evaluated the trash management methods used in a number of cities. They gathered enough information to publish *Collection and Disposal of Municipal Refuse* in 1921, the first known textbook about urban waste management.

During World War I, the War Food Administration collected data on food discarded across the United States. Researchers found that households threw away almost 30 percent of the food acquired for the home in 1918. In comparison, 21st-century citizens throw away less than 15 percent. The decrease is assumed to be related to the technology available for packaging and storing food to reduce spoilage.

The military also dabbled in garbology in 1941. Two enlisted men surveyed new recruits about U.S. Army life. They had to stop because it was against regulations to survey military personnel. They had already heard many complaints about the food, so they stationed observers in mess halls to record what the men threw away. After 2.4 million meals were observed, it was calculated that 20 percent of the food served was discarded. The report these soldiers generated listed many findings, from favored and not-so-favored foods to the simple observation that portions were simply too large. After the U.S. Army implemented a number of the suggestions made in the report, it saved about 2.5 million pounds of food per day.

A Peeping Tom version of garbology evolved in the 1970s. A. J. Weberman, a journalist fascinated with Bob Dylan, started ransacking his garbage cans and writing articles about what Dylan discarded. Weberman demonstrated once again that people say one thing while doing another. Dylan always said he had no interest in fan magazines, yet Weberman found many in his trash. He conducted similar raids on other celebrities, including Muhammad Ali, Neil Simon, and Abbie Hoffman, publishing exposés on his findings. Other reporters have followed Weberman's example by stealing garbage from the curbs of celebrities and politicians. Similar invasions of privacy still happen in the 21st century.

Another form of garbology is used in law enforcement. The Federal Bureau of Investigation and other police agencies have been known to delve into the discards of individuals suspected of illegal activity, often finding the proof needed to make an arrest. While these activities loosely fit the definition of garbology, they are conducted to stir up scandal and controversy or to find information on a specific individual. There is no application of the scientific process, and the data gathered are not used to analyze the behavior of the population as a whole.

Archaeologists, on the other hand, are not interested in the contents of the trash of one particular household. The true archaeology of garbage uses archaeological methodology to link artifacts (the garbage) to patterns of behavior in modern society. The seeds of this field were planted in 1971 when students in the archaeology program at the University of Arizona conducted small-scale research studies as class projects to evaluate common stereotypes versus reality. They collected the garbage from homes in the wealthy part of town and from a poor neighborhood to compare food consumed, household products used, and educational materials purchased. The study was too small to be valid as research, but the effort was promising. The idea that analyzing garbage would unobtrusively and objectively measure behavior was born. Similar

projects followed, and, in 1973, the "Garbage Project" was officially under way.

The Garbage Project

In 1973, the archaeology department of the University of Arizona launched an in-depth study of modern society by analyzing the garbage of contemporary Tucson, Arizona. This Garbage Project was conceived by William L. Rathje, a Harvard-trained archaeologist who originally specialized in the Classic Maya. Rathje was dissatisfied with the research techniques applied to modern society. Cultural anthropologists and ethnographers frequently rely on interviews, observations, and questionnaires with members of the target population. Interviewees are very aware that they are being examined and may not answer completely truthfully. Traditional archaeologists primarily focus on societies that cannot be observed directly. As a result, they have developed methods to study the behaviors and attitudes of people that are long gone by carefully analyzing physical materials left behind and using them to interpret past practices. Rathje decided that these archaeological methods and theories could also be applied to modern society. He entered into an agreement with the Sanitation Department of the City of Tucson to deliver several randomly selected pickups from specific census tracts to a sorting area at a maintenance yard.

The Garbage Project, a prime example of ethnoarchaeological research, has been running continually since 1973 and has expanded from the analysis of the garbage of select households "fresh from the sanitation truck" to excavating samples from landfills across the country. Hundreds of (fully inoculated) students over the years have sorted more than two million pieces of garbage into about 150 categories of data that are recorded on computer forms and saved in a database. To protect the privacy of individuals, elaborate safeguards are employed to assure the public that the information is completely anonymous. All student workers sign a pledge to not look at or save personal items, and a senior supervisor is present at all sorting. Personal data, including paperwork or photos, are never recorded or analyzed. The sanitation department foreman responsible for delivering the sample to the processing area is not allowed to be present when the bags are opened and does not have access to the database. As soon as the contents are recorded, any aluminum found is recycled and the rest of the garbage is returned to a landfill.

The tremendous accumulation of data gathered over three decades has had a number of practical applications. A good example was demonstrated in the early years of the project. A primary research interest of the garbologists involved analyzing the behaviors leading to food waste. In 1973, there was a widespread beef shortage. From 1973 through 1974, beef waste was analyzed and compared to data after the shortage was over to see if the scarcity of beef led to changes in behavior. One would assume that in times where a product is scarce and expensive, there would be less waste, but the researchers found the exact opposite to be true. The results showed that in average years, beef waste accounted for 3 percent of all beef purchased, but during the shortage, beef waste jumped to 9 percent. A hypothesis was suggested that when individuals were confronted with a shortage, they went overboard to stockpile beef, purchasing any cuts they could afford, even if they were unfamiliar. As a result, people either bought more than they could store and eat before spoilage occurred or bought cuts they did not know how to prepare, creating more waste. This hypothesis was put to the test in 1975 with a sugar shortage. Citizens of Tucson, being close to the border, were bringing less-refined Mexican sugar home. The sugar hardened quickly, which resulted in many bricks of crystallized sugar in the trash. Other atypical forms of sweetener were also used, once again tripling the amount of sweet food waste during a time of scarcity. From studies like these, the Garbage Project developed the First Principle of Food Waste: "The more repetitive your diet—the more you eat the same things day after day—the less food you waste." Over the years, a large number of agencies and groups have approached the Garbage Project for waste disposal information to support their studies.

Garbage Collection

There are two general methods used by the Garbage Project to collect their data. The methodology and duration is determined by the nature of the project.

The first is called a "regular sort." Neighborhoods are divided into groups based on selected criteria: anything from family size to census tract to economic level. The Garbage Project arranges to have the refuse from randomly selected households within the group delivered to the sorting area. The data collected in this way can be used to compare different types of households or be used to get a snapshot of all garbage disposal patterns across the population. The regular sort of garbage can give clear information on a broad topic (like whether total food waste increases over time) or can be used to look at very specific cultural behaviors, such as alcohol consumption, condom use, or correct birth control use. Garbage does not lie.

The second methodology combines the regular sort with self-reports from the individuals being studied. This matched study method requires the agreement of everyone in the household. Despite assurances that all information is kept confidential, it is difficult to find households that will agree to keep a log of everything they throw away that can be compared to the actual refuse. A personal interview is also used in the matched study in which most people refuse to participate. Few of these studies have been done, but certain quirks remain consistent. What people say they discard rarely is even close to what is actually in their garbage bags. Unhealthy snacks and processed meats are repeatedly underreported, and, conversely, produce, dairy products, and high-fiber cereal are overreported. Over and over again, Garbage Project studies illustrate how the average person in the United States is completely unaware of their actual consumption and waste. It is possible that any government agency conducting a study based solely on surveys or interviews will be using fundamentally unsound data.

The Garbage Project does not limit itself to observing food product waste. In the late 1980s, regular sorts were conducted in Louisiana, Arizona, and California to evaluate the disposal of hazardous household waste. It was found that these materials made up about 1 percent of household garbage. This figure does not seem like much until it is multiplied by an 88,000 household community, resulting in almost 65,000 pounds of toxic chemicals being shipped off to the local landfill annually. While this percentage stayed the same across the board, the content of the hazardous waste varied by the socioeconomic status of the neighborhoods evaluated. Low-income households discarded mostly car maintenance fluids, middle-class homes disposed of home improvement products like paints and varnishes, and wealthy households primarily removed pesticides and herbicides.

Landfill Excavations

Shortly after World War II, the sanitary landfill became the most popular way to dispose of garbage in the United States. Previous generations relied on incinerators to burn refuse or open dumps where garbage was piled and left to contaminate the air and land. A sanitary landfill is one where garbage is piled and compressed, then covered with several inches of soil or some other inert material nightly to reduce problems with odor or pests. The Garbage Project began excavating landfills for two reasons. The first was to see if the data being gathered from sanitation trucks could be matched, or cross-validated, by samples collected from municipal landfills. The second was to determine exactly what happens to garbage over time after it is deposited. The Garbage Project to date has excavated in 15 landfills across the United States and Canada, analyzing about 12 metric tons of debris deposited since 1952.

Traditional archaeological techniques can be used to "excavate" a landfill. The layers, or "strata," of the site are easily dated by newspapers, magazines, and mail. Seasons are reflected in Christmas wrap, heart-shaped candy boxes, Easter candy wrappers, and other seasonal trash. Trenches up to 25 feet deep were created with backhoes, and bucket-auger wells were drilled down 100 feet for samples that were sorted and analyzed. One key component of this research was to determine what was actually there. The public has made assumptions about what is filling landfills without any measurements being taken. At different times, fast food packaging, Styrofoam (expanded polystyrene foam), disposable diapers, and plastics have been reviled in the media and blamed for the massive mounds of trash produced by society. The Garbage Project discovered that diapers, fast food containers, and Styrofoam combined comprised less than 3 percent

of the content of the landfills. Plastics made up less than one-quarter of the contents. Building and construction debris claimed another 20–30 percent. By far, the largest and fastest-growing component is actually paper and paper products. While greater quantities of plastic are being discarded, the process of light weighting (making the same size container with less product) has kept the total volume of plastic from increasing. Despite the commitment to local recycling programs, the amount of paper found in landfills is rising. Packaging, phone books, magazines, catalogs, junk mail, and more are inundating the garbage.

Another myth commonly held about landfills is that the contents will biodegrade like a giant compost heap. Biodegredation does occur, but at a much slower rate than expected. A compost heap in a backyard works well because the materials are chopped up, water is added, and the pile is regularly churned up and turned over. This process does not occur in landfills. Materials are dumped, fluids are usually prohibited, and the garbage is regularly compacted so oxygen cannot reach the materials to begin the degradation process. Fifteen-year-old newspapers have been found that can still be read. The best way to reduce the amount of waste in landfills is to put less in them by reducing waste at the source—homes. A commitment to recycling and reuse programs would also be a pragmatic way to reduce garbage.

Garbology Applications

The archaeology of garbage has a number of useful applications. Excavations at landfills across the country by members of the Garbage Project have illustrated how little is known about what is actually discarded. These digs have had an impact on the perceptions of the public and on policy planners.

Various government agencies contract with the Garbage Project for information on U.S. citizens. Documented evidence on diet and nutrition, food consumption and waste, recycling, and the disposal of household materials will continue to be critical in the development of public policies.

Landfill archaeology can be used to measure the effects of these public policies after they are put in place. For example, to find out if a new recycling program established in a city reduces the amount of waste in its landfill. These research techniques could also be used to trace pollutants back to their source in the landfill and eventually back to the point of discard.

Garbology is used in the 21st century by scientists evaluating new processes for municipal waste management. A steadily growing population is generating an increasing amount of waste, despite the existence of recycling programs.

Decomposition in landfills generates methane gas, which has to be vented. Studies are being conducted to use this methane production to generate electricity.

Civilizations tend to cycle from a simple, efficient use of resources to a period of economic vitality and conspicuous consumption before returning to a "recycle and reuse" mentality. The United States is entrenched in that vital phase, and it has the mountains of trash to prove it. At the same time, the country has never had such a variety of resources and technology at its disposal to manage the waste stream. Rathje and Cullen Murphy have a number of suggestions to keep in mind:

- Americans have problems with garbage, but do not think of it as a crisis. Communities should steadily continue to make improvements to their waste management efforts, but nothing drastic.
- Be willing to pay for proper garbage disposal. The cheapest way to get garbage out of sight may not be the best option.
- Look at the big picture. Diapers and fast food packaging have taken big hits in the media, but the Garbage Project has proven that more than half of landfill waste is actually paper products and construction/demolition debris. Radically changing how these two categories of waste are handled will have a great impact on landfills.
- Modest attention to household behavior by average citizens will have a great impact. Rather than dealing with garbage after it is thrown away, individuals could easily put a little more effort into recycling and reusing products before they enter the waste stream. Deliberately purchasing goods made with recycled materials or things in recycled packaging would give a great boost to a growing industry.

The archaeology of garbage has proven that there is a great disparity between what people say they do and what they actually do. Widespread misconceptions about what is thrown out, the biodegradation of waste, recycling in communities, and other aspects of waste management have been clearly illustrated by the Garbage Project and its contemporaries. Researchers now have the knowledge and a great opportunity to use this information to improve society by raising awareness and increasing effectiveness in managing the waste stream.

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See Also: Archaeological Techniques, Modern Day; Archaeology of Modern Landfills; Construction and Demolition Waste; Garbology; Landfills, Modern; Paper and Landfills; Sociology of Waste.

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Archaeology of Modern Landfills

Archaeologists have long studied garbage (the remains of past societies) in order to both develop theories of behavior and gain overall insight into past cultures. The archaeology of modern landfills emerged from a desire to find out what was behind the media's portrayal of the "garbage crisis" faced by Americans and out of a curiosity about modern material culture. Defined broadly, material culture includes physical things modified by human behavior. Examples include plowed fields, polluted rivers, and modern landfills. In essence, the archaeology of landfills is the "archaeology of us." Studying contemporary garbage can provide useful insights into current behaviors that can be useful in the present. Learning about what society does now enables people to make changes in behavior now, instead of in the years to come.

The archaeology of landfills stems from the work of behavioral archaeologists. Specifically, the Garbage Project at the University of Arizona spent decades studying the garbage in modern landfills. Garbology (the study of trash and human societies) is carried out by garbologists—archaeologists who examine trash. This branch of archaeology posits that archaeology is the study of the relationships between human behavior and material culture. As such, behavioral archaeology is able to challenge societal myths about consumption patterns. The archaeology of modern landfills has led to myriad

Behavioral archaeologists study the contents of modern landfills to reveal societal practices regarding food waste and consumption. These discoveries can lead to more rapid implementation of practical changes in behavior rather than waiting years for habits to evolve. The Garbage Project has dispelled numerous misconceptions about landfill use that can help individuals and policymakers make better decisions about waste. For example, disposable diapers do not make up a significant percentage of landfill trash, as is commonly believed.

insights as well as the ability to debunk many modern garbage myths about what occurs in, and what makes up, landfill content. For example, the excavation of landfills has shown what the true composition of landfills is, and that organic matter does not decompose and biodegrade as many people believed it did. Important findings were discovered about food waste and consumption patterns and the accumulation of paper and construction debris in landfills.

Landfill Excavation

In 1987, the Garbage Project began excavating landfills throughout the United States and Canada. During these excavations, almost 30,000 pounds of garbage was removed, sorted, and analyzed. The process involved the use of auger machines that could dig down to 100 feet and remove undisturbed units of trash. Fully intact newspapers were used for dating the trash.

The excavation of landfills led to several insights regarding popular garbage myths and misconceptions. Among them were the myths of biodegradation, the realization of the myth of what landfills are actually composed of, and the misconception that society is running out of room for landfills. For example, while it is a popular notion that trash biodegrades inside landfills, in actuality most trash remains well preserved, even after decades of being buried. The main reasons for this are the lack of both oxygen and moisture inside landfills. The process of adding trash to landfills creates an environment that is not conducive to the breakdown of organic matter. When new material is added to a landfill, it is tightly compacted and covered with a layer of dirt. This process creates the

ideal environment for garbologists to gather well-preserved trash, but not the conditions required for decomposition.

The idea that society is running out of landfill space has been prevalent since the late 1800s, but remains unfounded. Throughout the United States, there are plenty of open spaces that could accommodate new landfills. While there are certain areas with landfill shortages, this may be more a function of landfills getting bigger and bigger, but with fewer and fewer of them opening up as needed. This may, in part, be due to environmental justice advocacy in which Not In My Backyard (NIMBY) protesters oppose garbage dumps in their communities. A concern with this idea is that existing problematic landfills may receive less attention than new, well-planned landfills.

The excavation of modern landfills began, in part, as an attempt to find out if the popular media representations of the garbage situation were accurate. Archaeologists wanted to get an idea of the actual volume taken up by various kinds of garbage. For decades, citizens had been told that they were about to be buried by their trash. Garbologists wanted to find out if public opinion and media representation were accurate depictions of the reality of the garbage situation. Their findings led to some similarities with national estimates, but many findings were surprising. One was the low volume of items the public believed to be the most problematic, including disposable diapers, fast food containers, and plastics. The other surprise was the large volume of paper and construction and demolition debris found in landfills.

Landfill Composition

Surveys reveal that most Americans are concerned about the amounts of fast food packaging, polystyrene foam (Styrofoam), and diapers that are thrown away. Survey respondents believed that about 75 percent of landfill volume consisted of these three items. Garbage Project results found that, in actuality, fast food packaging, polystyrene, and diapers account for only about 3 percent of landfill volume. National estimates of landfill composition do not include construction and demolition debris, which, surprisingly, accounted for as much as 28 percent of the volume of mixed refuse according to Garbage Project calculations. These findings provided useful information that could be used as a basis for policy development as well as insights into the inaccurate imagination society has regarding its garbage behavior and the actual makeup of landfills.

The Garbage Project compared a poll of what people think is in landfills and data from landfill excavations. The results show the large discrepancies between the mental and material realities of what goes into landfills. For example, the survey indicated that people heavily overestimated the volume of disposable diapers (estimate: 41 percent; actual: <2 percent), plastic bottles (estimate: 29 percent; actual: <1 percent), and large appliances (estimate: 24 percent; actual: <2 percent) while they underestimated paper (estimate: 6 percent; actual: >40 percent), food and yard waste (estimate: 3 percent; actual: ~7 percent), and construction debris (estimate: 0 percent; actual: ~12 percent). These huge discrepancies between perceptions and reality can lead to policies and actions that are inappropriate or inadequate to address the actual nature of the behaviors leading to the garbage predicament.

Paper contributes to a large percentage of landfill space, but its impact is highly underestimated by the general public. Even with extensive recycling efforts, paper still makes up a large segment of landfill volume. The Garbage Project describes paper as the "invisible man" in landfills, with volumes increasing more rapidly than plastics, which people tend to think of as more of a problem than paper.

Plastics remain an issue of confusion for the general public because of the change in the production of plastics over the years. Lightweighting is a process by which the characteristics of plastics are maintained, but fewer resins are needed for the final product. Once these lightweighted plastics are crushed, they take up minimal volume in landfills. This translates into more pieces of plastic being added to landfills, but at a consistent volume to those in the past. While the number of plastic items has increased considerably since the 1970s, the amount of space taken up by plastics has remained constant.

Social Contexts and Implications

Garbage Project landfill excavations led to a call for a "two realities" approach to studying the

relationship between behavioral-material patterns and societal self-perceptions. Such an approach, it is believed, could lead to an archaeological theory that integrates the interaction between the two. The hope is that this approach would lead to improved social policies that work as they are intended as opposed to falling victim to unrealistic expectations about behavior based on embedded and inaccurate societal self-perceptions that may serve to perpetuate behaviors, rather than reduce or eliminate them.

Several broad conclusions resulted from landfill excavations and may be useful in the development of more appropriate theory and policies based on the reality of behaviors and the perception of those behaviors. First, grand patterns of behavior can be overlooked by society, including policy makers and citizens. Social scientists, in this case archaeologists, can remove themselves from the entrenched social norms and perceptions and seek out and recognize the material realities of behavior. An example of this lies in the Parkinson's Law of Garbage. This law states that the rate of disposal increases with the size of refuse containers. Even though current waste management policies aim to reduce the amount of solid waste ending up in landfills, there has been an increase in items such as household hazardous waste ending up in landfills. The premise behind Parkinson's Law of Garbage states that garbage will expand to fill the available container. Even as policies have been implemented to reduce municipal solid waste (MSW), the container sizes available for trash have increased.

These contradictory messages may actually lead to an increase in MSW being landfilled as opposed to reduced. Second, systematic approaches to knowledge can lead to discoveries about the inaccurate self-perceptions that exist at a societal level. An example of this is the fact that construction and demolition debris are not included in national estimates on municipal solid waste. These estimates, on which many public policies are based, do not accurately depict the content of landfills. Third, it appears that there are certain conveniences that even self-proclaimed environmentalists will not do without. Among them is the disposable diaper, which according to Garbage Project findings, does not make up a significant amount of trash in landfills.

Why is it that modern culture, on the one hand, has such wild exaggerations about what is in landfills and, on the other, lacks insight into what trash is really made up of? The social, political, and economic realities of trash, what to do with it, and where to get information about the contents of garbage and landfills must be reconsidered if forward-thinking policies are to be developed that will actually help address the current garbage situation.

Major questions that emerge from landfill excavations have to do with why construction and demolition debris is excluded from national MSW estimates. With waste characterization studies being a popular source of MSW information, how can it be that such large amounts of actual landfill composition can be left out of the equation? Additionally, if paper is one of the largest categories occupying landfill space, why aren't there more or better policies and initiatives in place to reduce the amount of paper that ends up in landfills each year?

Moving forward, MSW policies may prove more effective at reducing the proportion of the waste stream that ends up in landfills each year. Landfill excavation reminds people to pay attention to where ideas come from and not assume that mainstream information is always correct. Through systematic analysis of landfills, garbologists have given society important insights into the reality of the garbage situation.

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See Also: Archaeological Techniques, Modern Day; Archaeology of Garbage; Garbage Project; Landfills, Modern; Paper and Landfills.

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Argentina

Argentina is a vast, geographically diverse country. It includes the semitropical forests in the north, the vast agricultural bounty of the Pampas, the tallest stretch of the Andes, and the frigid Tierra del Fuego at the southern tip of South America. Argentina has the eighth-largest area in the world but contains the 31st-largest population. Over 90 percent of the population is urban, with about one-third sprawled in and around the capital, Buenos Aires. At the beginning of the 20th century, Argentina was one of the richest countries in the world; at the beginning of the 21st century, it has middling economic power compared globally—its overall gross domestic product (GDP) purchasing-power parity (PPP) is ranked only a little higher than its population, at 24th. Its GDP (PPP) per capita is about 80th worldwide, at about $13,400 in 2009. Other indicators of consumption are consonant with Argentina's population, providing a further indication that Argentina is, in many ways, about average on a worldwide scale. For example, it is 31st in electricity consumption, 27th in oil use, and 19th in natural gas consumption.

Brief History

Argentina's political and economic history since the start of the 20th century has been tumultuous. In recent decades, a conservative military dictatorship has ceded control to democratic institutions. Much of Argentina's contemporary political organization continues the legacy of Juan Perón (1895–1974), who, as president, favored state intervention in economic activity and co-optation of mass organizations, especially unions.

Since the 1990s, and especially before the economic crisis began in late 2001, Argentinian lawmakers have adopted a variety of progressive environmental measures. Most fundamentally, the Constitution of 1994 explicitly establishes environmental sustainability as the government's responsibility. The same document prohibits the entry of hazardous or radioactive wastes.

During the 21st century, Argentina has struggled to recover from a devastating financial crisis that began in late 2001 and led to massive unemployment, manifold increases in poverty, and a quick succession of governments. One way of examining the economic fortunes of Argentina is through garbage. Each day, Argentinians discarded on average about 0.9 kilograms (kg.) per person in 2000 and 2004–2005 (similar to the averages for Poland and Chile). However, in 2002, this figure fell to 0.67 kg and then rose to 0.8 kg in 2003, as the crisis provoked Argentinians into consuming less and increasing their efficiency with what they did consume. As a result of the global financial crisis of 2009, a similar drop-off occurred, to 0.86 kg.

Cultural Consumption

In addition to soccer, the tango, and gauchos, beef and *yerba mate* (a drink made from steeping leaves in hot water) are essential elements of a traditional Argentinian identity. Consumption of these two items is nearly ubiquitous. Over 90 percent of Argentine households consume yerba mate. Most of the concern regarding mate focuses on its consumption. Waste from its production has not provoked large-scale environmental concerns beyond those generally applicable to agriculture, such as the runoff of pesticides. Its consumption usually yields a relatively light amount of waste, as it typically involves reusable and shared items, such as kettles or even larger containers of hot water, along with a gourd and metal straw for drinking. Some evidence suggests that mate can cause serious health problems, but other lines of evidence point to its health benefits.

Argentina had been the long-running world leader in beef consumption, surpassed by Uruguay in 2010. Argentinians still far outstrip any other heavy consumers, such as the U.S. population. Overall rates of consumption in Argentina vary mostly because of fluctuations in cost rather than concerns about beef's effects on health or about the environmental effects of beef production. These effects in terms of waste are quite high, as beef production represents, in terms of gallons per pound, perhaps the most inefficient use of water of any major food; likewise, it arguably results in the greatest release of greenhouse gas emissions of any major food.

Greenhouse Gas Emissions

Argentina has garnered attention for its commitment to reducing greenhouse gas emissions. It is a non–Annex I signatory to the Kyoto Protocol, meaning

that it can host Clean Development Mechanism projects and that it is not required to reduce its emissions. Nonetheless, in 1999, Argentina offered to voluntarily specify a legally binding limit on its emissions within the framework of the protocol. It proposed using a relatively stringent formula for calculating carbon intensity, which would allow its emissions to rise only slightly as overall GDP rose. However, some other developing countries opposed Argentina's proposal for fear that it would become a standard, and Argentina's economic collapse and political turmoil in the early 2000s, which actually caused its energy intensity to rise as its GDP dropped, caused it to withdraw this proposal. Renewable sources supply only about 1.5 percent of Argentina's electricity and about 7.5 percent of its total energy; both figures represent a decline compared to 2000.

Recycling

The financial crisis led to the precipitous expansion of *cartoneros* (Argentinians who filter and recycle other people's garbage). The root of this term is *cartón*, or "cardboard," one of the materials they collect. In Buenos Aires, perhaps as many as 40,000 people at one point—many of them newly unemployed because of the financial crisis that began in late 2001—stream into the city at night to pick recyclable materials out of garbage set out for officially designated collectors to retrieve. They then sell these materials to middlemen or directly to recycling plants. This process has become increasingly institutionalized. One early development was the provision of overnight train service between the city to its poorer outskirts, dedicated to cartoneros. One neighborhood in the city has worked with a cooperative of cartoneros to separate recyclables before the cartoneros arrive. The local government, as part of its implementation of an ambitious plan to reduce landfill deposits, has adopted aspects of this experience as it plans to further recognize and regulate cartoneros. The city is providing incentives for cartoneros to join cooperatives of collectors, giving them semiofficial status; new sorting centers might employ others.

The massive number of cartoneros in Buenos Aires has drawn considerable attention, but analogous phenomena occur in other cities. In Córdoba, the city has provided two cooperatives of cartoneros with uniforms, training, and specially designed motorized carts for transporting the recyclables to the various collection points for their loads. The city has also helped to arrange a contract with a recycling business and a secure method of payment for the collectors. Rosario's cartoneros have received permission to circulate in some areas with carts drawn by horses or humans. Some cities appear to leave cartoneros unregulated as evidenced by disputes among them over territory.

The resulting rate of recycling is difficult to determine. The federal government estimates that, nationwide, only 2.5 percent of solid waste was recycled; however, it is unclear whether this figure includes recycling performed by cartoneros before official collectors picked up garbage. Some have estimated that cartoneros recycle as much as 13 percent of the Buenos Aires' garbage. The potential exists for greater recycling. Half of the waste is organic; glass, paper, and cardboard compose almost half of the remainder.

Disposal

The largest percentage of trash ends up in modern, engineered landfills, especially in larger cities. A smaller percentage is placed in less-secure landfills. About one-fourth winds up in open dumps, especially in smaller towns and cities. As of 2009, none was incinerated, but this might change soon, although various proposals to incinerate trash have inspired considerable controversy. Few projects exist to convert trash or other waste, such as manure, into usable energy, but the great potential has generated considerable interest.

Water: Clean and Waste

Argentinians do not have universal access to running water in their homes. After considerable progress in the 1990s, rising from 66 to 78 percent of the population with connections, the 21st century has witnessed a slight dip followed by a slight rise, to an estimated 81 percent connected. The government's goal is to have 85 percent of the population connected by 2015. Access to sewage systems is more limited but growing more rapidly. As of 2010, only 55 percent of the population lives in homes with sewage connections, but this is an increase from 42 percent in 2001 and 34 percent in 1991.

A long-running dispute with Uruguay has centered on issues of waste and water quality. While political intrigue may explain part of the controversy, Argentina officially objected to the establishment of a pulp mill on Uruguay's side of the Río Uruguay, which flows between the two countries, on the grounds that the mill would pollute the river. Among other actions, Argentinians blocked a bridge over the river. The International Court of Justice eventually ruled in 2010 that Uruguay had failed to notify Argentina properly but that the plant did not present a danger. The countries then established an elaborate mechanism to monitor the river's water quality along its course, testing for pollution from either country.

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See Also: Buenos Aires, Argentina; Recycling; Street Scavenging and Trash Picking.

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Arizona

The sixth-largest and largest landlocked state by population in the United States, Arizona is one of the Four Corners states of the southwest and shares an international border with the Mexican states of Sonora and Baja California. Phoenix, the capital and largest city, has the largest metropolitan area. The Garbage Project originated in Tucson, the second-largest city. The last contiguous state to join the Union, Arizona was granted statehood in 1912, on the 50th anniversary of its recognition as a territory of the Confederate states. Arizona is notable for its desert climate, but also holds pine forest and mountain ranges in the higher north and a cooler climate in the southern deserts. The Grand Canyon and many other sites of national importance are located in Arizona, and over one-quarter of the state is Federal Trust Land, home to the Navajo Nation, Hopi tribe, Tohono O'odham, the Apache, and Yavapai tribes.

The state's population grew exponentially after World War II, in part because advances in air conditioning allowed more people to tolerate the intense heat of Arizona summers. The population was 294,353 in 1910, 1,752,122 in 1970, and 6,392,017 in 2010, with most residents clustered in the Phoenix metropolitan area. In the early 1960s, retirement communities (then a relatively new concept) appeared in the state, catering to those who wished to escape the harsh Midwest and northeast winters.

Garbage

The 16th Nationwide Survey of MSW Management in the United States found the following: in 2004, Arizona had an estimated 8,197,591 tons of municipal solid waste (MSW) generation, placing it 19th in a survey of the 50 states and the capital district. Based on the 2004 population of 6,165,689, an estimated 1.33 tons of MSW were generated per person per year (ranking joint 19th). Some 7,172,000 tons were landfilled in the state's 40 landfills; 85,000 tons of MSW were exported, and 438,000 tons were imported. In 2006, Arizona was increasing its landfill capacity—it was ranked joint 14th out of 44 respondent states for number of landfills. Only whole tires and white goods were reported as being banned from Arizona landfills. Arizona has no waste-to-energy (WTE) facility, but 1,025,591 tons of MSW were recycled, placing Arizona 24th in the ranking of recycled MSW tonnage.

Garbology

In 1973, the Tucson Garbage Project originated at the University of Arizona as *Le Projet du Garbàge*. It initiated the anthropological study of contemporary rubbish often referred to as "garbology." Although the study has since expanded beyond Arizona, the archaeology of garbage has probably been studied more intensively there than in any other state.

Early History of Waste and Disposal

For the Spanish colonial and Mexican periods, most data on garbage disposal is from archaeological research, with only a few known historical ref-

The mechanical arm of a garbage truck in Scottsdale, Arizona, picks up 320-gallon trash containers and dumps the contents into a truck nicknamed "Godzilla," in 1972. Garbage pickup was captured as part of the U.S. Environmental Protection Agency's project to document environmental concerns via photographs in the 1970s, the same decade that William Rathje's Garbage Project, which originated in Arizona, began studying the archaeology of garbage. The latter project has been studied more intensively in Arizona than in any other state.

erences. Excavation suggests that midden deposits were dumped outside the eastern gate of the Tucson Presidio and that there are refuse pits and concentrations of gardens inside the north Presidio wall near an *horno*. Field surveys of the Barrio de Tubac identified a large refuse area in the site.

The 1849 Gold Rush, the Gadsden Purchase of 1854, Mormon colonization, and the railroads in the 1870s and 1880s all added to the increasing population and urban development of Arizona during the territorial period. The railroad also increased consumption of goods by allowing greater volume, variety, and availability of products to reach Arizona. When this population increase began, urban and rural refuse disposal was completely unregulated. Dumping was commonplace in arroyos, rundown areas, disused privies or wells, and vacant or abandoned property. Rubbish was usually simply thrown into the street for roaming animals to eat. The persistence of this practice led to streets filled with excrement, trash, and animal carcasses. Outbreaks of disease and the appearance of germ theory resulted in legislation passed by the newly established town and city councils to try to control garbage disposal.

Local governments began passing ordinances to increase community safety and quality of life; sanitary ordinances were usually first. These early ordinances placed the responsibility and cost of trash disposal with the landowner or tenant for the first time, and were reinforced by penalties up to $300 and up to three months imprisonment. Tucson passed the first ordinances for controlling garbage in 1871 and 1872, which included the earliest

organized municipal trash collection, where the city marshall directed the emptying of rubbish pits every Saturday. Phoenix passed its first trash ordinances in 1881 when the city became incorporated, and soon after created the role of health officer to oversee public health. This office became common in most sizable communities, with Tombstone, then a village, gaining one in 1882. By the end of the century, however, the role was increasingly involved in infectious disease control.

Waste and Disposal in the 20th Century

Municipal government began taking more direct involvement in garbage collection and disposal in the early 1900s. This coincided with the public health director's remit becoming more focused on controlling infectious diseases, such as the influenza epidemic and tuberculosis. At this point, most incorporated population centers had ordinances in place to regulate garbage. Local government was directly involved in the removal of residential and business refuse, whether by agreement with an outside contractor or by their own dedicated department. Ordinances became more comprehensive and detailed, specifying containers for collection, separation of waste streams, and regulating garbage storage and pickup. Fees began to be charged for collection, and designated dumps appeared. Tucson opened an incinerator in the early 1930s, but (like many early incinerators) it was short-lived and was demolished in 1950. During World War II, recycling became a focus, with metal and rubber salvaged for the war effort; several metal and rubber drives took place in Tucson.

Post–World War II national environmental laws set countrywide standards for managing waste, which ceased to be under complete local control as the federal government targeted disease in the rapidly expanding population. Waste disposal sites were moved farther from populated areas, and landfills began to replace open dumping. Laws passed in the 1960s and 1970s regulated solid waste management, incineration, and discharge into waterways. The 1976 Resource Conservation and Recovery Act included the closure of all open dumps, which caused a crisis in some Arizona communities. Star Valley and Ponderosa dumps were closed by federal order but had to reopen briefly when a replacement landfill was not ready in time and illegal dumping skyrocketed. There were approximately 248 closed dumps and landfills in Arizona in 2010. The Silver Bell Golf Course in Tucson and Cave Creek Municipal Golf Course in Phoenix were both created to reuse space created by closure of old open dumps.

Water Consumption

The state's development in the desert would be impossible without extensive federal manipulation of waterways during the 20th century. Arizona's population grew substantially after President Lyndon B. Johnson signed the Colorado River Basin Project Act of 1968. That law created the Central Arizona Project, which redirected water from the Colorado River with dams and aqueducts to supply water and hydroelectric power to the growing Phoenix and Tucson areas. In the early 21st century, concerns over unsustainable water consumption patterns in the face of extended droughts led to conservation efforts throughout the state. Arizona entered into an agreement in 2007 with several other western states dependent upon the Colorado River to coordinate conservation efforts across the region, but sustainable water management remains a concern for the foreseeable future.

Garbage Archaeology

Beyond the Garbage Project, the relevance of garbage deposits to historical archaeology in general is highly appreciated in Arizonan archaeology. A key example of maximizing the value of garbage deposits is the work done at the Track Site. In the 1880s, with the Native Americans confined in the reservations, the federal government attempted a nonmilitary campaign to remove their presence by assimilating Native American children into Anglo-Saxon American lifeways. This was attempted by setting up Indian boarding schools, which set out to imprint a new identity on Native American children through education. The Track Site, a turn-of-the-century dump (use life 1891–1926) associated with the Phoenix Indian School, was excavated in the 1990s under federal government land exchange laws. Due to the size of the dump, approximately 9 percent of the deposit was sampled, yielding around 160,000 artifacts.

The methods used by the school to erode and replace Native American cultural identity were reflected in the excavated artifacts. The scale of the use of dolls to imprint socialization skills and reinforce U.S. gender stereotyping was demonstrated by the recovery of 136 fragments from 108 dolls. Indian school policy was to eradicate tribal identity by instilling a sense of the egotism of U.S. civilization, getting students to identity with "I and mine" instead of "we and ours." The success rate of this ploy is evidenced in excavated toothbrushes and combs that were meant to be marked with their owner's name, reinforcing ideas of personal rather than tribal property. Only 6 percent and 12 percent, respectively, had been marked. The marks made were often lines or dates rather than names, reflecting the survival of the Native American belief that a name is personal and not to be openly revealed.

Other artifacts symbolic of resistance included two clay objects that may be effigies and a possible fetish stone, which is bone shaped and of nonlocal geology. Items such as these were subject to confiscation by the school authorities. Shards of indigenous southwestern pottery were unexpected finds, as were knapped pieces of glass and ceramic, which showed that traditional lithic-working skills were still being practiced.

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See Also: Arizona Waste Characterization Study; Garbage Project; Garbology.

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Arizona Waste Characterization Study

The Arizona waste characterization study was conducted by archaeologist William Rathje and his team in 1973, and it was one of the first major studies in modern garbology (the archaeology of garbage). Rathje (1945–) was then a new professor at the University of Arizona and was the director of the Cozumel Archaeological Project sponsored by National Geographic. He and his students studied the waste at Tucson's local landfill from an archaeological perspective to learn what it would say about the surrounding community. Quantitative data formed pictures of consumption patterns, as information from landfills and garbage bins was compared with what was known about individual households and residents. Among early findings, it was discovered that Tucson residents discarded 10 percent of their food, and middle-class households discarded the most food. Later studies found that food waste was likely closer to a 15 percent average. Landfill analyses cannot perfectly estimate the amount of food waste, due to the use of garbage disposals, which diverts a portion of food waste to wastewater.

Discrepancies With Self-Reporting

The study also tested people's self-reported behaviors, finding that alcohol consumption was significantly higher than residents reported on questionnaires. Recycling was lower than self-reported. The repeated studies of Rathje's team have discovered some interesting trends in questionnaire accuracy; for instance, a nondrinking member of a household

is more likely to report the alcohol consumption of that household than a drinking member is, even though the drinking members would be presumed to have the most direct knowledge of it. Further, on average, female adults will overreport a household's usage of food and other goods by 10–30 percent, which Rathje calls "the good provider syndrome," reflecting an unconscious tendency on the part of mothers and housewives to assure the questioner that the household is well taken care of.

Disposal Habits

The studies have also highlighted dietary habits, such as the decline in purchases of raw red meat in the late 1980s and the tendency of eaters to trim away greater portions of fat (a decision informed by media campaigns warning of the dangers of heart disease). However, these same eaters ate greater amounts of processed red meat with less visible fat content, such as hot dogs, sausage, and salami, so that their fat intake actually stayed the same or rose. Similarly, during periods of specific food shortages, such as a beef shortage or sugar shortage, discarded amounts of the scarce food actually increase, presumably because of hoarding behavior.

The general trend with food waste seems to be that foods associated with food behavior that change little over time are the foods wasted the least: sliced bread, typically consumed frequently throughout the week, is wasted at a rate of less than 10 percent of purchased volume, which is below the average food waste level. Specialty breads, like hot dog rolls, muffins, and pita bread, are wasted at a rate of more than 35 percent. A similar principle is true of household hazardous waste: more of it is discarded when it is associated with one-off or infrequent tasks, such as reroofing or seasonal pool cleaning, than when it is part of regular periodic household maintenance.

A Marin County garbage investigation found that a household hazardous waste awareness campaign actually led to an increase in the amount of household hazardous waste being disposed of improperly, the exact opposite of its intent. The reason was that the campaign increased awareness of the hazards of certain materials, like paints and used motor oil, and households that missed the announced collection date still undertook to remove the materials from their homes using the easiest method available to them, disposing the wastes with their normal household trash. This discovery has led to Rathje's recommendation that such campaigns include and announce multiple, spaced-apart collection times for household hazardous waste.

Other Applications and Studies

The idea of using archaeological methods to study one's own modern civilization was a significant breakthrough in methodology and elicited interesting results across the board, leading to similar studies in other communities. University of Arizona teams continue to excavate landfills throughout North America. For instance, in the 1990s, their studies of 15 landfills found that the three types of items that were most commonly focuses of concern and emblematic of needless waste—grocery bags, disposable diapers, and fast food packaging—accounted for less than 2 percent of the landfill volume of the previous 10 years and that their absence would be barely noticeable if they were banned altogether.

What took up considerable volume and was rarely mentioned in public discussions of landfill issues was construction and demolition debris, which was not even included in the Environmental Protection Agency's national estimates of municipal solid waste landfills. Despite attempts to avoid this waste in its excavations because of the increased likelihood of equipment damage, the Arizona team found that construction and demolition debris accounted for at least 20 percent by volume of what it excavated.

Construction and demolition debris is thus the second-largest category of landfill material, next to paper. In most landfills, paper biodegraded very slowly and constituted the largest volume of landfill material not only in the 10-year-old landfills from the 1980s but also the 40-year-old landfills from the 1950s. By volume, nearly half of the excavated material consisted of paper products, like computer printouts, packaging paper, newspapers, magazines, and phone books. This discovery was an impetus behind the shift in the 1990s toward an emphasis on curbside recycling and the need to recycle paper products, whereas previously paper had been

treated as a more or less acceptable landfill material relative to specters like plastics and diapers.

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See Also: Archaeology of Garbage; Archaeology of Modern Landfills; Arizona; Garbology; Sociology of Waste.

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Arkansas

One of the southern states, *Arkansas* is the Algonquin name for the Quapaw Indians, an exonym adopted by European settlers. Diverse in geography, the mountainous regions of Arkansas in the Ozarks and Ouachita Mountains are part of the U.S. interior highlands. The Delta and Grand Prairie are the state's lowlands, lying along the Mississippi River, which makes up most of the eastern border. Arkansas has around 150,000 acres of wilderness areas, which are reserved for hunting, angling, hiking, and basic camping; mechanized vehicles are banned from these areas. The state is known for extreme weather, including thunderstorms, tornadoes, and high rainfall; historically, high water coming down the White River has flooded the cities in its path.

With so much open wilderness, tourism is an important part of the Arkansan economy; the official nickname "The Natural State" was coined in the 1970s. State agricultural outputs are poultry and eggs, soybeans, sorghum, cattle, cotton, rice, hogs, and milk. Industrial output includes food processing, electrical equipment, fabricated metal, machinery, paper products, bromine, and vanadium. Several global corporations have based their headquarters in northwest Arkansas since the 1970s, creating an economic boom; these include Walmart, JB Hunt, and Tyson Foods. Automobile-part manufacturing has come to eastern Arkansas to support automobile plants in neighboring states.

Waste and Landfills

The 16th Nationwide Survey of MSW Management in the United States found the following: in 2006, Arkansas had an estimated 3,468,842-tons of municipal solid waste (MSW) generation, placing it 31st in a survey of the 50 states and the capital district. Based on the 2006 population of 2,809,111, an estimated 1.23 tons of MSW were generated per person per year (ranking joint 27th); 2,900,689 tons were landfilled in the state's 62 landfills and 160,937 tons of MSW were exported; the import tonnage was not reported. In 2006, Arkansas was increasing its landfill capacity—it was ranked joint 4th out of 44 respondent states for number of landfills. Yard waste, whole tires, lead-acid batteries, and electronics were reported as banned from Arkansas landfills. Arkansas has three waste-to-energy (WTE) facilities, which processed 35,464 tons of MSW (27th out of 32 respondents), and 532,689 tons of MSW were recycled, placing Arkansas 30th in the ranking of recycled MSW tonnage.

Waste to Energy

Arkansas has been at the forefront of waste-to-energy developments, a technology championed by Governor Mike Beebe and Senator Blanche Lincoln. Waste Management, Inc.'s Two Pine Landfill gas-to-energy plant is the state's first landfill gas (LFG)-to-energy plant. Operational since 2006, the 4.8-megawatt facility powers approximately 4,500 homes in North Little Rock. While the landfill has approval for a 144-acre extension, it plans to build another LFG-to-energy plant on the expansion. A partnership with Audubon Arkansas will turn 300 acres of the site's total 500 acres into a wildlife refuge. A $3 million investment was required to design and install an LFG collection system that met the Environmental Protection Agency's New Source Performance Standards. A 15-year contract to pipe and sell LFG to GEO Specialty Chemicals is being used to recoup this investment. Gas is piped to GEO to fire an industrial kiln, saving annual greenhouse gas emissions equivalent to taking 5,650 cars off the

In the Ozarks, Native American artifact collecting became such a major problem that anti-looting laws and government intervention were deemed necessary. In Yell County, 16th- and 17th-century Native American garbage pits have yielded significant deposits.

road. In Fort Smith, the city's landfill uses its LFG by injecting it straight into the natural gas pipeline. SouthTex gas-treating company partnered with Cambrian Energy to create a treatment facility that would remove carbon dioxide from the LFG, bringing it in line with Arkansas Oklahoma Gas Corporation specifications. This treatment and utilization of LFG, rather than combustion in a flare, reduces the Fort Smith landfill's overall carbon dioxide emissions by 60 percent. The city also receives royalties from the gas companies for the gas rights, providing a revenue stream from the operation that comes at no cost to the public as the gas companies carry out all of the work in return for ownership of the gas. Fort Smith is the largest landfill in Arkansas; a fifth cell was added in 2010, this 12-acre extension cost $1.9 million and should last for three to five years. Covering over 1,000 acres, the landfill serves Fort Smith, six Arkansas counties, and parts of two Oklahoma counties; the landfill is expected to serve until around 2075.

Historical Garbage

Carden Bottom, Yell County, is an alluvial floodplain created by the Arkansas River, known as a site of international importance for Native American sites dating back as far as the Archaic period. The site was extensively looted from the late 19th century for its renowned Late Mississippian pottery finds, to the extent that some looted pots were falsely claimed to be from the site or were forged. Test excavation in the early 1990s found Native American garbage pits in the area, and potentially more were discovered at one site targeted by geophysics in 2009. A midden deposit of major significance was discovered, dating to the 16th and 17th centuries, when trash was deposited into a gulley in the back of the village in an attempt to backfill it. This midden has produced the full range of Native American artifacts and also iron artifacts and beads of glass and brass that could only have come from European contact. Therefore, this garbage deposit has provided artifacts and environmental data from the climax of the Mississippian culture and the beginning of the contact period.

Picking up arrowheads in the Midwest is a generations-old activity, involving collecting surface finds that were regarded as expedient items by their Native American creators. However, prolific widespread looting, which has come to involve digging into archaeological deposits, has become a major problem, especially when the looters are acting at night, armed, and involved in illegal drugs. Experts have noted the connection between illicit drugs and looting of archaeological sites for several years.

The term *twigger* (a portmanteau of the words *tweaker* and *digger*) has been coined in the Ozark Mountains, where a methamphetamine epidemic has been building. Here, archaeological sites, including burial grounds, have been systematically attacked for artifacts and human remains and left littered by the twigger's refuse, typically cigarette packs and beer cans. It is thought that the collectible items are being traded directly for drugs and are ultimately sold on the Internet. Suggestions have been made that artifact collecting is carried out by addicts on a methamphetamine high, who can stay awake for days completely focused on a single task before collapsing. In northwest Arkansas, law enforcement officers have been shot and attacked with knives and digging tools when confronting twiggers.

Federal archaeologist Caven Clark estimated that more than 90 percent of the 130 cave sites and over 95 percent of rock shelters in the Buffalo National River unit of the National Park System have been looted. Special Agent Robert Still has stated that 70 percent of the archaeological crime cases he worked on are connected to drugs. Anti-looting laws were not well received in the Ozarks, where mound digging and arrowhead collecting are popular activities and government intervention on landowners' property is unpopular.

Garbage and Law Enforcement

In 2004, an Arkansas legal case saw a couple placed on trial for drug dealing (*Morris v. State*) seek to have prosecution evidence disallowed as the search warrant was issued based on items taken from their trash without a warrant. The judge refused this request, and (after being found guilty) the couple appealed that the evidence had been wrongfully presented. Their defense cited the Arkansas Constitution, claiming a reasonable expectation of privacy that was violated by police officers setting foot on their property to open their trash cans. This appeal was rejected, as Arkansas law upholds warrantless seizure and search of garbage on the same grounds as the federal courts.

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See Also: Archaeology of Garbage; Crime and Garbage; Landfills, Modern; Methane; Power Plants.

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Atomic Energy Commission

The U.S. Atomic Energy Commission (AEC) was established by Congress in 1946, transferring control of the development of atomic science from the military to civilian hands after World War II. The AEC was emblematic of the postwar American notion—best articulated in President Dwight Eisenhower's 1953 "Atoms for Peace" speech—that while atomic weapons had ended the largest war in the country's history, atomic energy was the key to the promotion of world peace, public welfare, and a free marketplace. While the AEC regulated nuclear technology, it did so with the aims of encouraging its development, at least in the United States. It was eventually supplanted by the Energy Research and Development Administration and the Nuclear Regulatory Commission (NRC), both of which were established by the 1974 Energy Reorganization Act.

Powers and Authority

The AEC was given broad regulatory powers over atomic science. The McMahon Act, which created it, explicitly prevented atomic technology transfer between the United States and foreign countries, and the act also required federal background investigations of any worker or researcher who sought access to AEC-controlled nuclear information. Employees of the AEC were exempted from the civil service system in order to give the commission greater independence, power, and flexibility in its hiring practices. All nuclear reactors and production facilities were required to be government owned, and the national laboratory system was created, building on facilities established during the war as part of the Manhattan Project.

Along with computers and the space race, nuclear technology was the most significant, prestigious, and exciting sector of scientific research in the early cold war era. The AEC's strict control over nuclear technology was vociferously criticized by free-enterprise proponents, who pointed out that the commission had exclusive jurisdiction over technology with significant social and public health implications—an important and potentially profitable technology that the private sector could only access by going through public-sector channels, which would seem to make competition difficult. Even one of the drafters of the McMahon Act referred to the AEC as "an island of socialism in the midst of a free-enterprise economy." But he and other supporters recognized that it was necessary; a technology had been created that was too dangerous to leave unregulated, and

was too new to yet know what balance of power between the public and private sectors was safe. Rather than ban the technology, which has been done or at least proposed for other potentially dangerous technologies since (e.g., human cloning), its development was encouraged under strict government oversight intended to promote and protect the public interest.

Criticisms and Reorganization

Commercial nuclear power was legalized with the Atomic Energy Act Amendments of 1954, which tasked the AEC with regulating and encouraging the nuclear power industry, much as the Federal Communications Commission was meant to do with radio and television. However, the AEC was criticized for both erring too far on the side of encouragement at the expense of safety regulations and paying far too little attention to environmental concerns. As concerns about the environment grew throughout the 1960s and the 1970s, the AEC began to seem not like an obstacle to free enterprise so much as an agency in the pocket of industry, one with little vision for considering the long-term environmental consequences of nuclear power and nuclear technology. It therefore seemed like the AEC had little concern with regulations that would prevent those consequences. This was one of the factors leading to the 1974 Energy Reorganization Act, which divided the promotional and regulatory functions of the AEC into two bodies: the Energy Research and Development Administration, which was later absorbed into the newly created Department of Energy in 1977, and the Nuclear Regulatory Commission (NRC).

The NRC is tasked with the oversight of the licensing, safety, and security of nuclear reactors and radioactive material as well as the management of spent nuclear fuel. It is headed by five commissioners who serve five-year terms, appointed by the president and confirmed by the Senate. Every active nuclear power plant has resident inspectors who monitor day-to-day operations for the NRC, while special inspection teams made up of variously skilled specialists conduct regular site inspections.

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See Also: Fusion; Hanford Nuclear Reservation; Hazardous Materials Transportation Act; High-Level Waste Disposal; Nuclear Reactors; Uranium.

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Audio Equipment

Audio equipment includes the material devices involved in the processes of recording, processing, diffusing, and reproducing sounds and music. Developed after the invention of sound recording in 1877, 20th-century audio equipment has proliferated in many societal contexts in the form of a wide variety of devices such as microphones, recorders, players, mixers, amplifiers, loudspeakers, and sound editors. In the 21st century, audio equipment is used, and consequently discarded, in a wide range of social contexts, from professional fields (such as music production, medical diagnosis, or transport communication) to leisure activities (such as music and media consumption). A distinguishing feature of audio equipment waste is that the technology is subject to rapid and selective innovation cycles, making older equipment obsolete and in need of replacement.

Early History

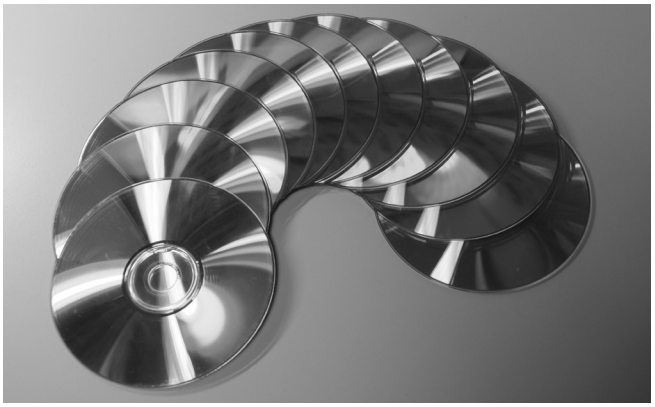
Audio recording and reproduction are relatively recent activities in human history. It was only at the end of the 19th century that sound started to be recorded and reproduced. Media sociologist Jonathan Sterne noted that before that time, other kinds of audio equipment existed and were almost exclusively used in professions such as healthcare (where the binaural stethoscope had been in use since the middle of the century) and communication (where

the telegraph mechanism was based on the Morse code). However, a larger diffusion of audio equipment took place only after Thomas A. Edison's invention of the phonograph, in 1877, and Isaac Berliner's development of the gramophone after 1888. Since then, the social diffusion of this equipment and its impact on culture and consumption has been highly relevant and subject to change following, as pointed out by media historian Patrice Flichy, the development of more general consumption patterns of the developing bourgeois family. Before the middle of the century, audio equipment became a common feature of leisure activities, contributing, as philosopher Walter Benjamin recognized, to the development of arts in the "age of mechanical reproduction."

The availability of sound recording equipment opened up new possibilities in many professional fields, communication, and art. Its impact on culture and consumer society became even more evident with further innovations introduced before World War II, especially with the diffusion of the radio and the introduction of electric sound recording devices. In the 1930s, the radio became the first great means of communication in modern society, establishing audio equipment as a common home appliance in modern houses. The use of electric reproducing devices became common in the 1940s, setting new sound quality standards, favoring the development of home high-fidelity systems, and becoming the basis for further innovations and transformations of technologies of sound recording.

Developments During and After World War II

During World War II, a variety of new equipment had been developed by military engineers, such as magnetic tape, which was mainly used in the coding and decoding of military communication and in SOund Navigation And Ranging (SONAR), which became an indispensable tool in naval transportation. In healthcare, audio equipment also had a crucial role in treating deafness and hearing impairment as well as in many diagnostic tests. Audio equipment became relevant in many fields: from automobile and air transport to industry and design, from work in organizations and commerce to political life. Composer Murray Schafer pointed out that the huge diffusion of audio equipment produced a radical change in the modern "soundscape" and an increase in the noise level in the contemporary world.



The use of the compact disc, which began to be marketed in 1982, is expected to be surpassed by newer technology in the 21st century. Audio materials have a rapid turnover rate as obsolete equipment is replaced and subsequently discarded.

One of the most relevant changes in audio equipment's consumption patterns consisted in its shift after World War II from a fixed and prevalently home-based use toward a mobile and individualized one. During the 1960s, audio equipment began to be installed in automobiles, and in the 1970s, it became miniaturized and battery powered, which made it possible to market devices such as the "boom box" and the personal Walkman. As a result, audio equipment became more and more personal, owned and used daily by an increasing number of people at any moment of their lives. Moreover, a further notable step in audio equipment development consisted in digitalization, a process that began with the digital compact disc and fully developed with the rise of the Internet and the commercial success of the iPod, personal computers, mobile phones, and digital personal devices integrating advanced audio features.

Disposal and Waste

Two phenomena related to the material presence of audio equipment in society can be identified: its accumulation and the consequent tendency to replace it periodically. Innovations occur rapidly with audio equipment, thus making old equipment

rapidly obsolete. This fact produces a constant tendency to discard older generations of equipment in favor of the adoption of newer ones. For example, magnetic audio cassettes were introduced in the late 1960s and substantially disappeared in the late 1990s; the digital compact disc and its player started to be marketed in 1982 and is expected to be surpassed in terms of diffusion by other digital music formats in the 21st century. The continuous evolution of objects and formats is one of the main causes for the constant replacement of older audio equipment.

A second phenomenon at the basis of the structural turnover of audio equipment consists in the fact that innovation processes are often characterized by "format wars," which also represent a common feature of other technologies such as television and DVDs. Format wars consist of the competition between mutually incompatible equipment that tries to achieve a prominent position in the market and results in the exclusion of losing equipment, which has no other use than to be abandoned and discarded. Notable examples of these cases are the wars between cylinder records and disk records; the 8-track and 4-track cartridges and the compact cassette; and the DVD and the SACD.

A last phenomenon connected with the social presence of old audio equipment is renewed consumer interest in old and obsolete equipment, which is culturally reframed into "vintage equipment." This process of reconfiguration of the sociocultural value of audio equipment explains, for example, continued interest in turntable and vinyl records, tube amplifiers, and old-fashioned music instruments, such as analogue synthesizers.

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See Also: Home Appliances; Household Consumption Patterns; Mobile Phones; Noise; Television and DVD Equipment.

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Australia

The tropes of *trash*, *rubbish*, or *waste* have saturated the Australian imaginary since white settlement, operating as a metonym for Australian culture at large and its relationship to European culture specifically. This is hardly surprising, given that contemporary Australia was founded as Britain's "dumping ground," functioning as an outpost for Britain's convicts for 65 years in most states since the first fleet of ships arrived in Botany Bay in 1788. Australia was henceforth understood as a colony of outcast populations, whose founding of the nation constituted the so-called convict stain right up until the 20th century.

Cultural Wasteland

Australia's identity as a cultural wasteland continued after Australia was federated in 1901, where it was repeatedly imagined as inferior in relation to its "mother country," the United Kingdom. This view continued to mire the cultural imagination for most of the 20th century, where Australia is repeatedly imagined to be devoid of the idealized versions of culture that characterize European civilization. A. D. Hope, for example, decried the nation as a vast cultural desert in his infamous poem "Australia"—a place where civilization has eroded, like a "sphinx demolished" or "stone lion worn away." This view of Australia as a cultural

desert is expressed in numerous other national writings, including Robyn Boyd's treatise on the nation and its design sensibility in the 1960 work *The Australian Ugliness*. For Boyd, the nation is an empty cultural wasteland—a chaotic and accidental rubbish dump fashioned in the image of U.S. urban culture. Australia's design ugliness is categorically distinct from the United States', however, evident not only in the trash spawned by the greed of mass production but also by the dreary conformity, banality, and complacency of Australian culture at large. It is for this reason that Boyd regards the Australian ugliness as the worst of its kind, evident in the wasted potential of the nation's natural beauty: the cheaply produced cream-brick veneer houses that line the sprawling suburbs, the mess of electricity wires that blight every street, gaudy plastic decorative flowers placed on restaurant tables, old mattresses thrown over back fences, chair lifts harassing holiday areas, and soft drink signs marring the highways and service stations. "Most Australian children grow up on lots of steak, sugar, and depressing deformities of nature and architecture," he writes.

Ten years earlier, A. A. Phillips decried Australia's belief in itself as a cultural wasteland in his infamous 1950 essay "The Cultural Cringe." Phillips critically addressed the ingrained feelings of inferiority Australian intellectuals evidenced when evaluating the nation's theater, art, and music. He critiqued the perpetual deference to British and European definitions of culture in which anything produced by local artists, writers, and musicians was regarded to be derivative and deficient by comparison. This had a major impact upon the way Australians began to view their own culture, and by the 1960s, there was a growing interest in the distinctiveness of Australian culture, including a revalorization of the cultural products previously dismissed as inferior or secondary to European forms, including Australia's distinctive folk culture and convict ballads. By the 1970s, the convict stain had largely diminished, as Australia began to value its unique history as a colony of convict "underdogs." Australian history was embraced with pride, as numerous Australians began to research their cultural heritage in the hope of finding a convict ancestor.

Recent Cultural Trash

In more recent years, trash and waste have continued to gain prominence as a distinctive feature of the Australian culture and national identity. Australian cultural production has begun to celebrate the nation's purported lack of European cultural references as a uniquely Australian sensibility, with numerous films, television shows, and art =works embracing its identity as trash, refuse, and kitsch. This reached its apogee during the 1980s and 1990s, when a spate of films were funded by the Australian Film Commission in order to produce and market a unique sense of national identity.

In the aim of creating a national cinema, numerous filmmakers emphasized the absence of "high art" (central to European definitions of culture), while celebrating trash and kitsch aesthetics as one of the defining and marketable features of Australian national identity. Films like *Sweetie* (1989), *Strictly Ballroom* (1992), *Muriel's Wedding* (1994), *The Castle* (1997), *Love Serenade* (1996), *Priscilla, Queen of the Desert* (1994), and television series like *Kath and Kim* (2002) and *Bogan Pride* (2008) embrace suburban kitsch as the defining aesthetic of the national sensibility. Suburban "trash" has become a well-recognized and celebrated national aesthetic, embraced with the sense of laconic humor that is said to define the nation at large.

Clashes With Indigenous Culture

This celebration of the trashy, kitsch, and camp aesthetic is also a defining feature of the films and photographs produced by one of Australia's best-known indigenous artists, Tracey Moffatt, whose works self-consciously represent Australian culture and identity with a flagrant flair for the "distasteful." Many of Moffatt's works, including her films *Bedevil* (1993) and *Night Cries: A Rural Tragedy* (1989) represent primal scenes from Australian settler culture in which Indigenous and nonindigenous relations are evoked in a hyperbolic campy excess of color saturation and over-the-top caricature as if to highlight the fabrications of Australian history and the impermanence of settler attitudes and stereotypes of indigenous Australia—their staginess and lack of fixity.

Moffatt's celebration of trash as a defining Australian aesthetic also speaks back to the canon of

"good taste" propagated by the European establishment, which allowed British colonists to celebrate European definitions of culture while denying that Australia had any culture at all. These definitions of Australia as a land devoid of culture perpetuated Australia's founding violent myth of *terra nullius*—the notion that Australia was cultureless by British standards—the "last" and the "emptiest" of lands, "without songs, architecture, history," as A. D. Hope puts it in "Australia." These reified views of European culture thus perpetuated Australia's founding erasure of indigenous cultural production that existed for 40,000–60,000 years in various forms, including storytelling, painting, and dance.

A Dumping Ground?

Despite recent attempts to embrace and revalorize Australia's unique cultural sensibility outside European standards and definitions of culture, traditional representations of Australia as an empty dumping ground continue to saturate the global imagination, with old imperial agendas being played out with new ecological imperatives. Since 1990, debate has ensued over Australia's suitability as a potential host for the world's increasing nuclear waste. These proposals have garnered support as nuclear power plants are increasingly touted as the solution to global warming and the reduction of coal emissions.

In 2005, Australia's prime minister, John Howard, introduced the Commonwealth Radioactive Waste Management Act to challenge indigenous property rights in the Northern Territory in a bid to secure parcels of land for Australia's nuclear waste dump. Amid much controversy, debate ensued about potential sites within Australia to locate a potential dumping ground, with Muckaty Station primed as the most suitable site for the dumping of nuclear waste in 2010. This proposal to dump nuclear waste at Muckaty Station—covering virtually 120,000 hectares in the geographical center of the Northern Territory—is part of a long history of imagining Australia as a dumping ground for the United Kingdom's waste. The United Kingdom's imperial view of Australia as a dumping ground was also evident in Australia's recent history as host to UK atomic bomb tests staged 1955–63. Seven major nuclear tests and hundreds of minor trials were staged at Maralinga in the Woomera Prohibited Area in South Australia. These tests had long-term health effects on some of the Maralinga Tjarutja people, to whom the government paid compensation money in 1994. The possibility of a new nuclear waste dumping ground has exacerbated ongoing issues relating to indigenous sovereignty in the Northern Territory, in addition to the future safety of the nation.

Waste Management

The primary method of waste management in Australia is landfill. In 2002–03, more than half of all the 32.4 million tons of solid waste generated in the nation (including 70 percent of municipal waste, 56 percent of commercial and industrial waste, and 43 percent of construction and demolition waste) went into landfills. The Department of the Environment and Heritage reported high rates of recycling, with 99 percent of Australian households reporting at least some sort of recycling or reuse activity in 2006. The overall recycling rate for all materials was estimated at 46 percent for 2002–03.

Conclusion

Waste has played a pivotal role in Australia's identity as a colonial outpost of the United Kingdom from 1788 into the 21st century. While Australia has been a dumping ground for numerous aspects of the United Kingdom's perceived rubbish—including some of its population and its material byproducts—the usefulness of this waste, in and for the nation, is part of ongoing cultural, ecological, and economic debate. Therefore, given that trash rests at the very helm of Australian modernity—in the very foundations of the colonial culture—waste signifies the presence of colonial culture in addition to its demise. Waste continues to suture Australia's imagination of itself in ways that both corrode and confirm the colonial center.

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See Also: Culture, Values, and Garbage; Hazardous Materials Transportation Act; NIMBY (Not in My Backyard); Politics of Waste; Toxic Wastes.

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Automobiles

The automobile, pioneered by German engineer Karl Benz in the 1880s, became one of the great engines of consumption during the 20th century. Available to the masses after Henry Ford developed a system of mass production that produced millions of Model T cars, the automobile made possible suburban patterns of settlement, long-distance journeys, the development of the modern shopping mall, and the consumption of millions of gallons of petroleum every year. The automobile is one of the defining elements of modern consumption, and both its use and disposal have substantial effects on the environment.

Brief History

The automobile is a symbol of prosperity, freedom, and consumption. Within 20 years of Benz's first motorized vehicles, enthusiasts had founded the American Automobile Association (AAA) in the United States (1902) and the Automobile Association in the United Kingdom (1905) to promote driving. Enthusiasts developed high-end racing automobiles. Sport racing flourished in the 20th century and continues with the popularity of National Association for Stock Car Auto Racing (NASCAR), Indy Car, and Formula One racing circuits worldwide.

The automobile became popular because of its utility to people seeking affordable, convenient transportation. The Ford Motor Company's affordable Model T cars (introduced in 1908) allowed unprecedented mobility to the masses, a sentiment later captured by its competitor General Motors in its "see the USA in your Chevrolet" advertising campaign. If Ford mastered mass production, General Motors mastered market segmentation, offering a variety of models and colors as early as the 1920s under brands such as Cadillac, Buick, Oldsmobile, and Chevrolet. This strategy proved popular; after World War II, General Motors grew into the largest business on Earth. By the end of the 1950s, three American companies (General Motors, Ford, and Chrysler) dominated the U.S. automobile market, producing over 5 million cars each year between 1949 and 1965. All three were headquartered in Detroit, nicknamed the "Motor City."

Automobile purchases changed with 1950s patterns of conspicuous consumption. General Motors continued to alter the color, shape, and styling of its models with garish chrome bumpers and tail fins, encouraging customers to purchase new vehicles every year on grounds of stylistic obsolescence. Its competitors followed suit. Manufacturers introduced new amenities to make driving more comfortable, including air conditioners, radios, and 8-track tape players. Attempts to introduce vinyl record players were brief and unsuccessful, but the amenities proved popular for people spending more time in their cars. Models on the road by 1960 included two-person coupes, larger sedans, station wagons often sporting three rows of seats, and trucks. Public transit options shifted from mass rail to buses in many areas.

Social Effects

The mass consumption of the automobile has had several social effects. One has been a major role in the spatial redistribution of population. Within the United States, suburbanization had already begun (assisted by streetcars) in the late 19th century, but

the automobile allowed suburbanites to conveniently live farther away from central cities. The U.S. landscape shifted rapidly between 1945 and 1970, reconfiguring in ways that made automobiles necessary for full enjoyment of the built environment. Population shifted from central cities to sprawling low-density suburbs, most lacking public transportation. Shopping malls with massive parking lots grew throughout suburbia, offering shopping and entertainment amenities that had previously only existed in downtown corridors of large cities. Drivers used automobiles to commute from suburban homes to urban jobs, as well as to shop and take children to school. The United States invested billions of dollars in an interstate highway system. This network of asphalt and concrete ostensibly provided security during the cold war, allowing the population to escape metropolitan areas in case of nuclear attack. The endless grey ribbon produced new road-based industries, including motels and fast food restaurants. Decentralized metropolises sprawled across the landscape of the west and south, forgoing densely spaced skyscrapers for endless swaths of parking lots and low, wide buildings. The billboard industry, on the rise since the introduction of the automobile, grew with the mass use of highways in the 1950s.

Emissions

Although the automobile has had a major effect on the spatial patterns of modern life, most attention to the environmental consequences of the automobile concerns the fuel used in the internal combustion engine. When the automobile first competed with the horse as a popular method of transport, observers found the lack of solid waste from "the horseless carriage" a marked improvement over the piles of manure left by animals. Tailpipe emissions seemingly disappeared into the air, leaving streets cleaner and safer.

Tailpipe emissions became atmospheric problems as the automobile grew in popularity. Although several inventors experimented with steam-powered engines, only automobiles powered by petroleum were mass-produced in the 20th century. Emissions leaving the tailpipe were not simply water, but a combination of carbon dioxide, carbon monoxide, nitrogen oxides, and particulate matter. Concern over smog produced by volatile organic compounds and particulate matter led to criticism of the automobile as a polluter of local atmospheres by 1970. Carbon dioxide emissions from the automobile were widely linked to global climate change by 1990. Despite international concern about atmospheric pollution, almost 1 billion oil-consuming automobiles were in use worldwide in 2010.

Some pollution concerns have been mitigated. Lead was added to gasoline for much of the 20th century to improve engine performance. Internal combustion vaporized the heavy metal and spread it over heavily trafficked areas, resulting in unsafe ambient lead levels as well as lead in the water table and soil. The United States began limiting lead as a fuel additive in 1973 after concerns about unsafe levels of lead found in children, eliminating leaded fuel use within 20 years. Lead reduction has since occurred in most of the industrialized world.

Oil Consumption

Although the automobile is not the only source of petroleum consumption in modern society, it is the primary one according to the U.S. Department of Energy, accounting for more that two-thirds of all petroleum consumption in the United States in 2008. The United States has increased imports of petroleum since World War II, complicating geopolitics because oil-rich nations often had disputes with the United States, leading to both diplomatic and armed conflicts. For consumers, the most visible geopolitical conflict was the Organization of the Petroleum Exporting Countries' (OPEC) oil embargo of 1973. OPEC members (including Iran, Iraq, Kuwait, and Saudi Arabia) opposed to the United States' alliance with Israel withheld petroleum from the United States. Since domestic oil production was insufficient for the needs of consumers, shortages led to rationing and long lines at gas stations. Rising energy costs contributed to economic decline in the mid-1970s.

In the wake of the 1973 embargo, several Japanese manufacturers (including Honda, Toyota, Mazda, and Nissan/Datsun) made inroads into the U.S. market with small models often getting more than twice the fuel efficiency as their larger U.S. counterparts. As the relative value of fuel lessened during the 1980s, automobiles gradually increased in size and amenities. At the dawn of the first Iraq

War in 1991, for example, a new Honda Civic was far larger than a 1977 Honda Civic.

Although fuel rationing had not been repeated in the United States as of 2011, concerns about the security of fuel supplies as well as criticism of the widespread environmental dangers of petroleum use have led to calls for alternative fuels for transportation. Automobile manufacturers have developed electric automobiles, and grassroots consumers have increased the use of biodiesel fuels, but the vast majority of automobiles on the road continue to be powered by petroleum.

Disposal

The environmental effects of the automobile also include the consequences of its disposal. Although millions of automobiles go out of service every year, most are not simply thrown into landfills. Mechanics scavenge automobile graveyards (specialized areas devoted to storing junked automobiles) for working parts to keep vehicles running. Reliable mass production meant that a transmission from a junked car might be used in a working car of the same make and model. Parts that cannot simply be transplanted into a working automobile still have value. The automobile, composed mostly of steel, became a major source of ferrous scrap in the 1920s as mass consumption of motor vehicles expanded. Scrap firms extracted the metal through manual labor, using torches and shears to harvest scrap in a slow, deliberate process usually requiring at least half a dozen laborers working on each automobile body. Scrap dealers classified the salvaged material as heavy No. 1 grade scrap steel, valuable in the making of structural steel skeletons for buildings, ships, and new automobiles. Automobile graveyards began dotting the U.S. landscape in the 1920s.

After the development of shredding automobiles and household appliances, scrap iron industry research estimated that by 1980, between 30 and 40 percent of U.S. ferrous scrap came from junked automobiles. Unfortunately, non-ferrous residue known as "fluff" has to be disposed of by incineration or dumping. The increase in automotive amenities, including airbags and their carcinogenic ingredient azide, has complicated the disassembly and shredding process and has contributed to the millions of tons of shredded material annually.

Although the manual process for harvesting ferrous scrap from an automobile was slow, it was sufficient for the demands of the 1920s. Military demand shaped World War II–era scrap sales, with much of the heavy scrap coming from salvaged ships and buildings. Automobiles were a useful source of scrap during the war, but not a main source.

By the end of the 1950s, when Americans disposed of over 9 million automobiles annually, more people were concerned with the problem of blight marring roadsides and the new suburban developments where millions escaped the dirt and noise of central cities for the promise of pristine, quiet communities. Like suburban subdivisions, scrapyards often were situated on the edges of urban settlements within plain view of major highways. More than 25,000 automobile graveyards lay scattered across the United States in 1951; as Americans migrated to suburbs, piles of automobiles once isolated from view became visible amid the malls and residential subdivisions springing up around them. State governments began attempts to control or remove junkyard blight in the mid-1950s, and federal attention increased once new First Lady Lady Bird Johnson began advocating the beautification of public space in 1964. One year later, her husband, President Lyndon B. Johnson, signed the Highway Beautification Act into law, requiring junkyards to remove or shield blight visible from the highways. Although the act did not eliminate automobile graveyards from the landscape, it was part of a widespread effort to limit the environmental effects of the automobile's use in the late 20th century.

Scrap firms adapted to the glut of junked automobiles by developing the automobile shredder, a device that automated the process of cutting up and separating an automobile's steel from its other materials, allowing more rapid and safer disassembly. Instead of having a team of 10–12 men work on an automobile with hammers, torches, and shears, one or two men fed the automobile body onto a belt that moved it into the shredder. Once inside, mechanized hammers and shears separated and shredded the entire vehicle. Once shredded, large magnets separated the ferrous material from the rest, allowing workers on the other end to quickly harvest the ferrous material. Instead of a dozen men, perhaps three or four were needed to supervise an automated disassembly process.

An analogy could be made between the disassembly of automobiles and the mechanization of the meat industry in the 19th century. The disassembly line transformed meat harvesting from a task performed by skilled butchers who honed their craft with long apprenticeships to a mechanized process involving little labor, processing a vast supply of material into sellable commodities. The analogy is not exact; the massive stockyards in Chicago fed giant killing floors in a handful of meatpacking plants, whereas automobile shredders spread to hundreds of scrapyards across the United States.

Non-Ferrous Scrap Disposal

The shredder was effective at quickly separating ferrous scrap from the other materials in an automobile, allowing recycling of steel; in 1980, scrap iron industry leaders estimated that between 30 and 40 percent of the United States' ferrous scrap came from junked automobiles. Unfortunately, that separation had consequences in the form of automobile shredder residue (ASR), also known as "fluff." All matter contained in an automobile was grist to be ground up during the shredding process. Once separated from the ferrous metal, the wastes might be incinerated, hauled to landfills, or left on the ground. However it was managed, ASR joined ferrous scrap as common products of the shredder. In 1960, the automobile typically contained steel, copper, lead, glass, several acids, rubber, several fabrics, asbestos (in brake pads), and a growing variety of plastics. As designs became more complex over the next half century, manufacturers added new materials to the automobile, including computer circuitry and airbags.

By the end of the 20th century, the amenities within automobiles increased, with cup holders being a particularly noticeable addition. Many models of sport utility vehicles (SUVs) feature DVD players and entertainment systems rivaling those in many homes. In the early 21st century, the automobile is as complex as ever, including computer circuitry and a variety of potentially hazardous materials. The airbag both increases safety and complicates disassembly. Since it reduces fatalities in accidents, it is a standard feature in automobiles. One ingredient

in airbags is the carcinogen sodium azide. During disassembly, it adds to the dangerous materials making up ASR. As the hazards in ASR have increased, so has the volume of ASR produced. The Environmental Protection Agency estimated that shredders produced about 3 million tons of finely ground ASR in the United States annually by 1990, creating concerns over how to properly landfill or otherwise manage the waste.

Despite calls for an industrial ecology approach to automobile assembly and disassembly that would eliminate hazardous wastes, more attention is paid to performance of the machine, safety of the driver, and fuel efficiency of the engine than the life cycle of the product. The automobile has become more complex over time because of innovations that increase the enjoyment and safe use of the vehicle, but they also complicate disassembly. Over time, shredding and burning of junked automobiles has had environmental consequences, including the release of hazardous, corrosive, and carcinogenic substances into the ground, air, and water.

More than a century after its invention and half a century after the U.S. government first tried to limit the consequences of automobile use, the petroleum-consuming automobile remains a vital part of modern life, continuing to shape patterns of settlement, energy use, shopping, employment, waste disposal, and climate change. The consequences of its use will endure and grow for the foreseeable future.

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See Also: Car Washing; Carbon Dioxide; Consumerism; Fuel; Iron; Junkyard.

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Avoided Cost

Avoided cost is a term used in waste management to represent monetary savings through the diversion of waste from disposal to a form of reprocessing, such as recycling or composting. Frequently used to justify either the initiation of new recycling or composting programs or the continuation of existing programs, avoided cost is an attempt to reflect how waste diversion may be economically beneficial and to assess alternatives to the disposal of material.

Motivations for Use

Municipal solid waste collection programs have existed in most communities since the early 20th century. Established as a response to public health, aesthetic, and commercial concerns, the collection of waste—or the provision of access to waste disposal locations—is considered a standard and necessary public service even in difficult budgetary times. Waste disposal, due to its necessity and long-term existence as a public service, is often financed by a complex and convoluted structure of fees and taxes.

Recycling and composting programs, which are forms of waste diversion, are newer additions to the waste management practices of most communities and are often viewed as optional services. When initiated, it is common that services for these programs are charged directly to citizens, making program costs easily visible. Presenting the full cost of waste diversion programs in this way can give the appearance that waste diversion methods are more expensive than traditional disposal of waste through landfilling or incineration. Avoided cost is a tool developed to provide a more accurate description and accounting of the comparison of the cost of waste disposal with potential savings through diversion activities.

Calculating Avoided Cost

Avoided cost is the amount of money not spent on disposing of waste because material has been diverted from the disposal stream. When calculating avoided cost, the net cost of waste disposal is compared with the net cost of a form of diversion, such as recycling or composting.

To determine avoided cost, the cost per ton for waste disposal must first be calculated. Several costs are associated with disposal of waste. First, waste must be collected from households, businesses, or other points of creation. Collection requires labor, equipment such as trucks and containers, and associated administrative or overhead costs. The cost of hauling this material to a disposal facility, also termed the *hauling fee,* may be included in collection costs or broken out as a separate cost. Finally, waste must be "tipped" or dumped into a landfill or incinerator, the cost of which is termed the *tipping fee*. Tipping fees include the cost for the management of disposal facilities. Disposal of waste in a landfill or through incineration is becoming increasingly expensive because of limited space available for landfilling, public outcry over placement of new landfills, and more stringent technological requirements regarding the operation and location of new landfills and incinerators.

The cost per ton of waste disposal is determined by calculating the cost of disposal (adding together collection and hauling fees, tipping fees, and other administrative overhead for overseeing the process) and dividing by the total number of tons of waste disposed. The equation may be described as: cost per ton = cost of disposal divided by total number of tons.

Next, the cost per ton of recycling is calculated. Costs for recycling include collection, which is similar to that of waste, and the processing of materials. The cost of processing recyclables differs depending on what material is being recycled and the market for use of the recycled product. In addition to costs for collection and processing, the sale of some recyclable materials also provides revenue. The amount of revenue gained is dependent upon local, regional, national, and global commodities markets.

The cost per ton of recycling is calculated by adding the cost of processing and collecting recyclable materials and subtracting any revenue gained from the sale of commodities. This number is then dividing by the total number of tons recycled. The equation may be described as: net cost per ton of recycling = (cost of processing minus commodity sale revenue) divided by total number of tons recycled.

Using these two figures, avoided cost is calculated by subtracting the net cost per ton of recycling from the cost per ton of waste. The result, if a positive number, is avoided cost. For example, if the cost for waste disposal is calculated as $100 per ton and the cost for the collection and processing recyclable materials is $100 per ton, but $25 in revenue per ton is gained from the sale of the recycled commodities, the cost benefit analysis is described as: $100 (cost per ton of waste) minus $75 (cost per ton of recycling) = $25 avoided cost. Recycling therefore results in not spending an additional $25. This formula does not always result in the calculation of a positive number. If the associated costs of recycling are greater than that of waste disposal, there will not be avoided cost or monetary savings.

Difficulties in Calculating Avoided Cost

Although the equations for calculating avoided cost use simple mathematics, determining appropriate numbers for use in the equation is often difficult. Waste disposal costs are often difficult to determine because of the nature of funding a long-standing public service. The calculation of overhead and administrative costs can also vary depending on the formula used for this determination.

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See Also: Economics of Waste Collection and Disposal, International; Economics of Waste Collection and Disposal, U.S.; Recycling; Zero Waste.

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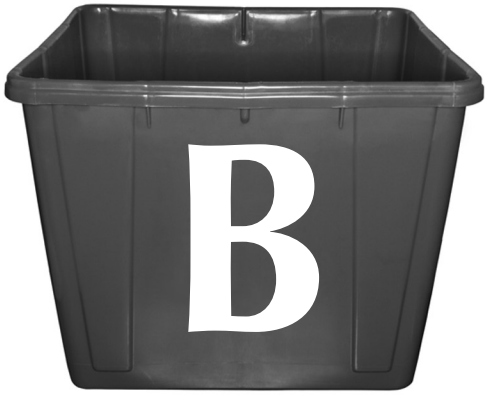

Baby Products

Starting in the 1800s, the clothing, diapering, and feeding of infants—activities that once rested solely in the hands of a baby's primary caretakers—has transformed into a medicalized and commercialized multibillion-dollar industry that now lies in the hands of business. In the early 21st century, global expenditures on children's toys and video games alone are estimated at $86 billion annually. With these newly invented baby products have come a historically unprecedented amount of baby-related trash, including mass manufactured artificial feeding implements (such as bottles and nipples), infant clothing, and disposable diapers.

Brief History of Baby Feeding

In a little over 100 years, infant feeding has transformed from a practice that was primarily dependent on an infant's mother's ability to successfully breast-feed her child to a powerful industry that brings in $3 billion annually and that makes feeding an infant possible without the presence of a mother. Archaeological and historical documentation make it clear that feeding infants, especially those who do not have access to a lactating individual, has long been a concern of human civilization. Up until the early 1900s, a woman's inability to breast-feed her child during the first months of an infant's life usually determined the fate of her infant. The infant was thus entirely reliant upon her lactating mother, or other lactating women, for nourishment and survival.

That did not stop mothers and their families from trying to come up with other viable methods of nourishing their babies. Ancient attempts at artificial feeding (such as horns and ceramic vessels) have been found in Africa dating to the Neolithic period and from Bronze Age Europe. Wet nursing (the act of having a child nurse from a woman who is not its mother) or having an infant suckle an animal's teats were two alternatives for mothers who either chose not to or could not breast-feed their infants. Wet nursing is ancient in practice and is discussed in Egyptian hieroglyphs, medical texts written in India between 400 B.C.E. and the 7th century C.E., texts found in ancient Greece, and in the Old Testament. When a mother either could not breast-feed or secure a wet nurse, pap and panada were used as breast milk substitutes, which involved cooking flour, bread, or cereal in water, butter, or milk.

Condensed milk became available on the market in 1853, finally offering a reliable—though not fail-safe—option for mothers who could not

nurse or afford a wet nurse. Gail Borden patented his milk evaporation technique in 1853 and then subsequently marketed Eagle Brand Condensed Milk starting in 1856. Because his formula contained sugar, pediatricians tended to shy away from recommending it to their patients. Unsweetened evaporated milk was introduced on the market in the late 1880s and 1890s by companies such as the Helvetia Milk Condensing Company (also known as the Pet Milk Company), Liebig, and the Pacific Condensed Milk Company (later known as the Carnation Company). With a safer condensed milk becoming available on a mass scale and advocated by pediatricians, the vehicle through which artificial milk could be fed to an infant also become available en masse. Still, pediatricians were hesitant to recommend formula over breast-feeding, as the medical benefits of the latter practice greatly outweighed the former.

It was at this time when baby feeding bottles were introduced on the market. Rubber bottle nipples were first distributed in 1830, yet consumers did not meet their introduction with delight. Lead, zinc, and arsenic were added to the rubber nipple, and bottles were labeled "instruments of death" in the mid-to-late 1800s. Sterilization, the widespread acceptance and application of germ theory, and pasteurization processes made drinking milk from a bottle much safer. Advertisements and articles promoting bottle-feeding appeared in women's magazines such as *Good Housekeeping* and *Ladies' Home Journal* as early as the 1880s. The surge in bottle and artificial feeding advertising and media helped usher in a new age of infant feeding. Rima D. Apple states that in the United States, breast-feeding dramatically decreased between 1917 and 1948, with more than one-third of mothers opting not to nurse their babies upon being discharged from their labor and delivery hospital stay. As Apple explains, this figure stands in stark contrast to the percentage of U.S. babies nursed upon their birth between 1917 and 1919, which ranged from 82 to 92 percent in a number of rural and metropolitan U.S. cities.

As of 2010, the Infant Formula Act of 1980 ensures that all formulas meet governmental standards for infant nutrition. Nonetheless, bottle-feeding remains such a contentious topic that the World Health Organization (WHO)/UNICEF Code of Marketing for Breastmilk Substitutes has requested that marketers not send out any products associated with bottle-feeding (such as samples of formula, nipples, or bottles) to pregnant women. The La Leche League also formed in 1956 to counter the recent tendency to opt for bottle-feeding and to highlight the benefits of breast-feeding for both mothers and their babies. The American Academy of Pediatrics and the WHO have taken a stand against bottle-feeding by recommending that babies be nursed for at least the entire first year of a their life, with 2 years of age being the optimal time for the mother's cessation of breast-feeding.

Formula must be made with food ingredients that are recognized as safe or approved as food additives for use in infant formula. Advances in sterilization and nutrition, along with marketing campaigns, created a surge in the use of commercial formula.

Solid Foods

The introduction and production of baby food has similarly been fraught with contention. Prior to the 1920s, it was common for families to wait to add solids until the first or second year of a child's life, with some cultures waiting until the age of 7 or 8 to introduce certain foods. Gerber, a well-known baby

food company, unveiled its first line of canned baby food in 1927. Other companies, including Beech-Nut and Libby's, followed suit by unveiling their own lines of baby solids in the mid-to-late 1930s. Advances in canning technologies, sanitation standards, and new developments in nutritional sciences (including the concept of "vitamins") helped push back the age at which babies were fed their first solids and assisted with the popularity and success of these companies' foods.

Disposable Diapers

Perhaps the most controversial product associated with babies is the disposable diaper, which constitutes approximately 1–3 percent of all solid waste in the United States. Before the 1800s, diapers consisted of absorbent grass, moss, leaves, linen, or cotton, with animal skins, wool, flannel, or linen acting as a protective outer layer. Reusable diapers made out of knitted wool, linen, or cotton came into fashion with the advent of industrialized textile production in the 1800s. The safety pin, which was invented by Walter Hunt in 1849, allowed caretakers to secure cloth around a baby, and by the 1890s, rubber pants were invented to cover the cloth and linen diaper as well as to protect the outer layers of a baby's clothes. The soiled inner layer of the diaper, typically made of linen or cloth in the mid-to-late 1800s, had to be washed or boiled by hand in hot water and soap. This was not an institutionalized practice until the 1930s, when both rural and urban families finally understood the medicinal and hygienic advantages of boiling diapers and sterilizing them with a hot iron. The 1930s and 1940s witnessed additional changes in diapering. As of 2010, nearly all diapers in the Western world consisted of a cloth or latex outer layer, with disposable cotton or gauze acting as the absorbent inner layer. This provided a simple, hygienic solution in a time when soap was scarce and rationed during World War II.

The first completely disposable diaper was introduced by Procter & Gamble in 1959, but disposable diapers did not become widely used until the 1970s. This new invention had and continues to have its critics, however. The average infant goes through 10,000 diapers and produces 1 ton of trash in its lifetime of disposable diaper use. Environmentalists have protested and raised red flags about the manufacturing processes and impact of disposable diapers. To produce disposable diapers, oil must be harvested to make the plastic in the diaper and trees must be cut down. Dioxin, which is produced when diaper manufacturers bleach wood white, is admitted into the air and enters into the soil during the manufacturing process; some claim that dioxin causes, among other things, cancer, male and female infertility, and short-term memory loss. Air pollution, soil pollution, deforestation, relocation of indigenous populations, and the exposure of toxic chemicals to oil workers (which can result in asthma, infertility, birth defects in unborn children, and cancer) are all directly caused by the manufacturing of disposable diapers.

In addition, diapers can present health hazards for adults living near and working at landfills. Although disposing of human feces in household waste is illegal, most parents do not place infant feces in diapers into adult toilets. Once household waste is transported to a landfill, pathogens and microbes from soiled diapers become a cause for concern. According to pediatric doctors Marianne B. Sutton and Michael Weitzman, these microbes can potentially leach into the groundwater below as well as pose a health risk to landfill employees. Consequently, environmentalists have now begun to advocate the use of reusable cloth diapers, though there remains some debate as to the environmental impact of these diapers as well.

Together, these new products—bottles, diapers, and baby-food containers—have made parents' lives both easier and more complex. Parenting is easier in that infant food, diapers, and formula can be instantly purchased without going to great lengths to procure, make, and guarantee the safety of such items. However, it is more complex because with these recent innovations, society continues to face and produce insurmountable amounts of one-time-use disposable items (such as glass jars, plastic containers, and diapers) associated with babies.

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See Also: Children; Disposable Diapers; Industrial Revolution; Landfills, Modern; Packaging and Product Containers; Race and Garbage; Shopping.

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Barges

Garbage barges have had a place in U.S. waste disposal since the late 19th century. The garbage barge is a social and historical product whose notoriety loomed especially large after 1980. Currently, when U.S. methods of production and waste are under scrutiny, the garbage barge may offer an important lesson through which can more effectively wrestle with the implications of throwaway society. Waterways have served urban waste management as sinks as long as there have been cities. During the late 19th century, cities such as New York City employed long flat barges to transport the city's garbage away from land and into the Atlantic Ocean for dumping. Workers on board, known as "scow trimmers," rummaged through the dumped waste for rags, scrap, and anything with a resale value. Even after opposition to ocean dumping in the 20th century led to an emphasis on landfilling as the ultimate destination for wastes, barges continued to play an important role in transporting waste. This role was largely obscured from public attention until a pair of embarrassing incidents in the 1980s brought them notoriety.

The *Mobro 4000* and *Khian Sea*

Garbage barges have been involved in remarkable incidents involving attempted waste disposal. In March 1987, the *Mobro 4000* left Islip, New York, and carried 3,000 tons of trash to a landfill only to face bans by five states and three countries before it was forced to sail back to Long Island three months later. Its load was burned in an incinerator and then buried in the same place where it would have gone months earlier. More spectacular than the *Mobro 4000* is the *Khian Sea* episode in 1986. Whereas the *Mobro 4000* carried trash, the *Khian Sea* carried nearly 15 tons of Philadelphia incinerator ash in search of a landfill—a search that became a 16-year journey during which it faced repudiation by at least 11 different countries and five states (Florida, Georgia, Ohio, South Carolina, and the Cherokee Nation of Oklahoma) and committed the illegal acts of dumping thousands of tons of ash into the ocean and subsequently onto a Haitian beach. Activism brought to light the predatory nature of *Khian Sea*'s activities and forced both the Haitian ash cleanup and the return of approximately 2,000 tons of its ash to a landfill in south-central Pennsylvania in 2002.

As illuminating and disconcerting as the *Mobro 4000* and *Khian Sea* incidents may be, they were not isolated episodes. Waste could be legally exported by barge from the United States to many places on the planet if the carrier registered with the Environmental Protection Agency's (EPA's) prior notification program. Garbage barges during the 1980s registered with the program. Debate over the cause of the burgeoning waste trade and garbage barge boom ensued; notwithstanding academic disagreement over whether a "garbage crisis" can be considered the culprit, no one denies that the saga of the post-1980 garbage barge was not created out of thin air.

Predating the unpleasant garbage barge venture was the 1973 report "Cities and the Nation's Disposal Crisis," issued by the National League of Cities and U.S. Conference of Mayors, asserting that the culprits were the skyrocketing waste vol-

ume and sharp decline of available disposal sites. David Pellow, suggesting possible causality, asserts that during the 1970s and 1980s aggressive environmental justice and antitoxic movements challenged dirty and unsightly landfill and incinerator systems; their pressure helped prompt a series of stringent regulatory requirements derived from the framework of the 1975 Federal Resource Conservation and Recovery Act. Throughout the 1980s, landfills closed, landfill capacity dwindled, and waste disposal costs skyrocketed. Numbers representing the cost of disposal varied depending on location and waste type, but in a 1987 issue of *The Nation*, Andrew Porterfield and David Wier offer one instance of the trend: "In 1976, disposal cost $10 a ton; today the figure is between $60 and $140 a ton, in some cases even higher."

Waste haulers, who faced a creeping devaluation of their investments, employed the garbage barge in desperate searches for cheaper dump sites. In spite of objectionable episodes like the *Mobro 4000* and *Khian Sea*, the use of waste barges continued as an affordable way of transporting unwanted waste great distances. In the early 21st century, barges drew new notoriety due to changing composition of the waste stream. Barges carried proliferating forms of electronic waste—such as obsolete televisions, air conditioners, VCRs, cell phones, personal computers—from the United States, the world's leading user of electronic equipment, to a slew of developing countries, particularly in Asia and India, exacerbating environmental inequalities as impoverished workers were exposed to the hazards created by consumers thousands of miles away.

E-Waste Collection and Transportation

Superficially, the garbage barges that drew public scorn in the 1980s seem different from the wave of e-waste barges that draw attention today. The former barges came into use in part because of dwindling domestic landfill options, whereas the latter barges arose in part because of many disingenuous domestic recycling schemes. As much as 80 percent of the e-waste collected for recycling is not recycled domestically but rather exchanged with electronic recycling companies that sell it in third world countries. However, these older and newer barges have substantial commonality. Both waves of barges emerged because of the necessary and sufficient conditions like productive consumption and state powers of mediation. The garbage crisis of 1970–80 is consequential upon what sociologist Giovanni Arrighi calls the 1945–67 surge of productive consumption, the most monumental recurrent cycle of material expansion and commodity production and consumption in the history of the capitalist world economy.

The proliferation of obsolete e-waste is consequential upon a recent, recurrent global phase of financial and trade deregulation and what sociologist Manuel Castells calls the most dramatic growth in telecommunication and computer networks that, since 1990, has propelled the formation and swift diffusion of Internet-mediated communication networks for the whole spectrum of human activity. Furthermore, the power of law has yet to be brought to bear on the garbage barge industry. The United States refused to sign the 1989 Basel Convention, which was designed to reduce the transfer of hazardous waste to "less developed" countries and was ratified by 172 countries. The United States also refused to sign the Basel Convention's 1995 amendment, which strictly prohibits the exportation of hazardous waste from "developed countries" to "developing countries"—an amendment implemented by 32 of the 39 developing countries to which it applies.

U.S. Municipal Waste

The question now shifts to whether the reputation of garbage barges is unwarranted. U.S. municipal waste may constitute as little as 2 percent of the country's total production of waste, while its e-waste production comprises perhaps 1.5 percent of its municipal waste. According to Adam I. Davis, a former compost and fuel programs director for Waste Management of North America: "For the roughly 210 million tons of MSW [municipal solid waste] the United States generates each year, we generate an additional 7.6 billion tons of industrial waste, and 1.5 billion tons of mining waste, 3.2 billion tons of oil and gas, electric utility and cement kiln wastes, and 0.5 billion tons of metal processing waste." Davis's statement helps put the picture of waste production into perspective, and the military is another massive source of waste. When scholars

Barges carry electronic waste (e-waste)—obsolete televisions, air conditioners, VCRs, cell phones, and personal computers—from the United States, the world's leading user of electronic equipment. Up to 80 percent of e-waste recycling is not conducted domestically but, rather, exchanged with electronic recycling companies that sell it in underdeveloped nations. The law has not yet caught up with the proliferation of e-waste; the United States has refused to sign laws designed to reduce the transfer of hazardous waste to less developed countries.

concentrate too much on the barge and its contents and too little on the fuller picture of our production of waste, they forgo an important opportunity to understand the origins of that waste.

Consider the incongruity between the amount of waste carried on any single barge and what it took to produce it. Conceivably, we could have encountered and experienced directly *Mobro 4000*'s trash, the *Khian Sea*'s ash, and any one of the more recent waves of barges brimming with e-waste. The *Khian Sea* sailed at a time when the U.S. EPA estimated the nation's solid waste stream was nearly 160 million tons, and the e-waste barges were sailing during the first decade of the 21st century when the Basel Action Network estimated that 100 million of the nation's personal computers became obsolete each year. These productions and re-productions of solid waste and e-waste are neither small nor appear to be dwindling—particularly because the systemic scheme of planned obsolescence continues to propel streams of consumption and waste while large portions of the population continue to enjoy extravagant lifestyles. For a simple glimpse at the incongruity between the enormous accumulations of waste and the very wasteful endeavors it took to produce them, consider two remarkably suggestive statements. William McDonough says: "What most people see in their garbage cans is just the tip of the material iceberg: the product itself contains, on average, just 5 percent of the raw materials involved in making it." David Pellow, who quotes a report generated by the United Nations University, says:

> By the end of 2002, 1 billion personal computers had been sold worldwide. Even though computers are becoming smaller and more powerful, their ecological impacts are increasing. The average 53-pound desktop computer with a monitor requires 10 times its weight in fossil fuels and chemicals to manufacture . . . which makes it much more materials intensive than the automobile or refrigerator, which only require one to two times their weight in fossil fuels to make. The natural resources extracted during the manufacture of computers are so intense that is likely to have significant impact on climate change and depletion of fossil fuel resources.

The garbage barge is a fluid social and historical construct and embodiment of the present system of production and consumption. The demand to

cease the processes of production and consumption with all the ensuing forms of waste, if taken literally, would likely prompt a public health calamity. The barges offer a significant lens through which one can either see yet ignore some of the most important roots of our socioecological woes or see and address them in ecologically and socially sensitive ways.

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See Also: Archaeology of Garbage; Hazardous Materials Transportation Act; Industrial Waste; Politics of Waste.

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Beef Shortage, 1973

The 1970s are sometimes called the "decade of shortages." Perhaps best known is the oil crisis, but oil was not the only commodity in short supply. In the summer of 1973, the United States was faced with a beef shortage. Grocers had difficulty keeping their shelves stocked. Cuts of beef, such as better-quality steaks, began to be used as prizes at grand openings of retail stores. Beef had joined blenders and toasters as highly desired incentives and giveaways. Furthermore, concerned consumers began to stockpile beef. This eventually led to a greater-than-average waste of beef.

The cause of the beef shortage is multifaceted. U.S. President Richard Nixon froze the price at which beef could be sold. The cost of beef production, however, was rapidly rising. This rapid increase in production costs was tied to both natural and artificial causes.

Beef packers were unable to pass along the increased costs to their customers, which resulted in a greatly reduced supply of beef to retailers, such as grocery stores. A number of factors influenced the beef shortage of 1973 and researchers have learned a great deal about the public's response to the shortage through the study of garbage generated during the time period.

Causes

One factor in the shortage was the increased demand for meat due to a rise in the average income in the United States. For example, in 1958, the average U.S. consumer used approximately 80.5 pounds of beef a year. By 1972, consumption had risen to an average of 115.9 pounds per person. While the demand for beef was growing, so was the cost of feeding cattle. In the early 1970s, the southern corn leaf blight damaged corn crops across the country. The poor corn harvests resulted in higher prices on corn, which is commonly used in cattle feed.

Another common crop used for feeding cattle is wheat. Wheat prices also surged in the early 1970s. In the summer of 1972, the United States sold approximately 440 million bushels of wheat to the Soviet Union. Following this sale, the domestic price of wheat began to rise, further increasing the cost of feeding cattle. The increased cost of production was

then passed on to the consumer in the form of higher beef prices.

By March 1973, the consumer price index for all beef, as well as other meats also affected by higher production costs, had risen by 15 percent. On March 29, 1973, President Nixon set a price ceiling on beef. The price of corn and wheat, however, were not capped. The price of live animals was also not capped. The price ceiling on beef meant that these rising costs of production could no longer be passed on to the customer. Meat packers could no longer afford to produce beef. Cattle production began to slow, and packing plants began to shut down. U.S. Department of Agriculture reports from August 1973 show a 17 percent drop in beef production from the previous year.

Reactions

Much of what is known about how people reacted to the beef shortage has been learned by studying garbage from the time period. The Tucson Garbage Project, which began in 1973, collected data on beef consumption and waste over a period of 15 months. The data collection coincided with the beginning of the beef shortage in the spring of 1973. Data collection ended in the spring of 1974. Using the labels from supermarket packages of beef, researchers were able to record the date the meat was packaged, as well as how much the package weighed. This information was then compared with the weight of the beef found in the landfill, and a rate of waste was calculated. This rate of waste included cooked and uncooked beef, but not fat or bone.

Once the data collection had been completed, the numbers were analyzed. The analysis revealed that after the beef shortage ended, the rate of waste was about 3 percent. During the beef shortage, however, the rate of beef waste was estimated at 9 percent. This means that during the beef shortage, 9 percent of all beef purchased ended up in a landfill, but after the beef shortage ended, only 3 percent ended up in a landfill.

Researchers offered several explanations for this increase in waste during a time of short supply. First, they suggested that consumers were concerned that stores would be unable to keep beef in stock, and so they stocked up on as much beef as they could find. Second, researchers suggested that consumers purchased unfamiliar cuts of beef, which they then did not know how to cook. Finally, researchers suggested that consumers did not know how to properly store the large amounts of beef they had purchased. These factors may have led to the increased amount of beef waste during the shortage.

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See Also: Food Consumption; Food Waste Behavior; Garbage Project; Garbology; History of Consumption and Waste, U.S., 1950–Present; Meat; Sugar Shortage, 1975.

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Beijing, China

The People's Republic of China (PRC) is a compelling contemporary site for considering both the relationship of consumption and waste production to economic development and the cultural specificities of refuse in social life. Wealth per capita is generally positively correlated with the volume of refuse generated by each person in a country. This idea has been clearly evidenced in the PRC, where modernizing urban centers, like Beijing, have increasingly produced more household waste and environmental pollutants per capita as individual real income has rapidly increased during the decades of development since the 1970s. With economic development, however, the challenge of increased trash generation has also increased, with China currently producing about one-third of the world's garbage. Like many other leading urban locales in the PRC, Beijing has struggled with managing the growing amounts of waste materials produced by its pop-

ulace. Infrastructure and public sector resources, ranging from landfill capacities to the number of sanitation workers, are strained by the unwanted byproducts of economic growth and consumption. In Beijing, there exists a simultaneous dilemma of how to judge and intervene in the social norms of behavior that lie behind the culturally particular conditions of waste. From a nascent consumerism to state-sponsored mass education campaigns on recycling, the questions raised regarding refuse in the Chinese capital are grounded in historically embedded practices.

Economic Expansion

The economy of Beijing has exploded since the 1970s along with garbage produced in this ever-expanding urban zone. Since 1978, the PRC has undergone *gaige kaifang* (reform and opening up) measures that have led to historically unprecedented levels of growth in personal wealth (though with a widening income gap). This has not been a uniform expansion with equally distributed benefits across the nation; large urban centers, such as Beijing, have disproportionately reaped the gains of these reforms. Led by state efforts at privatizing select sectors of the economy, attracting foreign direct investment, and allowing for an expanded personal employment market, not only has per capita gross domestic product (GDP) increased steadily in the capital, but a domestic consumer market has also taken hold.

Consumption Expansion

In addition to the PRC growing abstractly in terms of wealth, a structural change with economic and cultural ramifications has also occurred since the 1970s: the burgeoning consumer market. Before 1978, Beijing was barely a site of modern forms of consumption and consumer waste generation. A strictly limited range of choices in consumer products was readily available, while imported foreign items were almost impossible for the general public to obtain. Moreover, under the Maoist era before 1978, modern consumer values were not characteristic of the aspirations and dispositions of the citizenry of Beijing. Social norms and state ideology focused more on fostering a production-based economy and advocated the significance of consuming basic necessities, not consumer products believed to be characteristic of much-maligned Western capitalist cultures.

Beijing in the 21st century is a lesson in transformations brought about through economic expansion and rapidly changing consumer preferences. Shopping malls abound in the urban landscape as more and more wealth is spent in the capital on retail products. Within the capital, Beijing's residents saw an 8 percent increase in their disposable incomes in 2009, comparable to the average rate of yearly per capita income growth during the past decade. This is a provocative statistic, as garbage discharge in the city has also been growing in parallel at about 8 percent a year. Consumer marketing is in ascendancy as Beijing's citizens encounter billboards, print advertisements, social media, and television commercials on a regular basis. The combination of increased disposable income, the availability of a wide scope of goods, and a nascent cultural orientation toward consumptive practices has changed the scope of waste in Beijing.

Personal automobile ownership serves as a quick indicator of the rise of consumerism and its attendant waste production in Beijing. For the burgeoning middle class in Beijing, the automobile serves as a marker of socioeconomic status, much as it did in the United States in the 1950s. As over 15,000 new cars are bought in the capital every week, the Beijing government estimates that over one million new automobiles will be registered per year during the early decades of the 21st century. This explosive growth will lead to not only increased totals in environmental waste products, such as emissions, but will also mean increased garbage associated with automobile ownership and upkeep in the near future. Urban air pollution threatens the nation's status. In 2008, the government attempted to control air pollution during the Summer Olympic Games by temporarily restricting automobile use.

Garbage

The combination of these factors is leading to increased garbage production not only in the faraway factory sites where consumer goods originate but also within Beijing itself—the end point of purchase. While simple items associated with consumption, such as plastic shopping bags and item

packaging, may seem negligible, the aggregate of such waste products disposed of by Beijing's over 17 million residents is substantial. Likewise, the turnover rate in product ownership is increasing, meaning that, more and more, Beijing residents are disposing of durable goods in favor of more up-to-date versions. Simultaneously, the private-sector food market, a minimal dimension of the economy in the 1970s, has led to an explosion in organic refuse as a surplus of food now reaches the capital.

The most immediate challenge facing Beijing is an aging waste-processing infrastructure that has not been able to keep up with the growth in Beijing's volume of household garbage. As of 2010, Beijing generates a little over 6.5 million tons of garbage per year (approximately 18,000 tons of garbage each day). By 2015, it is predicted that the capital will produce 30,000 tons per day.

Landfills

According to the Beijing Municipal Commission of City Administration, the stress on the city's 13 landfills is a critical issue, as their strained capacities are no longer a sustainable solution for future waste management. In 2010, Beijing depended on landfills to dispose of over 80 percent of its annual garbage. By comparison, Japan, a country considered to have a highly sustainable platform for waste processing, incinerates over 90 percent of its waste. With the majority of refuse generated in the urban region heading to landfill sites, Beijing's facilities are expected to reach maximum capacity by 2012. Moreover, existing landfills have side effects: toxic leakages into water sources and noxious odors for nearby neighbors have led to protests by residents against the construction of new landfills. For the city government, innovative solutions for addressing ever-greater levels of waste produced within the city limits are required. The problem is as much a matter of contentious municipal politics as it is of technological solutions.

Solutions

The city government of Beijing has recently initiated a three-part approach to solving these dilemmas. As landfills and their stored waste are a long-

Rising consumerism in Beijing has prompted more private automobile use, which in turn has contributed to more urban air pollution. Over 15,000 new cars are bought in the capital every week. Air pollution not only threatens the health of Beijing residents, as seen in the heavy smog surrounding the city above, but also its status: in 2008, the Chinese government attempted to control air pollution during the Summer Olympic Games by temporarily restricting automobile use.

term component of the urban landscape, the city has attempted to address local complaints about their side effects. In 2009, Beijing installed deodorant guns at many of its landfills in order to minimize the odors that permeate nearby neighborhoods. The scaling down of dependency on future landfills demonstrates increased state responsiveness to local citizens. These varied adjustments indicate the complex intersection of new technologies for addressing waste and the changing political scene in the PRC around matters such as government accountability and expressions of popular opinion.

As exclusive dependency on landfills is phased out, the municipal government is implementing a shift to a more diverse set of methods for processing waste. City officials intend to shift from landfills as the primary method of garbage disposal to incineration and biotreatment. Both of these more-novel methods of garbage processing are considered a step in waste processing sustainability, with incineration generating heat for energy production and biotreatment producing fertilizers. However, these changes are facing popular opposition. The construction of new incineration facilities has become particularly unpopular as urban residents in the capital fear the release of poisonous dioxins from the burning of trash in a city where air quality is already low.

The final approach by the state points to a desired transformation in the public's cultural response to waste, rather than a change in waste disposal technologies alone. Recalling the PRC's long history of mass mobilization efforts, the Beijing government has recently initiated a campaign to encourage residents to sort their garbage at the point of disposal. Likewise, public institutions, such as government offices and schools, mandate selective sorting of waste. While this may seem second nature to those in countries with a longer history of recycling, Beijing authorities have undertaken an education initiative in public areas and the media to raise awareness of this novel practice in the Beijing populace. The goal has been to actively foster a citizenship that holds itself responsible and adjusts its behavior in relation to large-scale environmental impacts.

Overall, the problems and practices associated with waste in Beijing are as much questions of cultural and political forms as they are of refuse disposal technology and infrastructure.

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See Also: China; Consumerism; Household Consumption Patterns; Politics of Waste; Shanghai, China.

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Beverages

Beverages are liquids that have been prepared by various means for human consumption. The term is broad and encompasses both alcoholic and nonalcoholic drinks, carbonated and noncarbonated drinks, and hot and cold drinks; ranging from beer, wines, liquors, coffee, tea, bottled water, soda, milk, juice, and more. Beverages have a history as long as humans have existed and have as much cultural significance as physical function.

Commercial beverages are one of the most ubiquitous manifestations of modern consumer society and generate waste both upstream and downstream in production and disposal. In the United States alone, consumers purchased more than 57 billion liters of carbonated soft drinks, 31 billion liters of bottled water, 24 billion liters of beer, and 21 billion liters of milk in 2006. Globally, more than 200 billion liters of bottled water are sold annually. Most

of these beverages come in relatively small container sizes, up to one gallon. This means that there are billions of beverage containers (made of plastic, glass, aluminum, and paper) that require disposal or recycling every year.

Before the 20th century, beer and sodas were often consumed at the point of purchase (at the saloon or soda shop), and beverages like milk were delivered in refillable glass containers. Drinks—or "tonics" as they were often called—like sarsaparilla and root beer were popular in U.S. saloons in the 1800s. Historically, bottled beverages developed hand-in-hand with mobility and leisure.

In the post–World War II era, leisure time increased along with higher incomes in the entire Western world. Car ownership became more common in the United States and in Europe, which, combined with expanded and improved highways, encouraged both work and leisure on the go. Single-serving beverages became popular for consumption in the home and during recreational activities. No longer tied to the point of purchase, consumers could bring along their favorite drink wherever they went. Beverage container packaging also served as a branding and marketing surface in an increasingly competitive marketplace.

Container Disposal

Littering soon became a major problem. Because single-serving beverages were often consumed during outdoor recreational activities where trash cans were not available, consumers often simply threw the bottle or can along the highway, in nature, or in the city. During the 1960s, there was a worldwide backlash against littering, often targeting disposable containers, which had gained market share in place of refillable glass bottles. The iconic "Crying Indian" public service announcement from Keep America Beautiful in 1971 prominently featured empty bottles as litter and directed the awareness of an entire generation of Americans to the environmental damage done by littering.

While Keep America Beautiful promoted awareness campaigns as the most appropriate way to prevent littering, many states and countries introduced mandatory container deposit legislation (also known as "bottle bills") starting in the 1970s. Vermont had a brief period with a bottle bill in the 1950s, but the first lasting bottle bill was introduced in Oregon in 1972. By 2010, 11 U.S. states had some form of bottle bill, along with many European countries and others around the world. The most successful deposit-return systems reach recycling rates of over 99 percent, such as refillable glass bottles in Norway and Sweden.

Beer

Beer brewers led the way in the development of individual-sized containers and in the adoption of disposable containers. Until Prohibition, the United States had a multitude of local breweries serving a predominantly local market with beer in refillable glass bottles that often carried a deposit. Upon return, the bottles were washed, refilled, and resold, often with trippage numbers of up to 25–30. After Prohibition ended in 1933, the previously diverse U.S. brewery market was reduced to a few, larger companies. These large companies had the capital necessary to invest in new bottling and canning technologies for disposable containers (one-way glass and steel cans). These one-way containers allowed them to cut costs by not having to accept, handle, transport, or wash refillable glass bottles. Adolph Coors Company led the way in developing a recyclable can for beverages to replace the nonrecyclable steel can, introducing the first aluminum can in 1959. Although the U.S. beverage market continues in the 21st century to be controlled by a few companies (such as Anheuser-Busch Inbev and MillerCoors), there has been a large growth in the number of microbreweries.

Sodas

Sodas have seen a similar trajectory toward large multinational corporations like Coca-Cola and PepsiCo. Coca-Cola, which owns more than 400 brands worldwide, sells more than 1.6 billion drinks every day. While in the Western world one-way containers are the norm, refillable containers still dominate other markets like Latin America. Soda companies have been criticized about their use of scarce local water resources in the manufacture of bottled beverages, such as in the state of Kerala, India, where protesters first claimed in 2003 that Coca-Cola's manufacturing plant had depleted groundwater resources and emitted toxic

sludge. In the United States, beverage companies often use high fructose corn syrup as a sweetener, while the rest of the world generally uses cane sugar. Diet sodas use artificial sweeteners.

Bottled Water

Bottled water is the fastest-growing beverage industry in the world. In the early 1970s, bottled water hardly showed up in the statistics on beverage consumption. By 2010, bottled water was the second most popular commercial beverage in the United States. Internationally, Italy, France, and Mexico lead in consumption of bottled water. Bottled water is highly sensitive to narratives of origin. Many of the well-established brand names have their roots in historical spa resorts around actual springs, such as Evian, San Pellegrino, Perrier, Poland Spring, and Vittel, though some of these brands have been criticized for having lost the connection to the original spring in the transition to industrial mass production. Poland Spring, for instance, taps water from boreholes far from the original spring. Most low-end brands are purified water from municipal water supplies.

Coffee and Tea

Coffee and tea have a ritual place in many societies, such as the morning cup of coffee and afternoon tea time. In 1999, 54 percent of Americans drank coffee every day. Scandinavians consume the most coffee per capita in the world, with Finland topping the list at 12 kilograms per person per year. Americans, in comparison, averaged 4.2 kilograms in 2008. Starbucks, founded in 1971 in Seattle, Washington, has become emblematic of modern coffee consumption, with more than 15,000 stores in 50 countries by 2010. These new coffee houses offer coffee primarily in takeaway paper or styrofoam cups, rather than asking the customers to consume their coffee onsite from washable ceramic cups. The waste production from these throwaway containers is considerable, which has prompted coffee companies like Starbucks to offer incentives to consumers to use their own refillable mugs as well as to recycle the paper cups. The newest technological development in coffee consumption is espresso capsule machines that use a small prepackaged coffee capsule to prepare one cup at a time, such as Nespresso, founded in 1986. While this technology allows the convenience of an instantly brewed cup of coffee, it also generates considerable packaging waste of plastic or aluminum capsules.

Other Beverages

Other beverages for household consumption, such as milk and juice, come in either plastic jugs or plastic-covered cardboard packaging. Although milk continues to be primarily a short-traveled commodity, juice products are marketed as place-based commodities, such as orange juice from Florida. The commercial orange juice industry developed in Florida in the 1920s and expanded dramatically after the discovery of pasteurization methods and improvements in canning technology. Tropicana Products, which was the first company to sell not-from-concentrate orange juice in 1954, now has a 65 percent market share in the U.S. orange juice market and sells its products worldwide.

Brand Recognition

Beverages as consumer products are hard to separate from their packaging, which makes them portable, protects them, and serves as a branding and marketing surface. The packaging comprises a majority of the waste produced by beverages, though transportation and water extraction can also be environmentally damaging. Beverage producers are often reluctant to change the packaging or contents of beverages because many beverage brands have developed a strong consumer following and brand recognition. In 1985, Coca-Cola faced massive protests from its customers when the company changed its recipe in an attempt to modernize the classic drink; this event is now remembered as one of the biggest failures in the history of marketing. Likewise, some consumers claim that the packaging material changes the flavor of the contents, saying Coca-Cola tastes differently in glass bottles, aluminum cans, and PET plastic bottles.

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See Also: Consumerism; Food Consumption; Packaging and Product Containers; Recycling; Water Consumption.

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BFI

See Browning-Ferris Industries

Biodegradable

Biodegradable matter is material capable of being decomposed by bacteria or other biological means. Biodegradable matter usually consists of organic materials such as plant, animal, and other substance matter originating from living organisms. It has the ability to be broken down into smaller, harmless products by way of the action of living organisms. The term is often used in relation to ecology, garbology, and waste management. Biodegradable products are often associated with perishables (products, food, and waste materials subject to death or decay). The term *biodegradability* of a product refers to its disposition to disintegrate as the result of natural processes.

Benefits

Biodegradable waste is usually regarded as less harmful to human health and the environment than nonbiodegradable waste. Environmental pollution caused by discarding biodegradable waste products, such as human, animal, and vegetable waste, is normally rendered harmless by natural processes and so causes no permanent harm. Most biodegradable products and waste products can be used for replenishing the natural food cycle; such products can provide soil nutrients necessary for the regeneration of life. In urban, industrial environments, biodegradable waste products, normally well suited for natural cycles such as fertilization, are used less frequently than in agricultural areas.

Complications

However, because of human population growth and the steadily increasing levels of consumption, biodegradable waste produced in large quantities cannot be easily disposed of and processed and can cause severe environmental and health problems. Biodegradable waste such as cattle manure is produced in increasingly large quantities because of large-scale commercial farming targeted to meet demands of an increasingly wealthy population. According to research in garbology and waste management literature in industrial countries, most biodegradable (waste) products are destroyed in waste incinerators and processed together with nonbiodegradable waste. Because of chemical and often harmful substances used for sewage treatment, human waste is also mostly wasted. Household refuse analysis shows that the populations of industrial countries discard as much as 40 percent of biodegradable products, especially food remains, into mixed garbage containers.

Collection and Use

Urban biodegradable waste collection varies across countries. In most countries in Europe and in the United States, biodegradable garbage is collected or separated at waste processing plants infrequently and often only in the largest metropolitan areas. While statistics differ in each country and by the type of research conducted in the industrialized countries, there are virtually no statistics available on the use of biodegradable waste in developing countries. In many developing countries, biodegradable waste is dumped together with nonbiodegradable waste (such as plastic and chemical waste) in mixed landfills or burned in mixed incinerators. Aside from a few countries, notably in northern Europe, that try to promote use for the vast quan-

tities of daily discarded biodegradable waste, few global efforts have been made to address the issue of wasteful waste treatment practices.

Product Design Sustainability

In their influential 2002 book *Cradle to Cradle*, William McDonough and Michael Braungart pioneered the notion of product design sustainability that is primarily based on the importance of biodegradable products as a solution for modern industrial waste. In the cradle to cradle model, all materials used in industrial or commercial processes may be placed into two categories: technical or biological (biodegradable) nutrients. Biological nutrients are similar to biodegradable products and can be disposed of in any natural environment and decompose into the soil, re-entering the biological life cycle without affecting health or the natural environment. Technical nutrients, which are nontoxic, nonharmful synthetic materials that have no negative effects on the natural environment, can be used in continuous cycles without being "downcycled" into lesser products, ultimately becoming waste. In this view, both synthetic (but nonharmful) and biodegradable products can be either continuously "reused" or "re-entered into the (natural) cycle" without harming human health or the environment. While ecologically friendlier products, such as biodegradable washing detergents, gained in popularity among the industrial countries' environmentally conscious middle classes, these do not have a universal marketing appeal. Commercial companies have recently stepped up production of many types of biodegradable products, including cups, plates, and containers. Unfortunately, these products do not follow through the whole processing chain and get dumped in mixed garbage containers. In the early 21st century, such products are almost absent from developing countries, where few special processing facilities for such waste are present.

Biodegradable Plastics

One significant positive trend to counter the increased problem of waste is the introduction of biodegradable plastic and polymer technology. Biodegradable plastics and polymers are currently being developed, and, according to Emo Chiellini and Roberto Solaro, their use in industrial countries is on the rise. Originally, synthetic substances were produced to counteract biodegradable processes and were widely praised for their durability and inability to disintegrate for centuries. Even the simplest consumer products whose cycles were supposed to be stopped with one-time use, such as plastic water bottles or aluminum beer cans, were made of materials that would "live" much longer than the consumable product they contained.

The production of plastic materials has risen sharply in both industrialized and developing societies. This is due to expectations for the rising demand of polymeric production and the expected tripling of this demand in the first decade of the 21st century. The average annual consumption of plastic materials per capita in industrialized countries was over 100 kg (and rising) per capita per year in 2010, and developing countries were catching up. This created a serious plastic waste burden, which can be tackled by developing biodegradable plastic products.

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See Also: Composting; Downcycling; Food Waste Behavior; Garbology; Human Waste; Incinerator Waste; Sewage Treatment.

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Books

In an industrial culture governed by the logic of planned obsolescence and disposability, books seem to enjoy—more than most commodities—a durable sense of value. Books are eminently collectible. Libraries, both personal and public, are dedicated to the preservation of durable hardback volumes, while even the flimsiest mass-market paperbacks can circulate for many years in a thriving resale economy. Nevertheless, this elect status among consumer goods is, for the most part, a matter of delaying the inevitable; the majority of books sooner or later end up in the landfill.

Production

Over the 20th century, the way books were both published and distributed changed substantially, contributing to a system based on the production—and, in many cases, the overproduction—of massive numbers of books every year. A booming paperback industry contributed greatly to this postwar abundance of reading material as did the rise of "big box" chain stores in the 1980s and 1990s, bringing the book market to consumers in smaller cities and suburbs.

Inexact and conflicting as they might be, figures on the number of books published each year are available, and these estimates suggest that the industrial-scale production of books is a massive potential source of material waste. Bowker, the company responsible for assigning ISBN numbers to published books, determined that 288,355 new U.S. book titles and editions were published in 2009. This means that approximately 794 books are published every day (around 33 new titles per hour). This figure does not, however, take into account the exponential growth of the "publication on demand" industry being pioneered by small presses. When the estimated 764,448 new titles and reprints produced in these nontraditional venues are accounted for, the United States published over a million new titles and reprints in 2009.

The total number of books published each year is likewise difficult to establish with any certainty. For trade books, the average "first run" of any new title is around 5,000 copies for a medium-sized publisher and 10,000 for the larger publishing houses. These numbers, however, can vary significantly; a first printing for a cultural phenomenon such as the Harry Potter series can run to several million copies, while the small presses catering to the "on demand" market can print as few as one copy at a time. Estimates that account for every major publication category (adult and juvenile trade, mass-market paperbacks, religious, professional/scholarly, university press, elementary, high school, and college texts) suggest that nearly 2.5 billion units were published in 2005, the largest share of those (nearly 1 billion) coming from trade books.

Disposal

Unfortunately, none of these figures help resolve the problem of determining how many of the books purchased in any given year end up in the trash. The findings of a landfill excavation project conducted by William Rathje of the University of Arizona suggest that paper is the greatest contributor to the municipal waste stream. The study attributes much of this paper waste to two sources: telephone directories and newspapers. However, considering the massive numbers of trade books published over the course of a year, it is reasonable to conclude that the multibillion dollar publishing industry makes a substantial contribution to the mass of waste paper consigned to the landfill every year.

Historical Recycling

Books have a complicated history with waste and recycling; the publishing industry at the beginning of the 19th century created a market for linen and cotton rags. It represented an important early market for postconsumer materials, allowing networks of rag dealers and scavengers to return discarded materials to paper mills. Changes in papermaking, including a transition to woodpulp, gradually lessened the market for rags and increased consump-

tion of wood fibers by the beginning of the 20th century.

Waste

A startling amount of waste is actually built into the system of publication and distribution through the long-standing policy of buying back remainders (unsold titles) from booksellers. Estimates suggest that as many as 30 percent of hardbacks and 40 percent of paperbacks travel from the press to the landfill without being purchased or read. The economics of traditional publishing, which relies on lithographic printing technology, requires a set number of copies (usually a few thousand) to be "run" to allow for a sufficient return on the publisher's initial investment, and the more copies of a book produced in a run, the greater the return potentially becomes. Once all the preproduction labor required to produce a book has been completed, lithographic presses are extremely efficient in satisfying the demand that a bestseller can generate; a lithographic (or "offset") printing press can churn out more than a million books in a 24-hour period. It therefore makes better economic sense for a publisher to produce more copies of a novel than the amount that will actually be sold, since every subsequent run requires its own start-up costs that cut into the publisher's profits. Overproduction is the result of such a system, and warehouses (and landfills) full of remaindered books are the inevitable outcome when even a small percentage of the hundreds of thousands of titles produced every year fail to sell out their first edition.

Waste paper consigned to landfills, including discarded books and telephone directories, may be the biggest contributor to the municipal waste stream. Some estimates calculate that an average of 35 percent of printed books go directly to a landfill.

Print on Demand and E-Books

Print on demand (POD), which relies on digital production technologies that can publish individual texts to order, promises to alleviate some of the habitual excess attending mainstream publishing practices. While huge first runs for big name authors remain standard due to the efficiency of lithographic printing technology, POD is currently the most rapidly growing branch of the publishing industry.

Though e-books, which are electronic reading devices that allow customers to purchase and read portable document files (PDFs) of books, have made inroads into 21st century reading culture, they have yet to seize a substantial share of the publishing market. Estimates suggest that only around 10 percent of books purchased are electronic versions. While these devices, in conserving paper and trees, arguably offer an environmentally friendly alternative to the paper-based texts currently depleting forests; the rapid evolution of electronic reading platforms and programs suggests a calculated obsolescence to e-books that far exceeds the impermanence of their analog counterparts. In addition, these devices' status as toxic e-waste further underscores the fact that the publishing industry, even if it does successfully shift to electronic formats, can never completely eliminate waste from the technologies of reading.

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See Also: Consumption Patterns; Garbology; Magazines and Newspapers; Paper and Landfills.

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Brazil

The Federative Republic of Brazil is the largest country in South America. It is the world's fifth-largest country, both by geographical area and by population, and the only Portuguese-speaking country in the Western Hemisphere. In 2010, its population was estimated at 193 million people by the Brazilian Institute of Geography and Statistics (IBGE), occupying an area of 5,290,899 square miles. The territory of the country is divided into five main regions (South, Southeast, Central-West, North, and Northeast), 26 states, one Federal District (where the capital city, Brasília, is located) and 5,565 municipalities. Some municipalities are considered megacities, with populations greater than 10 million inhabitants (for example, São Paulo and Rio de Janeiro), and some have less than 1,000 people, showing the level of diversity that represents the different regions of country.

The Brazilian economy was one of the fastest growing in the world by 2010, making Brazil one of the major emerging markets. The country occupies the eighth position when ranked in terms of nominal gross domestic product (GDP) ($1.571,979 trillion 2009) and the ninth world economy by purchasing power parity (PPP). This level of GDP was achieved despite significant parts of the population living at very low income levels and thus falling outside the consumer market for most significant sectors. This situation has been improving in the 21st century due to economic stability, public investments, and social programs.

History

Europeans first encountered Brazil on April 22, 1500, with a fleet of ships led by Pedro Álvares Cabral, a Portuguese noble, military commander, navigator, and explorer. Initially, the Portuguese called it *Terra de Vera Cruz* (Land of Vera Cruz) and the territory was claimed by Portugal after its discovery, although colonization was only effective in the early 1530s, when the first settlement was founded.

By the time of the Portuguese arrival, the territory was already occupied by different indigenous people divided into more than 2,000 nations and tribes. These people were traditionally seminomadic tribes who subsisted on hunting, fishing, and agriculture. Fossil records show evidence that the area had been inhabited by indigenous groups for at least 8,000 years. Some of these tribes were assimilated by the Portuguese, while others were enslaved or exterminated during various periods of war. The indigenous people were also affected by different types of European diseases (such as measles, smallpox, tuberculosis, and influenza) to which they had no immunity, killing tens of thousands. The Portuguese saw the natives as "noble savages," and miscegenation of the population was commonplace.

After years trying to enslave the native people in order to use them as labor to exploit the abundant natural resources and in sugar production, which had become Brazil's most important export and economic activity in the 16th century, the Portuguese started to import African slaves to work in the sugarcane plantations. Portugal controlled the African slave trade by the time of the sugar expansion. These processes are important to acknowledge as they have profoundly shaped the country's social structure and economy, and the cultural and ethnic diversity that still characterizes Brazil in the 21st century. Historical data show that about 3 million Africans were brought to Brazil from the 16th to the 19th century, when Brazil was officially a Portuguese colony. This process lasted until 1888, when slavery was finally abolished in the country by the *Lei Áurea* (the Golden Law), a legal act of Princess Isabel, Empress of Brazil. Brazil was the last nation in the Western world to abolish slavery.

The end of slavery was part of a broader process that contributed to the construction of Brazilian society in the same period of time that the country

became independent from Portugal (September 7, 1822), when Dom Pedro I—the son of Dom João VI, King of Portugal—declared the independence of Brazil. After its independence from Portugal, Brazil became a monarchy called the Empire of Brazil, which lasted until the establishment of a republican government on November 15, 1889. The end of the empire in 1889 and the foundation of the republic was a direct consequence of the abolition of slavery the year before, which had created a serious threat to the interests of the economic and political oligarchy.

The period of the Old Republic (1889–1930) marked the replacement of sugar by coffee as the country's main export in the late 19th century. The economic prosperity brought by the coffee trade was the main attracting force for foreign immigrants, mainly from Italy, Japan, and Germany. This influx of labor allowed the country to develop an emerging industrial economy and expand its economic activities away from the coastlines. This period ended with a military coup that placed a civilian and dictatorial ruler, Getúlio Vargas, into power.

After 1930, the successive governments, with many periods of dictatorships (1930–34, 1937–45, and 1964–85) and democracy (1934–37, 1946–51, 1951–54), continued the expansion of industrial activities and the development of agriculture throughout the vast interior of Brazil. In 1960, the capital of Brazil moved from Rio de Janeiro to Brasília.

The period after the military dictatorship (1964–85) was marked by several financial crises, hyperinflation, and the beginning of the neoliberal agenda in the country. Although the consolidation of democracy and some economic and financial stability were achieved during the 1990s with the change of the currency to the Brazilian real (R$) before and during Fernando Henrique Cardoso's terms (1994–2002), it also deepened social inequalities and poverty. This socioeconomic contradiction opened the opportunity for the election of Luiz Inácio Lula da Silva, a former trade union leader, as the president of Brazil. Although Lula had social programs at the top of his political agenda during his electoral campaign and two administrations, he kept very strict macroeconomic policies that gained confidence from the market, providing a favorable environment for public and private investments. These investments, combined with policy improvements in the social area, have fostered a large-scale process of economic development and social inclusion.

Consumption

Since the 1980s, Brazil has undergone a notable and accelerated modernization process. From a rural and single-product economy, Brazil's economy has become dynamic. Brazilian industries have been growing not only in numbers but also in size and competitiveness, although major political and institutional reforms are still needed. The financial stability achieved, combined with more effective 21st-century social and economic policies, have paved the way for the recent economic growth that has also benefited from high commodities prices. These changes fostered an important internal market, as many historically poor families have been brought to the middle-class lifestyle that includes different patterns of consumption.

The new Brazilian middle class is an important part of the social, economic, and cultural change of the country. This group has the opportunity to buy a number of products that it was not able to in the past. According to official data, 97.8 percent of Brazilian households own an oven or gas cooker, 50.3 percent are equipped with water filters, 89.2 percent have a refrigerator, 16.4 percent have a freezer, 37.5 percent have a washing machine, 87.9 percent own an AM/FM stereo radio, 93 percent own a television, 22.1 percent have a personal computer, and 74.5 percent have at least one telephone (mobile or fixed).

The Brazilian population does not have a homogenous consumption habit, since different classes of consumers are encountered in the Brazilian internal market as a result of a historical inequality in income distribution. For instance, lower-income groups spend more on food and beverage items. On the other hand, new and traditional middle class consumption patterns show an increase not only in expenditures on transportation, communication, and durable goods but also on leisure activities, health, and education. Shopping is integrated into the lifestyle of the Brazilian urban population as a

usual and necessary activity. Shopping malls, outlets, supermarkets, and convenience stores can be found in many cities.

Waste

As a direct consequence of the social inclusion process and economic growth, combined with an urbanization rate of more than 82 percent and a lack of adequate urban planning, solid waste in urban areas is considered one of the most pressing issues and a top priority for environment sustainability. It is also one of the most costly services provided by a Brazilian city to its residents, and is becoming even more expensive.

It is estimated that from the 170,000 tons of solid waste generated on a daily basis in the country (13 larger cities generate 32 percent of the total; 525 municipalities with more than 50,000 inhabitants generate around 80 percent), only 140,000 tons are collected. More than 60 percent of the total solid waste collected, however, does not have an adequate final destination. It is mainly disposed of in landfills or simply dumped into empty areas, the so-called *lixões* (big trash). The situation requires solutions for the final disposal of waste, with a view to increasing recycling participation and reducing the total volume of waste generated.

There is also a threat that the current model based on landfills will physically collapse. With an increasing urban population and higher consumption levels, the model to dispose solid waste in landfills is expected to be exhausted in the early or mid-21st century. With the upcoming end of many landfills in Brazil, some states and cities have been looking for more modern alternatives to dispose of their solid waste. This is especially true in the southeastern large cities, the region where the important areas of São Paulo, Rio de Janeiro, and Minas Gerais are located. They account for more than 40 percent of the total population and just over 50 percent of Brazil's GPD. Many disposal alternatives may economically value the waste, which in most cases is simply burned.

The Basic Sanitation Act is considered to be a landmark for the implementation of initiatives related to solid waste. At the same time, the National Solid Waste Policy was approved in August 2010, after 20 years of discussion in the national congress. It regulates the collection, final disposal, and treatment of urban, hazardous, and industrial waste. It also provides the guidelines to reduce the generation of waste and the level of pollution of the environment by instituting a waste management hierarchy. It has also introduced measures to facilitate the return of solid waste to original producers with emphasis on reverse logistics so that they can be treated and reused in new products.

The framework also provides the opportunity for the introduction of economic incentives for recycling activities at the same time that it establishes the principle of shared responsibility for the lifecycle of the products in which manufactures, importers, distributors, vendors, and consumers are responsible together with solid waste management agents. The law has also introduced the National Solid Waste Planning Program under responsibility of the federal government that will be updated every four years, taking into account new developments in the area. This planning process will also be able to establish recycling goals and provide financial support to improve solid waste models.

One of the opportunities that appears as an alternative to the old landfill model is solid waste thermal treatment with power generation systems, widely used in Europe and Japan. In Brazil, there are no specific instruments in place to encourage this type of thermal treatment or other possible existing technologies, although there are some experiments under way, especially in large cities such as São Paulo and Rio de Janeiro. Some of these alternatives still face a number of barriers, including a lack of adequate funding for new technologies and solid waste management models, technical and institutional barriers, and cultural resistance. However, alternatives to current models are not only desirable but also necessary. After a long history of low consumption patterns and inadequate solid waste management, Brazil will have to face this challenge to sustain its social development and economic growth.

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See Also: Developing Countries; Rio de Janeiro, Brazil; São Paulo, Brazil.

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Browning-Ferris Industries

Before its acquisition by Allied Waste, Browning-Ferris Industries (BFI) was the second-largest waste disposal company (second to Waste Management, Inc.), offering a full range of waste, recycling, and sanitation services. At one time, BFI operated in nearly 800 locations in Asia, Australia, Europe, the Middle East, New Zealand, and North America with BFI's North American operations including 104 solid waste landfill sites, 32 medical-waste treatment facilities, and 125 recycling facilities.

Birth and Rise of BFI

Tom Fatjo Jr. founded BFI in 1966. The birth of BFI was a result of national legislation, the Solid Waste Disposal Act, designed to regulate waste collection and disposal services, including higher standards of sanitation from collection trucks and increased use of landfill burial over incineration due to concerns about air pollution. Tighter government regulation necessitated larger capital investments by waste collectors, unobtainable by most small, family-owned businesses, which were the primary waste collectors of the time. This regulatory change created an opportunity for a larger, broader-reaching company that could professionalize the waste-management business.

Beginning by collecting residential waste with a single truck in Houston, Texas, Fatjo expanded his business to include collection of commercial and industrial waste. By 1968, Fatjo expanded into waste disposal, winning a large contract from the city of Houston. Partnering with corporate financier Louis A. Walters, Fatjo and Walters formulated a program of acquisitions of smaller collection and disposal companies across Texas and the southern United States. To raise capital for the acquisition program, in 1969, Fatjo and Walters acquired control of Browning-Ferris Machinery Company, a publicly traded manufacturer of, among other things, garbage trucks and landfill equipment.

In 10 short years, BFI had grown tremendously. Revenues were over $250 million, and the corporation accumulated over 60 landfills, becoming a critical asset. Regulation and increasing public anxiety made the creation of new landfills nearly unobtainable and maintenance of existing landfills increasingly expensive, thus helping create a natural monopoly. As early adopters, BFI and Waste Management were able to grow largely as a result of barriers to entry.

Congress passed the Resource Conservation and Recovery Act in 1976 (implemented by 1980), which was legislation designed to tighten control of potentially dangerous landfills, including chemical and toxic waste. With a similar effect as the Solid Waste Disposal Act, this legislation again helped create natural monopolies, as experienced companies such as BFI grew, while others were denied entry. By 1983, chemical waste provided 10 percent of BFI's revenue. However, by 1984, BFI was under investigation in seven states for charges of monopolistic practices, including price-fixing. These charges were denied, although BFI paid $15 million in out-of-court settlements by 1989. BFI's toxic landfills became a liability, ultimately resulting in BFI's withdrawal from the toxic-waste industry in 1990.

Recycling

Diversifying its interests, BFI experimented with paper waste recycling. However, declines in paper manufacturing proved detrimental to the paper recycling business for BFI, which created a spin-off company in 1975 for this segment of the business.

After instituting effective operational cost-cutting measures to resurrect the organization, BFI CEO and former Environmental Protection Agency director William D. Ruckelshaus was determined to grow the organization through recycling efforts despite wary naysayers. Focusing on paper waste, which accounted for 45 percent of the U.S. waste stream and soon would represent 85 percent of BFI's recycling business, BFI's recycling division grew astronomically, from less than $10 million in 1990 to $675 million annually by 1995.

With its recycling initiatives proven successful, BFI began to duplicate its earlier strategy of rapid acquisition. Also reflective of the past, government regulation in the waste industry ensured BFI's success by denying entry to smaller, would-be competitors.

Decline

In 1997, Browning-Ferris Industries Inc., retreating from an ambitious global expansion, agreed to sell its international operations to Sita, a unit of France's Suex Lyonnaise des Eaux SA, for $1.4 billion in order to focus on its core North American business. Sita's purchase of BFI's international operations made Sita Europe's largest waste-management company.

In 1998, BFI's internal growth averaged less than 1 percent, with Deutsche Bank Securities analyst Mari Bari downgrading the cost per share, maintaining a hold rating on BFI's stock, and not recommending BFI stock for purchase or sale.

By 1999, BFI had lost its acquisition power, selling its medical waste unit to Stericycle after a failed bid to acquire Texas-based MedServe, Inc., Stericycle's distant competitor. The remainder of BFI was acquired through a merger with Allied Waste Industries, making Allied Waste the second-largest waste management company in the United States (still second to Waste Management, Inc.). The U.S. Department of Justice's Antitrust Division approved the merger with the caveat that the merged corporation (Allied Waste) sell operations in 18 metropolitan areas in 13 states, from Massachusetts to California, to avoid monopolization.

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See Also: Recycling; Recycling in History; Resource Conservation and Recovery Act; Solid Waste Disposal Act; Waste Management, Inc.

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Bubonic Plague

Bubonic plague is the most common and curable form of the bacterial disease plague and is caused by infection with the *Yersinia pestis* bacterium. The term *bubonic plague* comes from the classic symptom of swollen glands, or buboes, on the body. There are also pneumonic and septicemic forms of plague. Plague is a disease found naturally in rodent populations. While rats are the most common carriers, it occurs in mice, squirrels, prairie dogs, chipmunks, marmots, and dozens of other species. It is transmitted from rodent to rodent by fleas. Occasionally, humans enter the cycle, resulting in havoc.

Plague caused three of the most devastating pandemics in history, including the Black Death of medieval Europe. During a pandemic, spread of the disease is accelerated by specific environmental conditions. In the past, overcrowding in villages and cities, proximity to dirt and filth, poor personal hygiene, the absence of public sanitation, and limited medical knowledge all combined to create the ideal breeding ground for plague. Modern public health standards and antibiotics keep outbreaks of the plague contained in the 21st century, although cases do still occur where humans encounter affected animals in the wild.

Forms of Plague

Humans can display three different forms of plague. Bubonic plague is the most common, causing the

vast majority of cases throughout history. It spreads by *Yersinia*-infected fleas transmitted from rodent to person. Two to six days after bites from infected fleas, individuals show signs of infection. The most characteristic symptom is the appearance of swollen lymph glands, called "buboes," in the groin, neck, and armpits. Other symptoms include headache, dizziness, vomiting, shivering, sleeplessness, apathy, delirium, and terrible pain in the extremities. Death typically occurs in untreated individuals within a week of the emergence of symptoms. The bubonic form of plague causes death in more than 50 percent of untreated cases.

Septicemic plague can occur when *Yersinia pestis* enters and quickly multiplies in the bloodstream. It can result from direct fleabites or as a complication of bubonic plague. The bloodstream can be invaded so quickly that a person can die from septicemic plague before the bubonic symptoms even appear. Symptoms of this form of plague include septic shock, meningitis, and coma. Uncontrolled bleeding under the skin can cause black patches. Untreated, the mortality rate is almost 100 percent.

Pneumonic plague is the least common but most fatal form of plague. It is highly infectious and is the only form that can be transmitted human-to-human. It can appear as a complication of bubonic plague. If *Y. pestis* invades the lungs, severe pneumonia follows. Weakness, shortness of breath, and coughing increase as the lungs fill with fluid. Coughing and spitting produce droplets filled with the highly infectious bacteria, which is easily inhaled by those nearby. Patients who do not receive treatment within hours of the onset of symptoms will not survive. Death can occur within 24 hours of exposure.

Plague in History

There have been three distinct and well-documented plague pandemics in the last 2,000 years, each having a huge impact on human society. The first, called the plague of Justinian, arrived in Constantinople in 542 from either northern India or central Africa. The plague followed trade routes as infected rats hitchhiked on ships of grain being delivered throughout the Mediterranean Sea. Waves of the plague reappeared throughout Europe for 200 years. It is estimated that over 100 million people died.

The second pandemic began in 1346. By the time it was over, the population of Europe and the Middle East was reduced from 100 million to 80 million people. At the height of the epidemic, thousands were dying daily in larger cities such as London and Marseille. The bodies could not be collected and buried fast enough, increasing the spread of sickness. At the time, the plague was called the Great Pestilence or the Great Dying. Centuries later, it was referred to as the Black Death. During the Great Pestilence, the infected fleas and their host rats traveled along the Silk Road from central Asia. From the caravan routes to ships that crossed the Caspian Sea, the rats traveled from port to port, spreading plague to humans living in filthy, crowded, rat-infested cities. By 1348, the plague was in England. It reached Scandinavia and Russia, making a complete circuit, by 1352.

No one in the medieval era knew that microbes cause disease. Public health measures were crude and often caused more harm than good. During the epidemic, ships were quarantined upon docking for 40 days, but rats left the ships by way of the ropes. Infected individuals were closed up in their homes with healthy family members, causing entire families to die. Human waste and dead rats littered the streets. People rarely bathed, changed clothes, or washed bedding, providing an ideal environment to harbor infected fleas. So many people were sick, dead, dying, or fleeing from the plague, there was no one left to maintain the few social services that existed—nursing the sick, cleaning waste from the streets, or collecting and burying the dead. Plague epidemics continued to strike Europe at irregular intervals through the 18th century.

The third pandemic began in the 1860s in the Yunnan Province of China. After killing millions again in China and India, the plague spread worldwide, thanks to modern rail and steamship trade. For the first time, bubonic plague spread to all inhabited continents. The pandemic was considered active by the World Health Organization until 1959, when worldwide casualties dropped to under 200 per year. Although the plague appears to be dormant, the disease still exists in rodent populations, and occasional cases of bubonic plague still appear where people come in contact with these animals.

Treatment and Prevention

Researchers working in Asia during the third pandemic finally isolated the plague bacterium and identified fleas as the plague vector (the delivery method). In the 21st century, vaccines are available, and antibiotics exist that can cure most cases of the plague when identified and treated quickly. Streptomycin, tetracycline, and doxycycline are all effective in curing bubonic plague. The mortality rate for plague has dropped to 5–15 percent, and the majority of those deaths are the result of a delay in diagnosis and treatment.

Modern medicine, well-developed public health and sanitation policies, and increased standards of personal health and hygiene have made outbreaks of plague very rare. However, it is still endemic in regions of Africa, Asia, and North and South America. Agencies like the Centers for Disease Control, the World Health Organization, and other state and local agencies perform active surveillance for outbreaks of the plague and other infectious diseases. Decreasing the rodent population through proper waste management, using insecticides to control the flea population, and educating the public about signs and symptoms of infection all help minimize the impact of the plague on 21st-century society.

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See Also: Funerals/Corpses; Germ Theory of Disease; Public Health; Slums.

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Buenos Aires, Argentina

Buenos Aires is the capital of Argentina and the nation's center of economic activity since its establishment by Spanish merchants in the 16th century. As of the 2001 census, the greater metropolitan region is home to one-third of Argentina's population, with more than 13 million people.

The impoverished people of the shantytowns within the capital and in the larger Province of Buenos Aires carry out most of the recycling in the city. Since the 2001 economic crisis, a common figure roaming the capital's streets is the *cartonero* (a cardboard recycler) who retrieves the remnants of society's consumption, thereby contributing to the environmental cleanup and overall conditions within the metropolitan area. Argentine recycling thus is quite unlike efforts in more developed nations where recycling typically falls within the province of an educated, relatively affluent class of citizens. Recycling in Buenos Aires also is clearly decentralized and piecemeal; it is comprised of a series of individual efforts toward economic survival, rather than a coordinated campaign whose aim is ecological sustainability. Buenos Aires has no municipal department or organization devoted to recycling. Solid Waste Management Department is in charge of a recycling service.

Cartoneros

The cartonero first emerged on a widespread scale in Buenos Aires with the 2001 demise of the 1991 Convertibility Plan, whereby the Argentine peso was tied to the U.S. dollar. The collapse of the national economy resulted in the freezing of bank accounts and the biggest foreign debt default in world economic history. The percentage of people who were unemployed or underemployed increased dramatically in the wake of this crisis, and many of the newly unemployed were from the middle classes who encountered poverty for the first time. Confronted with this hardship, people turned to rummaging and sorting through trash to collect recyclable material—usually cardboard—in order to sell it to the recycling companies located in the suburbs of Buenos Aires. The term *cartonero* is somewhat of a misnomer because these informal circuits of recyclers also collect glass bottles, plastic, newspapers, and metal.

History

Although the cartonero is a recent phenomenon, the history of the disposal of material wastes and the circulation of garbage in Buenos Aires stretches back centuries, beginning with the foundation of the city, in 1580, by Juan de Garay. Governmental urban hygiene policies have shaped the living conditions of the poor who depend on others' trash to survive. In 1860, for example, the municipality established the system of the *Quema* (meaning "burn") in the southern part of the city where trash was sent for incineration. This was a new technique that illustrates a major change in how Buenos Aires treated and disposed of waste. Before the Quema, trash was typically thrown into streams, indoor wells, or fields. Accompanying the advent of the Quema was the emergence of a new neighborhood in the same area inhabited exclusively by people devoted to the collection of garbage. By the end of the 1920s, the lower Flores neighborhood dump in the capital became the largest waste disposal site in the city. It lasted until the 1960s, when it was cleaned up and urbanized with the construction of the Almirante Brown Park and the channeling of the Cildañez stream. For many years, men, women, and children had collected paper, used rags, cans, glass, and even bones, gathering them for use as a source of heat. Argentine painter Antonio Berni portrayed the misery of the garbage collectors in the lower Flores neighborhood by inventing a character, Juanito Laguna, a young man whose daily survival depends on scraping together all sorts of remnants from the city.

Between the 1930s and the 1970s, two different social actors emerged in the domain of informal trash collection: the *botellero* (the bottle collector) and the *ciruja* (the junkman), the former surviving by collecting trash that had been initially disposed of in both municipal and clandestine dumps. In 1977, with the creation of the company Cinturón Ecológico Área Metropolitana del Estado (CEAMSE or State Metropolitan Area Ecological Belt), the government forbade the use of industrial incinerators in the Buenos Aires area and replaced them with landfills. In this same year, through the enactment of law 8782/77, the government prohibited the act of collecting garbage and waste, which was thought to inevitably result in their incineration. This new policy put an end to burning trash and made garbage collection accessible to only a select group of companies. The economic crisis and unemployment of the 1990s once again led to the emergence of waste collection through new and very different modalities.

Effects and Culture of Cartoneros

Cultural anthropologists, sociologists, and historians do not agree on the exact date for the emergence of the cartoneros phenomenon. While some scholars directly connect it to the economic collapse in 2001, other scholars have suggested that the practice of collecting waste was already well under way by the middle of the 1990s. A major source of this scholarly disagreement stems from the fact that it is quite difficult to calculate the precise number of cartoneros circulating within Buenos Aires, as it is an ambulatory profession that is neither closely monitored nor legally sanctioned. For this reason, estimates have ranged from 25,000 to 100,000 cardboard collectors.

The cartonero has generated much interest for social scientists, writers, and documentary filmmakers. The 2001 novel *La Villa* (The Shantytown) by Argentine writer César Aira, and the 2006 documentary film *Cartoneros* by Eduardo Livón-Grosman are paradigmatic of the increased visibility of the cartonero as an object of scholarly inquiry. *La Villa* narrates the story of Maxi, a middle-class teenager, who offers every evening to help the cartoneros in the lower Flores neighborhood in collecting cardboard. The body of Maxi, which is portrayed as both athletic and healthy, is markedly contrasted to the cartoneros, who are represented as silent, feeble, hard-working, and frightened people. The Livón-Grosman documentary conveys the abrupt social changes that have been disrupting ordinary Argentines, emphasizing the transformations within the middle classes who have been reduced to rummaging through garbage in order to survive.

The cartoneros are to be credited with transforming the practice of waste collection in the city as their activities have made waste into a veritable commodity. What originally was an urgent effort to economically survive, rather than an ecologically informed gesture to preserve the environment, has become one of the most active waste management industries in Argentina. The cartoneros have led to the creation

of cooperatives such as El Ceibo within the capital and Nuevo Rumbo, El Orejano and Alicia Moreau de Justo in the larger province of Buenos Aires.

Goals

In 2005, following a campaign by Greenpeace, the city council approved the first municipal zero waste plan in Latin America. The Integral Management Of Solid Urban Waste law set goals of 0 percent reduction of waste to landfill by 2010, a 50 percent reduction by 2012, and a 75 percent reduction by 2017. The law bans landfilling of recyclable and compostable waste by 2020 and bans incineration of solid waste until 75 percent diversion has been achieved. The baseline used in the law is the 1.5 million metric tons of solid waste disposed in 2004. While nongovernmental organizations have clashed with the city about adhering to its provisions (notably, the city attempted to incinerate waste in 2007), the law marks an important development in Latin American waste policy.

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See Also: Argentina; Dumpster-Diving; Paper Products; Recycling Behaviors; Zero Waste.

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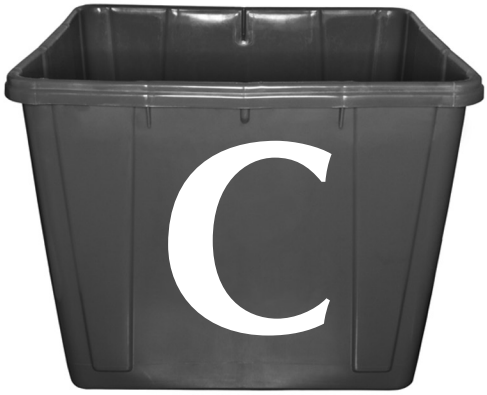

C&D Waste

See Construction and Demolition Waste

Cairo, Egypt

Cairo is the largest city in Egypt, with roots in settlements more than two millennia old. Its waste management challenges in the 21st century reveal longstanding social and economic tensions. The core of Cairo's solid waste management system is exemplary with its recycling rate of about 85 percent. Based on garbage collectors (called *zabaleen*), their families, and communities, this labor-intensive core is among the most sustainable systems in the world. The zabaleen have come under attack, however, by neoliberal privatization and gentrification. Metropolitan Cairo (including parts of Giza and Qaloubiya governorates) has about 17 million inhabitants. Authorities are overwhelmed with keeping up with urban services. Modern amenities abound in wealthier quarters; poor residents lack many such conveniences.

Colonial municipalities did not spend much time on waste. In the early 20th century, migrants from desert oases (called *wahiya*) started to collect waste from wealthier households. They sold waste as fuel to public bathhouses or makers of *fuul*, a bean dish. In the 1940s, as garbage increased, poor Christian migrants became subcontractors of the Muslim wahiya. These migrants, the zabaleen, bought organic waste (the largest part of the refuse) for their pigs, which the Muslim wahiya were prohibited by Islam to keep. Brokers (called *mu'allim*) set up new arrivals with pigs, shacks, and pigsties. Humans and pigs shared one yard. Wahiya oversaw the garbage business, and zabaleen worked the garbage routes. In the 1950s and 1960s, mu'allims set up zabaleen settlements on the urban fringes. With urban expansion, zabaleen were relocated to more distant locations.

As garbage proliferated, the zabaleen refined waste processing. Glass, metal, bones, or rags were sorted and sold to middlemen who resold them to workshops. Garbage was—and remains—a family business. Husbands left settlements in the early morning with donkey carts. Children traveled with them to guard carts, while fathers went into buildings to collect garbage. Upon returning home, men dumped the carts of waste into family yards, where women and children sorted the garbage and pigs and goats consumed organic waste. The wahiya-zabaleen system resembles those of 19th-century Western cities, where urban waste fed into rural-to-

urban waste and agricultural circuits, except theirs is an urban-to-urban fringe circuit and has a higher recycling rate (New York's Barren Island recycled 60 percent in the 19th century).

In 1970, authorities relocated a zabaleen community to the Moqattam Mountain east of Cairo. The community received no municipal services. Regardless, the zabaleen worked and improved recycling. Driven by poverty and maintained by both family labor and an understanding of the value of resources, the system provided work for thousands. Leftover garbage was dumped on the street or dumping grounds outside the community and burned. Their smoldering clouded the community in pollution.

This efficient system had flaws. Because zabaleen sought valuable garbage, they did not service poor neighborhoods. However, no municipal waste management existed through the 1970s, and poor people simply threw their garbage on neighborhood dumps, which were regularly burned. The system's worst flaw was its human cost; in the 1970s, infant mortality among the zabaleen was 40 percent, as diseases were pervasive. The Moqattam community started organizing, and the first Garbage Collectors' Association was registered in the 1970s with the Ministry of Social Affairs.

In 1976, the Moqattam community burned down twice in one year. The fires and public attention they produced, combined with growing waste, generated a political understanding that waste management was necessary and that the zabaleen's conditions needed to be addressed. In 1980, local and international agencies started projects in the Moqattam village to establish cleaner ways of working and on-site recycling to add profitable jobs for the zabaleen. Electricity and water were installed and social services (such as clinics and schools) were added. A composting plant for manure was constructed, and plastic-processing facilities were built. Loan programs allowed families to set up recycling workshops. A rug-weaving workshop opened where women, upon completion of a course, could buy their own loom on loan. Combined with urban upgrading schemes, the projects transformed the community. Tin shacks were replaced by concrete buildings, where humans and animals had separate quarters. The village grew from 5,500 to over 15,000 residents in the 1980s. Similar interventions followed in the other six zabaleen communities.

Cairo and Giza, overwhelmed by waste problems in 1984, founded the Cairo (and Giza) Cleansing and Beautification Authorities. Solutions overlooked the existing system, and ecology and sustainability were secondary. In 1990, authorities banned donkey carts for garbage collection, and the zabaleen founded cooperatives to purchase vehicles. By the late 1990s, the zabaleen still handled 30 to 40 percent of the 14 million metropolitan residents' garbage (about 3,000 tons per day), recycling 85 percent. By the turn of the century, local companies were hired to take the waste of poorer quarters to public dump sites, where it was burned and produced pollution.

Decline of the Zabaleen

In 2003, with growing garbage mountains and pollution, Cairo and Giza contracted multinational waste management companies. The zabaleen were neither consulted nor were they given roles in the contracts. The new companies were to clean streets and collect household trash. Unlike the zabaleen, they did not collect waste from front doors; instead, containers were placed in streets for households to deposit their waste. Companies had to recycle only 20 percent of the waste. This system had various problems, including angry residents who had to pay more for less service; company vehicles were too large for small alleys, public garbage receptacles were stolen, and zabaleen and other scavengers mined containers and left a mess. Some zabaleen made informal arrangements with the companies and received garbage for fees or services. Wealthier households continued to pay zabaleen in addition to company fees. Companies contracted zabaleen for some routes.

Framed by neoliberal policies and real estate speculation, metropolitan Cairo mushroomed throughout the 1990s. Upscale Moqattam City expanded on the plateau above the zabaleen village. Gentrification and concerns about the city's aesthetics brought zabaleen villages under scrutiny. Authorities decided to provide land 15 miles outside the city for the Moqattam zabaleen's recycling operations. Other plans foresee the entire community's relocation to this site.

At the onset of the 2009 swine flu, the Egyptian government decided that pigs were to blame. In May, authorities slaughtered about 300,000 pigs, even though experts advised against it. This slaughter was a disaster for the 70,000 metropolitan zabaleen, and many saw it as another governmental measure to eliminate their jobs. Observers commented that the slaughter reflected the influence of Islamist groups on the government and its attempts to destroy the livelihood of Christian zabaleen. The zabaleen's response was straightforward: no pigs, no organic waste collection. Of the 6,000 tons of waste collected daily by the zabaleen before May, 60 percent had been organic waste, which was now left to rot in the streets. Simultaneously, the multinational waste company in central Giza went on strike that summer. In 2010, metropolitan Cairo was far from achieving viable waste management or any system that remotely approached the rate of recycling and sustainability that the zabaleen developed. Many zabaleen continue to work.

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See Also: Culture, Values, and Garbage; Developing Countries; Organic Waste; Street Scavenging and Trash Picking.

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Calcutta, India

See Kolkata, India

California

California and its waste practices are a study in contrasts, ranging from cities with some of the strictest laws and innovative ideas to some world-class, man-made environmental disasters. The Golden State is the third biggest state by geographic area and has both the largest population (37,253,956 as of 2010) and largest economy of any of the United States. California is not one culture but a myriad, each with a specific take on garbage and disposal. California is also a bellwether state, with legislative initiatives that are often the model for other states to adopt.

People have been creating, handling, and disposing of waste in California for thousands of years. The oldest archaeological site found as of 2010 in California is the Daisy Cave rock shelter in the Channel Islands off the coast of Ventura County, which has been dated to somewhere between 12,300 and 11,120 years old. While any archaeological site by definition traffics in garbage, a shell midden on San Miguel Island in the same group dating to 9,700 years old is evidence of collective, managed, and intentional disposal of food waste. Later, kitchen middens from Spanish colonial-period missions, like those in Santa Clara and San Juan Bautista, give evidence of the interaction between California natives and Spanish missionaries. In Riverside, two Chinatowns have been excavated, and the artifact-rich trash pits have helped tell the story of Chinese migrants to California in the latter half of the 19th century. Excavations in West Oakland have detailed changing practices with respect to waste disposal and the arrival of both sewage systems and indoor toilets in the 1880s. Collections of the California State Historical Parks contain artifacts recovered from residential refuse deposits in Monterey, which provide a detailed image of the material conditions in a mid-to-late 19th-century seaport on the west coast, while a collection of early-20th-century items from a site called the Spain Street Dump excavated at the Sonoma State Historical Park give insight into this period.

Modern Innovations

In the 21st century, the state of California and its cities have often been innovators in waste management, along with other environmental issues.

In 1986, the California Beverage Container and Litter Recycling Act was passed; three years later, in 1989, the California Integrated Waste Management Act mandated that municipalities achieve waste diversion from landfills of 25 percent by 1995 and 50 percent by 2000. Other acts, which include the Electronic Waste Recycling Act, Cell Phone Recycling Act, and Rechargeable Battery Recycling Act, require that either consumers pay an additional fee for managing the recycling of electronic devices, or that producers and retailers of products containing hazardous materials, such as batteries, are responsible for their collection when spent.

The Recycled Newsprint Act mandates that at least 50 percent of the newsprint used by printers and publishers in California contain a minimum of 40 percent post-consumer paper fiber. As of 2010, Californians were diverting 58 percent of waste, and no new landfills had been opened in over a decade, though California remains home to the largest active landfill in the United States. The Puente Hills Landfill is also using biogas generated by decomposition to fuel a power plant, called the Puente Hills Gas-To-Energy Facility, generating up to 50 megawatts of energy per day.

Disposal Diversity and Controversy

Across California, municipalities have been granted a wide degree of latitude in interpreting some of these acts. The form that waste diversion takes can vary in means and effectiveness from city to city, with some cities like San Francisco being consistently far in advance of the vanguard, while others, like Sacramento, can lag. San Francisco became the first city in the United States to ban plastic grocery bags in 2007 (a similar attempt to institute such a ban statewide failed to pass the California legislature in 2010). Already diverting an impressive 72 percent of waste into recycling and compost in 2009, San Francisco is aiming for zero waste by 2020. San Francisco has instituted the first large-scale urban program for collecting food waste for composting. Meanwhile, Sacramento as recently as 2010 has allowed residents to pile green waste in the streets for pickup, called "loose in the street pickup," by the Public Works department. A voluntary rollout of bins for green waste in March 2010 did not prevent a record number of complaints about street-side debris in April.

A famous example of the controversy that can arise over innovative plans is the "toilet to tap" process pushed by various Southern California municipalities at the beginning of the 21st century. Facing chronic water shortages and regular contamination of coastal waters by fecal coliform bacteria, "indirect potable reuse" was proposed as a method whereby local aquifers would be "refreshed" deep underground by injecting them with previously treated wastewater. The wastewater would, over time, pass through strata of rocks, sand, and minerals, rendering it safe. Unfortunately, the concept was christened "toilet to tap" by the media and seized upon by, among others, influential comedian Jay Leno, who used it as the basis for several monologues. The idea, miscommunicated as it was to the public in this disastrous public relations debacle, slunk away for the next few years. Within a decade, it had quietly been revived and put into practice in Orange County, politically a more conservative region than Los Angeles County to the north, but with similar issues concerning saltwater intrusion of groundwater and disposing of wastewater along the coast. Orange County's Groundwater Recharge Project is now the largest such project in the world.

Agriculture Operations

Further inland, concern over large-scale wastes turns from drainage issues to agricultural runoff and waste by-products. In Imperial County, the All American Canal brings in water from the Colorado River to irrigate fields, whereupon the runoff is discharged into the New River, commonly considered the most severely polluted waterway of its size in the United States. This channel originates in Mexico, crosses the border, and flows into the Salton Sea, thus becoming an international political issue—and has been so since at least the 1940s.

California's Central Valley is another agricultural center, with the Imperial Valley as the largest economic driver in the state. Enormous agricultural operations have been experimenting with the use of biosludge (a wastewater treatment by-product) as fertilizer. It comes from a variety of source material, ranging from human feces to slurry

resulting from the papermaking process. The reuse of such material, which is sprayed onto fields supporting food crops, is not without controversy. Despite treatment, the biosolids can retain heavy metals and organo-chlorines, and there are limitations to how much can be spread upon a field at any given time.

Hazardous Waste

In addition to agriculture, one of California's other iconic industries, Silicon Valley, has had specific impact on the landscape. Silicon Valley, despite the aseptic appearance of high tech, is actually very toxic in terms of waste. Santa Clara County is home to the most Superfund (Comprehensive Environmental Response, Compensation, and Liability Act of 1980, or CERCLA) sites in the country—23 out of around 60. Semiconductor manufacturing has now moved largely offshore, but a toxic legacy remains. Until the 1976 Federal Resource Conservation and Recovery Act, hazardous waste disposal was largely unregulated, and companies could pump it into the ground at will, only later discovering that this threatens groundwater supplies. A prime example of this type of contamination is the Superfund site Newmark, in San Bernardino, where two underground plumes of contaminants, including chlorinated solvents, tetrachloroethylene (PCE), and trichloroethylene (TCE), resulted in the temporary closing of 20 wells within a six-mile radius. Eight of the 20 were never reopened, and the plume continues to threaten supplies downgradient, including those of the neighboring city of Riverside, in Riverside County, which services approximately 300,000 customers. Across the state, many of the rural counties have also suffered from improper disposal of hazardous waste. Siskiyou County, on the border with Oregon, has a Superfund site at the former location of a lumber products facility. Groundwater contaminants discovered there include arsenic compounds, creosote, and heavy metals.

Due to their size and the concentration of population in urban areas along the coastline, many of these rural problems go underreported in the mainstream media. California is a study in contrasts, both social and environmental. Home to unique animal and plant life, gorgeous scenery, and diverse microclimates, it attracts tourists from around the world. Meanwhile, inland, where tourists less often go, the dirty work of maintaining a giant economic engine, the millions of people who labor in it, and the mountains of waste that they generate lie hidden.

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See Also: Archaeology of Garbage; Farms; Human Waste; Industrial Waste; Public Water Systems; Shopping Bags.

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Campbell Soup Study (1930s)

The Campbell Soup Company was the largest marketer of soup cans in the 20th century and has a history that dates to the late 1800s. The development of Campbell represents an interesting case study regarding the field of consumption and waste research.

Innovations in Marketing and Advertising

Campbell is considered one of the pioneering companies regarding marketing, advertising, and brand development. Between 1910 and 1930, the Campbell Company (which changed its name to the Campbell Soup Company in the 1920s and specialized in soup production) was among the first to advertise in full color in women's magazines, explicitly addressing housewives as targets of its advertising campaigns.

In the same period, Campbell was part of the early stages of marketing research because of the study made about Campbell's consumption trends by Charles Coolidge Parlin, a forerunner in the field of marketing studies. Parlin started to work on Campbell in the early years of the 20th century, trying to convince the company to advertise in the *Saturday Evening Post*, a newspaper with readers who were typically in the lower classes. Campbell's marketers were uncertain about the potentials of a campaign like this, since they were persuaded that Campbell's typical consumers were higher-class people who could afford to buy soup cans. Lower-class people were believed to cook their own soup to save money and were therefore not interested in buying soup cans. Parlin, who used to work for the newspaper as an ad marketer, conducted a study in which he counted the number of soup cans collected from garbage in different neighborhoods across Philadelphia, Pennsylvania, and demonstrated that the lower classes consumed more soup cans than higher-class people, since the latter had cooks to cook soup for them at home. Campbell then started to advertise—successfully—in the *Post*.

Campbell was also one of the pioneers in the use of radio advertising. The company started to broadcast brief ads during radio shows in 1931, and the catchy slogan "Mm . . . Mm . . . Good!" (which used to characterize Campbell's radio ads) soon became very popular and contributed to the strengthening of the company's brand.

Art and Culture

Late in the 20th century, Campbell happened again to become part of another crucial development in consumption studies, this time regarding aesthetics. In the early 1960s, several examples of a

The columns of the Royal Scottish Academy in Edinburgh are wrapped with artist Andy Warhol's 1960s Campbell's soup can art in July 2007. Warhol's pop art image embraced mass consumerism while demonstrating its iconography and inherent contradictions.

Campbell's soup can became the iconic subject of one of the most famous serial prints by Andy Warhol, the founder of the art stream known as pop art, whose aesthetics enthusiastically embraced consumerism and mass culture while playing with their iconography and contradictions. The image of the Campbell's soup can printed by Warhol in so many different varieties has entered the collective imagination as the aesthetic icon of the age of culture industry and mass society, when consumption and mechanical reproduction met and conflated with culture, aesthetics, mass media, and advertising.

This is a crucial meeting, since it actually represents the core of what is referred to as postmodernism, or postmodernity. Postmodernism is the sensibility that epistemologically characterized the end of the 20th century, and pop art represents the aesthetic paradigm in terms of considering pop art as the "cultural crossroad." Postmodernism is usually contextualized as the epistemological evolution of modernism, whose aesthetics at the beginning of the 20th century were characterized by a strong cultural opposition to the emerging instances of mass society and mass culture, which were believed to be carrying the germs of a cultural impoverishment due to the spreading of standardized reproduction and mass consumerism.

The Campbell Study of the first half of the 1900s can therefore be read as running against the tide of

modernist sensibility. It is a cultural forerunner in the sense that it perceived in advance the growing importance of marketing and consumption research. Campbell's cans portrayed in Warhol's prints can be considered as the iconographic display of consumer culture contradictions, showing the threat to originality that mass reproduction represented at the time, in the sense of a renewed relationship between the concepts of image and commodity in the era of mass society. Campbell's studies and activities, throughout the many different instances in which the company and its products have been involved, can therefore be read in a timeline perspective as a metaphor for the whole historical narrative of the 20th century.

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See Also: Capitalism; Commodification; Food Waste Behavior; History of Consumption and Waste, World, 1900s.

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Canada

A nation of vast landholdings, yet fewer people than the state of California, Canada shares consumption and waste patterns similar to the United States. Canada generated 791 kilograms (kg) per capita of municipal waste in 2005, which is highest among all the Organisation for Economic Co-operation and Development (OECD) countries (the average of all OECD countries is 610 kg per capita) and is almost twice as much waste as Japan generated per capita in 2005. The waste generation in Canada—and, in fact, in all OECD countries—has been on the rise since the 1980s when the rate of urbanization, economic growth, income levels, revenues, and consumption started growing. With the increase in per capita income level and more disposal income, lifestyles and consumption levels increased and changed the waste stream pattern, increasing overall waste production. Waste generation in Canada has steadily increased from 510 kg per capita in 1980 to 737 kg per capita in 1995 to 894 kg per capita in 2007. Other OECD countries (which have experienced similar growth patterns) have, however, managed to keep the municipal waste generation under better control than Canada.

Table 1 Waste Generation Data by Province, 2002

Province/ Territory	2000	2002	2000	2002
	tons		kg per capita	
Newfoundland and Labrador	X	231,291	X	445
Prince Edward Island	X	X	X	X
Nova Scotia	246,792	252,012	262	270
New Brunswick	243,300	256,190	322	342
Quebec	3,175,000	3,471,000	430	466
Ontario	4,191,337	4,388,239	359	363
Manitoba	501,921	494,535	438	428
Saskatchewan	305,901	321,069	299	323
Alberta	994,555	1,159,697	330	372
British Columbia	1,292,999	1,354,177	319	329
Yukon, Northwest Territories, and Nunavut	X	X	X	X
Canada	11,242,405	12,008,338	365	383

Ontario is the largest generator of waste. Waste generation data per province in 2002 is shown in Table 1.

On average, the composition of Canadian municipal solid waste consists of 40 percent organics, 26 percent paper, 9 percent plastic, 3 percent glass,

4 percent metal, and 18 percent other (a mixture of animal waste, textiles, wood, and tires).

Disposal

In 2002, Canadian households generated over 12 million tons of municipal waste, of which only 2.5 million tons was diverted to either recycling, reuse, or composting. The remaining 9.5 million tons were disposed of mainly in landfills, and part was incinerated. According to the statistics for 2000, about 95 percent of the waste was disposed of at landfill sites, and the remaining 5 percent was incinerated. About 83 percent of the waste disposal facilities are publicly run, but they dispose of only 56 percent of waste, while the 17 percent of facilities that are privately run dispose of about 44 percent of the waste. Since landfills are the most commonly used method of disposal, they exist in every province and territory of Canada. The new landfill sites are sanitary, properly engineered landfills, but there are still a few landfill sites that are old and have issues with leachate and greenhouse gas emissions.

Most of the waste in Canada is landfilled, and municipalities are having trouble finding space for landfills, mainly because people do not want landfills in their neighborhoods. For example, in the 1990s, when Toronto's Keele Valley landfill reached near capacity, the municipality explored the possibility of shipping its waste 590 km north, by rail, to Kirkland Lake, Ontario. The 9,000 residents of Kirkland Lake protested the idea of having Toronto's municipal waste dumped into an abandoned mine in their community. In the end, the community won, and the decision to use the mine was overturned by the Toronto City Council. Instead of working on better solutions or waste management planning in Toronto, the decision was made to export the waste from Toronto to a landfill site in Michigan. Toronto paid $55 per ton for shipping its trash to Michigan ($35 for trucking and $20 for landfilling). There are additional environmental impacts associated with transporting the waste. Toronto is working on reducing the municipal household waste going to landfill sites; yet, instead of developing a landfill near the waste-generation source, it has begun trucking waste to London, Ontario, and its surroundings.

Other municipalities are also sending waste out of city boundaries; for example, the Greater Vancouver Regional District sends about 16 percent of the solid waste generated to Cache Creek Landfill (330 km northeast of the city). Kenora transports part of its waste out of province to the Winnipeg landfill site.

Recycling

Most of the waste management programs originate at the municipal level, hence waste management differs from city to city. Many Canadian municipalities have, however, initiated successful recycling programs. Paper, fibers, glass, cans, and organic materials are recycled and composted across Canada. Many municipalities have ambitious programs to divert as much as 60–70 percent of the waste away from landfills. In Hamilton, Ontario, some communities have a one-bag-per-week limit of waste going to landfill sites but can have recycling and compostable waste in addition to it. Toronto has set the ambitious goal of diverting 100 percent of all household waste—meaning everything will be somehow reused or recycled—by 2012.

In general, recycling in Canada has grown since the 1990s and has become an integral part of waste management practice. According to 2002 data, 6.6 million tons of nonhazardous waste material was collected by local waste management companies or organizations. The bulk of this material was mixed paper (23 percent) and organic waste (18 percent).

Composting has also become popular since the 1990s and is used at both household levels and on a larger scale. In 2002, about 1.2 million tons of organic waste was composted at 351 centralized composting facilities in Canada. There is no data available on composting performed in backyards or on-site by some institutions.

Incineration

In 2000, 5 percent of total municipal waste (1.1 million tons) was incinerated in about 21 incinerators across Canada. There is an ongoing debate about the use of incinerators in Canada. For example, in 1991, Ontario's New Democratic Party (NDP) government placed a ban on the construction of new incinerators to burn municipal garbage and the expansion of existing incinerators. One of the reasons given by

the NDP government for placing in the ban was that "incineration is incompatible with the 3Rs." This ban was removed in 1995, when the Progressive Conservative government came into power.

Incineration opponents use two main arguments to support this contention. The first is that it is incompatible with the reuse, recycle, and reduce principles (the 3Rs) because incinerator operators and recycling operators compete for the same materials. Most of the time, the materials recycled, such as paper, plastic, and fiber, are the ones with high calorific value that are also needed for incineration. The only exceptions are glass and metals. When the Ontario government was considering a ban on new or expanded incinerators, the pulp and paper industry opposed the move because the industry had invested in recovery, recycling, and de-inking facilities, and it feared that it would lose the waste paper that it wanted back in production. The second argument given by opponents is the high cost of building an incinerator and its ability to move attention away from diversion activities. Incineration experts argue that for an economically viable operation, the capacity of an incinerator should accommodate at least 1,000 tons of garbage per day (which is massive if diversion activities are carried out). The cost to build such a facility is approximately $100 million. Operating costs to maintain the equipment, especially the pollution control equipment, is also high. Incineration opponents say that dramatic increases could be made in waste diversion programs if these resources were put into diversion programs instead of incinerators.

Changes made in 2007 at the behest of the municipalities to the Environment Protection Act (Ontario) made it easier to test emerging incineration and thus encourage municipalities to consider incineration as a means of disposing of garbage and probably cogenerate electricity. Although several municipalities in Ontario are poised to exploit the legislative changes, the chair of Toronto's works and infrastructure committee was against in 2010.

Waste Management Responsibilities

The responsibility of solid waste management in Canada is shared among all three levels of government: federal, provincial, and municipal. Collection, diversion (which includes both recycling and composting), and disposal fall under the jurisdiction of municipal governments, while the approval, licensing, and monitoring of operations come under the supervision of provincial governments. The federal government monitors issues related to toxic substances, the international movement and trade of waste, federal lands and operations, air emissions (including greenhouse gas emissions), and strategic planning to include sustainable development goals in waste management across Canada through federal funds.

Conclusion

Canadian municipalities are working toward ambitious goals of diverting waste away from landfill sites but more needs to be done to move toward sustainable and integrated waste management. New legislation is also in place to minimize waste; for example, user fees, tipping fees, and limitations of waste bags. Edmonton, Prince Edward Island, Guelph, and Halifax are some municipalities leading the programs to divert waste in Canada. Other instruments, such as deposits for bottles and producers' responsibility for packaging waste, have also been introduced.

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See Also: Composting; Incinerators; NIMBY (Not in My Backyard); United States; Zero Waste.

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Candy

The package that candy comes in is a large part of its pleasure. From the tale of the five golden tickets in the Wonka chocolate bars in Roald Dahl's iconic novel *Charlie and the Chocolate Factory* to the heart-shaped gold and velvet embossed Valentine's Day candy boxes to Cracker Jack toys and comics or baseball cards bundled in with bubble gum, people love candy and the package it comes in.

Marketing

Even everyday candy sells itself through its packaging; a cursory look at the candy section of even the smallest convenience store will reveal an amazing display of marketing strategies in the form of package design, materials, color, and font. Novelty candy, like some breakfast cereals, have actually become part of the broader marketing strategy of other products. There are candies that are tied to the release of new movies, sporting events, and even concert tours as exemplified by the guitar- and microphone-shaped gummy candy sold to promote the 2010 concert tour of 15-year-old Hannah Montana.

Holidays

Candy is celebratory. Almost every culture celebrates with sweets, but in the United States, candy and its holiday packaging is central in the celebration of holidays such as Easter, Halloween, Valentine's Day, Christmas, and New Year's; a box of chocolates is often considered the perfect gift for the person who is "hard to buy for." Candy is also big business. Much of the candy industry's total sales of around $28 billion per year are sold around the holidays. According to the National Confectioners Association, of the $92.91 spent on candy per person in the United States, $20.39 is spent on Halloween candy alone.

Most candy packaging ends up in landfills and can also be found anywhere people litter, such as on streets or in waterways. The mixed polymers used in plastic-film candy packing do not recycle well; most of this waste eventually winds up in a landfill.

Consumer-Driven Packaging and Waste

All of this celebrating results in a punishing amount of material being sent into the waste stream. Waste and Resources Action Program (WRAP), the United Kingdom's waste management program, estimates that 3,000 tons of waste are generated by the packaging of Easter candy bought in the United Kingdom. In 2009, WRAP worked with confectionary manufacturers, who then significantly reduced the environmental impact of their Easter products.

Not all of candy's packaging is based on marketing strategy; much of it is driven by science. A candy dish is still seen as a form of hospitality, whether it is sitting on a grandmother's coffee table or on a hostess counter at a restaurant. Historically, people would simply reach in with fingers to grab a few unwrapped candies, but people now want after-dinner mints to be individually wrapped so that they are germ free. Keeping germs out of foodstuffs requires packaging.

Some design is concerned with keeping candy from breaking; people want to open candy and find it intact to have the pleasure of breaking it, dividing it up, unraveling or stretching it into bite-size pieces. Keeping candy intact during shipping and storing requires packaging.

People want candy to have beautiful colors, to be glossy, and to have a delightful aroma on its way to salivating mouths. In order to keep good odors in (and other odors out) and in order to minimize the exposure that will dull color and sheen, packaging is required. And all this cardboard, paper, aluminum foil, and plastic packaging that preserves the purity, appearance, and shape of the candy has to go somewhere.

Disposal

According to an Environmental Protection Agency 2008 report, containers and packaging generate 30.8 percent of municipal solid waste, representing the largest portion of the total amount. Food scraps made up 12.7 percent of the total municipal solid waste that year, but candy is really not a major offender in this category. Candy is not highly perishable, and for most people, candy is a prized food, meaning the candy is likely to be consumed. However, most candy packaging ends up in landfills. It is also present as litter: on the street, in waterways, and along roads. The packaging consists of some paper, aluminum foil, and plastic. The mixed polymers that compose the plastic film used in candy packing do not lend it to recycling; it can be incinerated, but most of this waste eventually finds its way into a landfill.

Bulk candy, some of which is not individually wrapped, is sold in some venues, and is the best choice for anyone concerned about unnecessary packaging entering the waste stream. As in other product categories, there has been some effort to use biodegradable packaging, and there is a small industry that uses recycled juice bags and some brands of candy wrappers to create tote bags, jewelry, and other accessories. But these efforts are small in proportion to the problem.

Maybe the worst offenders are products that are both candy and toys, such as lollipops that have flashing lights, lollipops attached to a battery-powered motor that makes it spin, and plastic covers that make them look like microphones.

Although it seems a large part of candy marketing is aimed at children, it may be more correct to say it is directed at childhood. Adults buy candy for children as a means of vicarious pleasure, remembering how much candy meant to them as children. Part of the pleasure of candy is nostalgia, not just of the candy itself, but also of the packaging. One development in the candy industry is marketing of nostalgia candy; consumers want the candy of their childhood, and this demand is being met primarily through Internet sales. The home delivery of products has some increased impact on the waste stream if consumers do not make the effort to recycle the cardboard boxes, plastic bags, and the other packaging required to get the product to them intact.

Production and Globalization

Candy consumers have been affected by both globalization and the difference in government standards for food quality. These factors have impacted the safety of the commodities used to make candy products. Lead is a toxin that disproportionately affects children, and starting in the 1990s, the California Department of Health and the U.S. Food and Drug Administration found that some Mexican candies had large amounts of lead in them because of the candies being stored in lead-glazed clay pots and candy wrappers printed with lead-based ink. Additionally, some Mexican chili powder (an ingredient in many kinds of Mexican candy) contains high lead levels. In 2007, the world learned about Chinese products that were laced with the toxin melamine; as the scandal unfolded, melamine was found in milk and milk products, which resulted in melamine being found in candy and other food products that were distributed inside China and exported to countries around the world, including the United States.

There are also some social justice issues tied to the consumption of chocolate, as the average person in the United States consumes 11 pounds of chocolate a year, but essentially all cacao beans, chocolate's primary ingredient, are grown outside the United States. The poor countries in west Africa produce 70 percent of the world's cocoa. In 2000, in response to reports of child labor exploitation, the Harkin-Engel Protocol was developed by two members of the U.S. Congress, nongovernmental organizations, labor experts, and the World Cocoa Foundation. There have also been some efforts to establish Fair Trade sources of cocoa, to improve the economic conditions of the farmers who grow this commodity in poor countries. Candy, as a processed food containing sweeteners such as cane sugar or high fructose corn syrup, is also a conspicuous symbol of caloric overconsumption in the industrialized world.

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See Also: Children; Consumerism; Fast Food Packaging; Food Consumption; Food Waste Behavior; Gluttony; Packaging and Product Containers.

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Capitalism

The word *capitalism* has become heavily politically loaded in contemporary usage; it is a term that nearly always arouses dispute, and there is no consensus on its exact definition. It has been identified with a variety of different phenomena across a range of historical contexts and is subject to very differing interpretations according to one's worldview. It has been used to describe a set of social and economic practices and relations, but it is also seen as an ideology or way of thinking. As a set of practices, capitalism refers generally to a free, competitive market economic system in which the means of production (such as materials, land, or tools) are privately owned, as opposed to cooperatively or state owned, and they are managed and operated for private profits. In addition, private individuals and organizations, as opposed to governments, make decisions regarding supply, demand, distribution, price, and investments. Most developed countries are regarded as mixed economies as opposed to purely capitalist economies as governments continue to play a role in regulating the economy through ownership and intervention. Countries and regions such as Europe, the United States, Canada, Japan, Singapore, and Australia all rely on a largely mixed economy, where many transactions occur outside the marketplace and are subject to public-sector regulation. These include, for example: public pensions, social security, unemployment benefits, healthcare, and education. In this sense, the operation of a completely free-market-driven economy remains largely elusive.

Ideology

As a way of thinking, capitalism embodies a series of ideologies. It embraces the ideology of individualism, wherein individuals are seen as free to make market choices based on self-interest. Along with competition, supply, and demand, self-interest is thought to be a key mechanism for allocating resources in society. Some scholars also observe that the amalgamation of individual interest will benefit society as a whole. A second key tenet of capitalism is the Enlightenment idea of progress. This idea of progress is seen as synonymous with economic growth achieved through the exploitation of productive labor and technological advancement. The idea of productive labor is central to capitalist thought, viewed as vital to economic growth and central to a meaningful life. Some also argue that capitalism is almost entirely future focused. In the view of humans as rational and self-interested, attention is placed on the future of economic decisions. Finally, in capitalist modes of thinking, the object takes on specific significance. The gap between consumers and producers widens, and consumers have little or no social relationship with the producers of the goods they consume. In the absence of this set of social relations, increased emphasis is placed on objects of consumption, and individuals become increasingly defined by—and take meaning from—their role as consumers, as opposed to producers, of goods.

Etymology

A useful inroad to understanding capitalism might be a consideration of the etymology of the term. Early use of the word *capital* is associated with the trade in livestock. It evolved from the word *capitale*, which is based on the proto-Indo-European word *caput*, meaning "head." It is also developed from the terms *chattel* and *cattle,* referring to movable property. While it is difficult to trace the first use of the term *capitalism* in English, novelist William Thackeray is widely cited as the first to refer to it in his 1854 text *The Newcomes*. In an essay published in 1851, a French socialist politician and one-time friend of Karl Marx, Pierre-Joseph Proudhon, argued that capitalism as an economic idea was analogous to government. In their earlier writings, Karl Marx and Friedrich Engels used the term *capitalism* only a few times, instead preferring to refer to the "capitalist mode of production," in the three volumes of *Das Kapital* (1867, 1885, and 1894). It was not until the beginning of the 20th century that the term came into widespread use and began to stimulate debate. Werner Stombart's 1902 *Modern Capitalism* introduced the term to the political arena. This was followed in 1904 by Max Weber's use of the term in *The Protestant Ethic and the Spirit of Capitalism*.

History

Historically, the roots of capitalism can be traced through a series of market forms: mercantilism, industrialism, Keynesianism, neoliberalism, and globalization. Commentators typically observe the roots of capitalism to lie in mercantilism, which originated in the Middle East and Rome in the Middle Ages. Mercantilism was underpinned by protectionist policies involving the restraint of imports and encouragement of exports in order to produce a favorable balance of trade. The differences between imports and exports were then paid by foreign countries in precious metals. One of the ideas central to mercantilism was bullionism, which stressed that the economic health of a nation could be measured by the amount of precious metal, gold, or silver it possessed. The mercantile system, however, was far from egalitarian; it largely served the interests of merchants and producers whose activities were protected or encouraged by the state. Organizations such as the British East India Company and the Dutch East India Company profited vastly from a system wherein their trade interests were protected and supported by nation-states. This era was characterized by sea travel and discovery, an increase in the capacity for trade, the establishment of a series of colonies beyond Europe, and significant growth of European industry relative to agriculture.

The period of mercantilism in the 16th to mid-18th centuries was followed by industrialism. Key thinkers such as Adam Smith challenged the central tenets of mercantilism, in particular, its focus on the idea that the world's wealth was finite and that gains could only be made by transferring capital between countries. Instead, he focused on creating efficiencies through the mechanisms of production. Smith is often cited as the "father of capitalism," and in his rationale for free trade, he promoted the idea that rational individual self-interest would promote the wider well-being of society. Therefore, along with supply and demand, self-interest ought to be a key mechanism for allocating resources in society. The mechanization that accompanied the Industrial Revolution marked the decline of small-scale artisan and handicraft production.

During this period, the idea of the factory and factory work emerged in the guise of Frederick Taylor's principles of scientific management, also popularly termed *Taylorism*. Here, the focus was on the application of scientific principles to management in order to improve economic productivity and labor efficiency. Work was divided into small, specialized functions involving a de-skilling of labor and the rise of monotony in the workplace. This period of industrialism also marked the heyday of a series of successful U.S. industrialists who were aggressively innovative and competitive, including Andrew Carnegie, the Scottish American entrepreneur who developed new methods to mass-produce steel rails for railway lines and John D. Rockefeller, who made his fortune in the oil industry by tightly controlling costs, using refineries' waste, and developing his own oil pipeline network.

Keynesianism and Neoliberalism

While mercantilism and industrialism both contributed to the capitalism commonly understood in

the 21st century, the two economic systems most closely associated with its development—although in very different ways—are Keynesianism and neoliberalism. Keynesianism is so named after British economist and social liberalist John Maynard Keynes. Largely in response to the 1930s United Kingdom (UK) recession, Keynes developed a series of monetary and fiscal measures to alleviate the effects of economic recessions and stabilize the economy. These measures included greater government involvement in regulating the business cycle. These policies were largely successful in the 1950s and 1960s in the United Kingdom and other Western economies.

This period saw the establishment of the welfare state in the United Kingdom. By the 1970s, Keynesianism started to fall out of favor, spurred by the critiques of economists such as Milton Freidman, who argued forcefully for a laissez-faire economic system, which emphasized individual choice and reduced government intervention in markets. During the 1980s, the governments of Margaret Thatcher in the UK and Ronald Reagan in the United States were heavily influenced by the neoliberal school of thought, in particular, free markets, control over public expenditure, tax cuts, and privatization. Many of the received contemporary capitalist ways of thinking stem from the ideas of the neoliberal school of thought.

Globalization

The increasingly global nature of economic systems makes it important also to consider the impact of globalization on the development of capitalism. The term *globalization* embraces a wide range of cultural, political, social, and economic trends, but in general, globalization refers to the integration of national economies into the international economy. This is achieved in a variety of ways, but includes the reduction and removal of barriers between national borders, which has resulted in an increased flow of people, ideas, and capital. Another trend contributing to globalization includes improvement in communication technologies, such as the World Wide Web and satellite communications. In the West, it has also marked a shift away from the focus on manufacturing and production that formed the basis of industrialism. Trade liberalization and labor law reforms meant that companies could easily outsource production and labor to cheaper sources in developing countries as a way to increase cost efficiencies. Emphasis shifted away from manufacturing and instead toward marketing.

Whereas in the past, companies competed primarily on the strength of the goods they produced, 21st-century companies compete in the brand market for the most powerful brand image. Commentators such as Naomi Klein have termed this shedding of staff and manufacturing processes a "race toward weightlessness."

Major Social and Cultural Impacts

The idea of capitalism is not merely restricted to it as an economic system. Many of the critiques of capitalism are based on the social and cultural outcomes and implications of such a system. Critiques are diverse and varied, but it is possible to identify three key dimensions to them: alienation or separation, the exploitation of labor, and the profit motive.

Alienation. Karl Marx argued that alienation was a result of capitalism. His theory of alienation observed that workers become alien or foreign to the world they inhabit because workers in the capitalist system do not own the products of their labor. In addition, the means to define themselves as individuals resides entirely in a system of production that is privately—as opposed to collectively—owned. In such a system, the individual is not viewed as a social being, but rather as an instrument to produce surplus value through work. In individuals' bid to work to earn money for consumption, they are increasingly defined as consumers as opposed to producers, which brings with it critiques of consumerism as inauthentic and as ultimately unsatisfying. In a contemporary twist to the alienation perspective, sociologist Juliet Schor highlights the problems inherent in the work-to-spend cycle in the United States, observing spiraling levels of debt and increasing working hours among U.S. laborers.

Exploitation. Commentators observe that in a capitalist system, individuals are forced to sell their capacity to work in order to survive, and labor

becomes a commodity. Here, work becomes the central, organizing motif of life and is seen as the only way to enjoy a meaningful existence.

Increasingly long working hours are required, and the gradual encroachment of work time on leisure time and a blurring of boundaries between working lives and private lives ensue. In a capitalist system, work therefore increasingly structures individuals' identity, sense of self, and sense of place within the world. In addition, the fundamentally unequal labor relation built into the capitalist system results in inequality on both local and global levels and stimulates the gap between the rich and the poor both within societies and between countries. Because capitalism is about the concentration of wealth, a concentration of power follows this flow of wealth.

Profit Motive. The third key criticism of capitalism is the limitless search for profit that is central to its survival. In its ceaseless search for growth, capitalism demonstrates a predatory disregard for both people and the environment, viewing them as resources for exploitation. Environmentally, capitalism's hunger for growth is depleting the Earth's finite natural resources. Capitalism has recently been heavily involved in harnessing global labor surpluses. Driven by the profit motive, corporations have looked to less-developed economies for cheaper sources of labor.

This process has been epitomized by the establishment of Export Processing Zones (EPZs) where trade barriers, including tariffs and quotas, are eliminated. Factories in these zones involve highly labor-intensive work to transform raw materials into products. However, as activist Naomi Klein observes, the lack of regulated labor laws in EPZs in parts of South America and Asia result in sweatshop-labor practices, with employees working long hours in very poor conditions for below-subsistence wages.

Effects on the Environment

The spatial reorganization of local, national, and global economies under capitalism has consequences for the environment. The wealth of Andrew Carnegie, for example, affected several regions. When Carnegie lived in New York City, his company extracted iron ore from rural Minnesota, leaving gaping holes and toxins in the soil. The ore was sent to Pennsylvania steel mills, producing pollution in the land, air, and water. Resulting steel was sold all over the world, with Carnegie amassing great profits. He subsequently engaged in philanthropy, redistributing wealth on his terms.

Twenty-first-century developments include the evolution of globalized waste markets, with exports of hazardous waste from wealthy nations to developing economies. These developments exacerbate concerns over growing environmental inequalities as the global economy grows.

Anticapitalism

In response to the many critiques, a series of anticapitalist groups have developed over the years. The anticapitalist position is a particularly difficult one to occupy given that capitalism is consistently promoted as the only possible—and only natural—means of organizing the economy. Therefore, much anticapitalist activity is about developing and promoting alternatives to a capitalist way of thinking. In doing so, anticapitalism is concerned with interrupting the ceaseless search for profit, reuniting individuals with the means and processes of production through collective activity, and placing values other than economic ones as central to meaning in life.

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See Also: Commodification; Consumerism; Industrial Revolution; Materialist Values; Needs and Wants; Socialist Societies.

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Car Washing

Along with motels, auto cinemas, drive-ins, and other symbols of roadside architecture, car washing became an essential component of the U.S. car culture for a large part of the 20th century. Professional car washes thrived whenever the suburban Saturday morning dream of household car washing became a practical impossibility because of time constraints for car owners and new environmental restrictions and regulations.

Waste

There are some differences in the level of waste and resulting environmental damage derived from car washing, depending on the type of car wash (driveway versus professional). According to engineering studies, a 5/8-inch hose running at 50 psi uses approximately 14 gallons of water per minute. This means that a rather short domestic car wash can use between 116 and 180 gallons of water. Professional car washes consume approximately 60 percent less water than driveway washes, depending on the method they use (manual, conveyor, in-bay automatic, or self-service systems).

Pollution

Besides water-consumption issues, the dirt washed off vehicles as well as many of the materials used in the process of cleaning are generally harmful to the environment. Washing vehicles (both by hand or using a machine) on an impermeable surface can cause wash wastewater flow into storm drains. Soap from washing cars at home or charity car washes generally causes a lot of pollution, since soap and dirt flow freely through storm drains and ditches, ending up in streams untreated.

Contaminants in most of wash wastewater include the following:

- Petroleum hydrocarbons (such as gasoline, diesel fuel, motor oil, fluids, and lubricants) from automobile engines, leaks, and fuel combustion processes. Oil and grease contain hazardous materials such as benzene, lead, zinc, chromium, arsenic, and metals resulting from normal wear of auto brake linings (copper), tires, exhaust, and fluid leaks.
- Detergents, including biodegradable detergents. Surfactants that are present in detergents and cleaning formulations (both synthetic and organic agents) lower the surface tension of water, allowing dirt or grease to be washed off. Detergents can destroy the external mucus layers that protect fish from bacteria and parasites. Detergents can also damage the gills. Most fish will die when detergent concentrations approach 15 parts per million. Detergent concentrations as low as five parts per million can kill fish eggs.

  Surfactant detergents are implicated in decreasing the breeding ability of aquatic organisms. Organic chemicals such as pesticides and phenols are then much more easily absorbed by the fish. A detergent concentration of only two parts per million can cause fish to absorb double the amount of chemicals they would normally absorb, although that concentration itself is not high enough to affect fish directly.

  Phosphates and nitrogen-containing detergents (nitrates) that are plant nutrients could cause excessive growth of pest plants at or in nearby water bodies. Water naturally contains less than 1 milligram of nitrate-nitrogen per liter. State and federal laws in the United States set the maximum allowable level of nitrate-nitrogen in public drinking water at 10 milligrams per liter (10 parts per million). Infants who ingest water that is high in nitrate can develop methemoglobinemia.

  This condition is also called "blue baby syndrome" because the skin appears blue-gray or lavender. This color change is caused by a lack of oxygen in the blood. Common sources of nitrate contamination include fertilizers, animal wastes, septic tanks, municipal sewage treatment systems, and decaying plant debris.
- Chemicals harmful to living organisms, such as hydrofluoric acid and ammonium bifluoride products (ABF), along with solvent-based solutions. Also, chemicals and oils used for the maintenance of cleaning machinery (for automatic systems) can be discharged into sewers.

The U.S. Clean Water Act of 1972 requires professional car wash facilities to pipe their wastewater to water treatment facilities or to state-approved drainage facilities designed to protect the environment and avoid pollution. Contaminants in car wash wastewater include dirt, debris, and petroleum products from the automobile; biodegradable detergent products; surfactants; phosphates and nitrogen-containing detergents; and chemicals harmful to living organisms, such as hydrofluoric acid and ammonium bifluoride products.

- Debris that can clog storm sewer inlets and grates and thereby prevent storm water drainage to the sewer.

An empirical quantification of the environmental effect of driveway car washing was revealed by the Residential Car Washwater Monitoring Study published by the city of Federal Way, Washington, in July 2009. The study concluded that an estimated 18.85 washes per car per year sent a significant amount of pollutants directly to the community's water bodies. It was calculated that each car contributes each year with approximately 0.05 pounds of petroleum hydrocarbons (gasoline, #2 diesel, and motor oil), 0.093 pounds of surfactants (MBAS), 0.0042 pounds. of metal (chromium, copper, lead, zinc, and nickel), and 0.019 pounds of different inorganic substances (ammonia, nitrate-nitrite, and phosphorus) that are thrown to water bodies. Additionally, driveway car washing in the Federal Way sends 1.43 pounds of solids per car per year to those water bodies.

Treatment and Filtration

The U.S. Clean Water Act requires professional car washes to direct car wash wastewater to water treatment facilities or to state-approved drainage facilities designed to avoid pollution. Filtration of the wastewater is a recommended practice conducted before discharge to a sanitary sewer. Filtration leaves fewer solids present in the wash wastewater stream discharge to the sanitary sewer system. The sludge can be dried by removing it from the car wash system and allowing the water to evaporate. Since the transportation of sludge to be dried requires a special permit, some places have on-site drying facilities where water from sludge is evaporated before disposing of the resulting solids as nonspecial waste that can be disposed of with general refuse. Special waste derived from car washing must be handled and disposed of in accordance with specific Environmental Protection Agency (EPA) regulations. Special waste must be disposed of in a licensed, special waste disposal facility and must be transported

by a licensed special waste hauler using a special waste manifest.

Most states require a National Pollutant Discharge Elimination System (NPDE) permit from the respective state EPA for businesses that discharge car wash wastewater directly into a surface water body or to a storm sewer that discharges to a surface water body. It is a common practice that if car wash wastewater is discharged directly to a sanitary sewer system, the business must apply for a state construction permit and may also need to apply for a state operating permit. Nonetheless, car wash regulations vary from city to city.

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See Also: Automobiles; Engine Oil; Pollution, Water; Sewers; Sociology of Waste.

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Carbon Dioxide

Carbon dioxide (CO_2) is ubiquitous. It is a chemical compound that is commonly encountered, for example, in chemistry classes in high school. It also entered the global stage of climate change politics and economies as a currency of emissions to be traded on carbon markets. Thus, a definition of carbon dioxide must engage with the complexity of its status in society.

Definition

From the point of view of the scientific discipline of chemistry, the concept of carbon dioxide refers to a molecule in which two oxygen atoms are bonded to a central carbon atom. Technically speaking, at standard pressure and temperature (near mean sea level pressure and at 0 degrees Celsius) CO_2 exists as a gas. Only at lower temperatures, below minus 78 degrees Celsius, the gas deposits directly in its solid form: dry ice. Carbon dioxide exhibits a variety of traits, making it useful for contemporary societies. To illustrate, the beverage industry uses the acidic characteristic of CO_2 to produce carbonated drinks, like soda water. Another characteristic of the gas is its nonflammability. This is used, for example, in fire extinguishers.

Effects on Climate

In the second half of the 20th century, scientists increasingly alarmed the public about the relationship between the proportion of CO_2 in Earth's atmosphere and global warming. Svante Arrhenius provided an argument mentioning the possibility of such warming in 1896. This relates to another quality of the chemical compound: CO_2 in the atmosphere lets solar radiation pass onto Earth, but traps some of the radiation when reflected back toward space. In effect, the atmosphere is heating up—just like a greenhouse experiencing increasing temperatures under solar radiation. Thus, the more carbon dioxide is in the atmosphere, the more intense is the greenhouse effect. Based on this understanding, which is routinely elaborated on and updated by the Intergovernmental Panel on Climate Change (IPCC), many governments set up mechanisms to reduce the concentration of CO_2 in the atmosphere.

Reduction Initiatives

For setting up such mechanisms, the sources of the increase of atmospheric carbon dioxide had to be identified. The Environmental Protection Agency (EPA), for example, names as the five largest human-related sources of carbon dioxide emissions as the combustion of fossil fuels, nonenergy use of fuels, iron and steel production, cement manufacturing, and natural gas systems. All these processes are not primarily targeted to produce carbon dioxide. Rather, CO_2 is a by-product. Thus, carbon-as-waste is socially created by defining processes as designed to produce a specific output (for example, energy), while the by-product CO_2 emission is implied as something not wanted.

At Kyoto, Japan, in 1997, the international community devised a central mechanism through which

the concentration of atmospheric carbon dioxide was to be reduced: carbon markets. At these markets, permits to emit CO_2 would be traded. Furthermore, the international community intended to reduce the amount of several other significant greenhouse gases in the atmosphere, rather than merely focusing on carbon dioxide. Other greenhouse gases have also been conceptualized in magnitudes of the global warming potential of CO_2. This allowed using the market mechanism to target CO_2 as well as equivalent greenhouse gases.

Carbon as a Signifier of Greenhouse Gases

The Kyoto Protocol referred to six greenhouse gases (and groups thereof) slated for reduction: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). Within the hegemonic climate change discourse, these gases are measured in terms of their global warming potential. The global warming potential (GWP) of a gas is calculated by incorporating the lifetime of the gas and the degree by which it influences global warming as much as carbon dioxide. The GWP is defined relative to a time horizon, typically 100 years. The reason for translating greenhouse gases into carbon dioxide is its usability as a historical proxy of atmospheric warming due to being well distributed in the atmosphere. Therefore, scientists and policy makers co-constructed carbon dioxide as a currency in which the effect of greenhouse gases can be measured. For this to work, the global warming potential of CO_2 is defined as 1. For methane, for example, in 1995, the IPCC calculated methane's GWP for a time horizon of 100 years as 21 CO_2 equivalents (CO_2eq). Thus, over a period of 100 years, 1 unit of methane causes as much global warming as 21 units of CO_2. Later, the IPCC's 2007 analysis reported the GWP of methane as 25 CO_2eq over the same horizon. The reported GWP of the hydrofluorocarbon HFC-23 changed between 1995 and 2007 from 11,700 to 14,800 CO_2eq. Thus, GWPs are subject to change. The reports themselves recognize significant degrees of uncertainty.

To understand discussions about climate change and the significance of the amount of CO_2 emissions to be avoided, it is relevant to recognize that carbon dioxide is used as a currency representing GWPs and the unit is CO_2eq. When politicians discuss reducing the concentration of carbon dioxide, they are likely to refer to a variety of substances summed up as CO_2. The result of this has been the notion of carbon. The term *carbon*, then, refers to all of these six gases that have been made commensurable.

For the hegemonic discourse, the establishment of carbon as a signifier of greenhouse gases had positive effects. The fight against climate change was now addressable in a common currency. Different policy instruments and technologies can be assessed in terms of their carbon saving potentials. However, while carbon is used as a general token for those gases that have global warming potential, the scientific-legal implementation of the concept actually limits its range of representation to the six Kyoto gases, necessarily silencing other climate change–relevant dynamics.

Carbon Accounting

The regime to tackle climate change is fundamentally based on reducing carbon input into the atmosphere. The management of the atmospheric carbon load is based on quantifying (potential) carbon emissions. Such quantification can be achieved through a variety of direct and indirect paths of calculation. In principle, physical devices can be used to measure the amount of carbon emissions. This end-of-pipe measurement is, however, rarely used. Normally, actors use less direct quantification strategies:

To comply with the Kyoto Protocol, countries may determine their direct carbon emissions by including all the carbon emissions associated with, for example, fuels sold and cement produced in the given state. Then, the carbon emissions are counted as the country's emissions independently of where they are actually used. This approach requires knowing the quantities of those substances that are conceptualized as causing the country's carbon emissions. To know the amount of fuel sold in the country, accountants might use the tax on fuels. One can derive the amount of fuels sold via the sum of value-added taxes paid for fuels to the country.

A corporation, on the other hand, may want to establish the amount of carbon it emits. For that, it would use a number of indicators such as fuels and

energy consumed or kilometers flown by airplane. These quantities are known indirectly. For companies often having to account for their expenses anyway, it is rational to use simple calculations to derive their carbon emissions. For example, suppose a company bought gasoline for $20,000 at a price of $2 per liter. Thus, it consumed 10,000 liters of gasoline. According to the United Kingdom (UK) Department for Environment (DEFRA), a liter of petrol causes 2,3307 kilograms (kg) of CO_2 emissions. Thus, this company's gasoline use caused 23.3 tons of carbon emissions.

Individuals may calculate their carbon emissions by using carbon footprint calculators. These typically ask for several lifestyle decisions, such as the kind of vehicle the individual uses for mobility, or the kind of nutrition consumed.

These examples show that carbon emissions are constructed. For managing emissions, it is necessary to count carbon emissions avoided by specific practices. Thus, to make decisions on how to reduce carbon emissions, actors have to assess the carbon emission–saving potential of an action. While it is simple to calculate the average amount of carbon emissions avoided when, for example, switching from a vegetarian to a vegan diet, an expert-based bureaucracy is involved with assessing the potential to avoid carbon emissions by reforestation projects.

The Kyoto Protocol envisaged such projects. These and other kinds of projects are intended to reduce the amount of carbon emissions that would occur if the project had not been implemented. This part of the Kyoto Protocol is called Clean Development Mechanism (CDM). By running a CDM project, the responsible operators are able to produce carbon reductions—Certified Emission Reductions (CERs). Thus, such CDM projects are built to produce negative carbon emissions. These negative counts of emissions can be summed up with positive counts of carbon emissions. Hence, a company that established 500,000 tons of carbon emissions can neutralize this amount on its carbon balance sheets by adding negative emissions—CERs. Thus, carbon emission counts may consist of both actual emissions and certified CERs.

Analytically, two processes are common to all these approaches to quantify carbon. First, accountants draw boundaries as to what emissions they will include in balance sheets. Thus, some sources of emissions are included and accounted for. Other sources, however, are silenced and will not show up in the balances. Second, carbon emissions counts are not obtained by direct chemical measurements, but rather are based on a variety of factors (for example, the GWP emission factor of natural gas). The emission factor of any specific good, service, or lifestyle is always an average of a number of measurements. Both social constructivist and statisticians' readings of measuring explain the reality of diverging measurements. Disparate organizations often come up with different carbon counts for the same activity.

Economic Implications

The hegemonic discourse and structure of nation-states installed carbon markets to trade permits to emit carbon. Following the economist Ronald Coase, the mechanism assumes that market structures allow for the optimal (the most cost efficient) allocation of emissions. In effect, the creation of carbon markets commodified the atmosphere. This has significant economic implications: the rights to emit can now be accumulated within the dominating economic dynamics of capitalism. This ties material carbon politics to the accumulation of capital by economic elites.

Conclusion

The management of carbon-as-waste uses market mechanisms with an underlying system of experts devising factors to translate selected emissions into carbon. Political discourse is able to hide its agency behind the scientific side. The politics is summed up by many observers as capitalist technocracy: rather than opening up a democratization of the politics of carbon-as-waste, climate change has been reduced to an engineering and accounting problem and an economic profit zone. Thus, the problem of getting rid of carbon has been transformed into a business challenge. Other possibilities to tackle climate change have been silenced in favor of commodifying the atmospheric commons.

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See Also: Automobiles; Capitalism; Commodification; Emissions; Pollution, Air; Zero Waste.

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Celluloid

The first modern plastic, called celluloid, was initially developed as a synthetic replacement for diminishing natural resources, only later becoming closely associated with the development of motion pictures. Despite its extreme flammability, celluloid performed a crucial role, albeit in different ways, in the popularizing of both photography and the cinema. In addition, celluloid maintains throughout its history an intimate relation with both the conservation and consumption of animals, paradoxically promoted as preserving animals against environmental devastation while nonetheless depending upon a medium composed of the waste products of industrialized animal slaughter.

History

Marketed as a material for mass-producing cheap simulacra of scarce natural resources, principally ivory and tortoiseshell, celluloid was patented in 1870 by John Wesley Hyatt, who set up the Celluloid Manufacturing Company in the following year. By 1880, Hyatt's company issued licenses to a variety of firms, producing everything from dental plates and piano keys to jewelry, combs, and novelties, the latter being advertised as a luxury previously only available to the wealthy. In this way, Hyatt capitalized on the development of nitrocellulose by Christian Friedrich Schönbein in 1846. Two decades later, Alexander Parkes combined nitrocellulose with a plasticizer-solvent to produce the stable and fully formable forerunner of celluloid, which he named Parkesine. By varying the solvent employed, this new material was found to accurately mimic a wide range of naturally occurring substances.

This history of material mimicry is, however, largely forgotten today, eclipsed by the association of celluloid with the invention of film. By the early 1880s, photographers were already experimenting with transparent sheets of celluloid coated with a gelatin emulsion, seeking to replace the fragile and unwieldy glass plates that were in use at the time. Consistency remained a serious problem, however, and it was only with the introduction of John Carbutt's sheet film in 1888 that celluloid could finally be relied upon to provide a uniform thickness and unblemished surface, thereafter becoming widely available as a base for photographic plates. It was this base stock that Thomas Alva Edison (or rather,

Despite its extreme flammability, celluloid, the first modern plastic, was crucial in popularizing photography and films. The word film *originally referred to the coating of gelatin emulsion produced from connective tissue and other slaughterhouse byproducts.*

his chief engineer W. K. L. Dickson) used in the development of perforated 35mm celluloid film bands—Edison's major contribution to the invention of cinema—for use with his peep-show Kinetoscope. Thin and flexible, and thus allowing for its production in long continuous rolls, celluloid made photography available to amateur hobbyists for the first time. When, also in 1888, George Eastman introduced the Kodak system—a 100-image celluloid-backed roll film, which was to be returned to the manufacturers for developing—demand immediately outstripped supply.

Celluloid quickly established itself as the only suitable material base for "living pictures," used not only in the Edison Kinetoscope but also by the Lumiére brothers in their Cinématographe and by many others. Nevertheless, it was unable to shed its explosive origins, the nitrocellulose rendering it highly flammable and thus an unacceptable danger in the minds of many people. This danger was cemented in the popular imagination by a fire during the 1897 ball of the Société Charité Maternelle in which 143 people died (although celluloid was not in fact to blame). This hastened the imposition of safety restrictions upon the practitioners of early cinema, pushing it out of the domestic setting common to the magic lantern shows and into the less reputable theaters and fairgrounds. As a result, motion pictures became increasingly identified with popular public entertainment, as distinct from the domain of scientific research within which it originated.

Relationship With Animals

While often overlooked, celluloid maintains an intimate relation with animals throughout its history. As Nicole Shukin persuasively argues, the popular tours of the "disassembly" lines of the Chicago stockyards, insofar as spectators were treated to a view of time as a linear sequence of discrete moments, in fact constituted protocinematic technologies. More directly, celluloid and its constituents capitalized on the consumption of animals in a variety of ways, from the initial development of nitrocellulose as a gunpowder alternative to the marketing of celluloid as a material for mass-producing simulacra of commodities originally culled from the bodies of animals. Most notably, in the development of celluloid as a photographic and cinematic medium, animals again played a crucial role, with all of the three main figures associated with photographic motion in the late 19th century—Eadweard Muybridge, Étienne-Jules Marey, and Ottomer Anschütz—first employing the new technology to record the movement of animals. The promotion of early motion pictures was organized around a rhetoric of wildlife conservation, figured both by Marey's "Photographic Gun," and by the reemploying of such terms as *shooting* and *snapshot*.

While the words *celluloid* and *film* have long since become synonymous, the term *film* originally referred only to the coating of gelatin emulsion produced from connective tissue and other slaughterhouse "leavings." Film was thus the medium in which the movement of animals was first captured, permitting the reconnection of discrete images. With or without its film coating, celluloid was thus the first mimetic plasticity, at once replicating, breaking down, and reconstituting the lives of animals, while remaining materially dependent upon their slaughter. In other words, the strength and flexibility of celluloid, which serves to preserve animals—to "save" them by recording for public consumption that which might otherwise be lost forever—could nonetheless take place only through the "waste" of animals slaughtered for consumption.

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See Also: Commodification; Environmentalism; Television and DVD Equipment.

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Central America

Central America is the geographic region that lies between Mexico and Colombia. Historically, it

has included Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica, though contemporary geographers now also include Belize and Panama. Known for its biodiversity, rich archaeological heritage, and linguistic and ethnic diversity, the region is home to some 41 million people. The largest Central American country by geographical area is Nicaragua (80,778 square miles [sq mi]), and the smallest is El Salvador (13,000 sq mi). By population, Guatemala is the region's largest country, with 14 million inhabitants, and Belize is the smallest, with less than 400,000 people.

Colonized since the days of Christopher Columbus, Central America has been the scene of intense agricultural development, including cacao, coffee, bananas, and cotton. Military action during the leftist revolutions of the 1980s and 1990s (in El Salvador and Nicaragua), U.S. counterinsurgency projects in the same period (in Honduras), and decades of ethnic strife (in Guatemala) have led to intense deforestation in much of the region, along with extensive water and soil pollution. Central Americans have rolled back some of the ravages of colonialism and war through organic, fair trade, and cooperative forestry and agriculture, but consumption and waste problems persist. Notably, gold mining has been a source of fast wealth and ecological ruin in the central mountains that run from northern Panama to Guatemala. Although much of the population continues to depend on the production of a few key crops, namely, coffee, beans, rice, and corn, Central America is rapidly urbanizing in the 21st century. The region confronts five principal types of waste disposal issues: military, agricultural, mining, industrial, and municipal.

Military Waste

Often disregarded in discussions of waste, military refuse remains a pressing issue in Central America. Civil wars, revolutions, and narcotics-related violence have been particularly important in shaping the region's contemporary landscape. It was not until 2010, over 20 years after the cessation of hostilities between the leftist Sandinista government and U.S.-backed contra revolutionaries, that Nicaragua was able to declare its countryside land mine–free. Evidence of armed struggle, including unexploded ordnance, erosion, and unmarked graves, also pepper the countryside of El Salvador, Guatemala, Panama, and Honduras.

Agricultural Waste

Nicaragua's experience with industrial agriculture since the 1950s provides perhaps the most dramatic example of the region's struggle to govern industrial agriculture and its resulting wastes. In the mid-20th century, Nicaragua was Central America's breadbasket, with production of cotton, wheat, corn, and beans at record highs. By the 1970s, however, overuse of chemical pesticides had made Nicaragua a net importer of these products, with many fewer working farms in its once-fertile Pacific coastal plain. Malaria, a disease that was once under control in the country, made a comeback when mosquitoes became resistant to pesticide treatment. Across the region, pesticides applied on the banana plantations of the U.S.-based United Fruit Company have had serious health effects on workers and their families. Current and former plantation laborers continue to raise questions about the long-term environmental and health impacts of pesticide use, but they have had little luck in foreign courts.

Gold Mining

Gold and silver mining have been part of Central America's economy for centuries. Since colonization, the potential of a strike has drawn both large corporations and small prospectors to the mines. Though it presents opportunities for great wealth, gold extraction is not without its critics. For example, during the 2000s, indigenous Maya activists in the Western Highlands of Guatemala engaged in vocal and often tense clashes with their own government and the Glamis Corporation of Canada. The Maya leaders argued that although Glamis's open-pit gold mining project was initiated with the blessing of the United Nations Development Programme, indigenous people were not fully consulted about the mine's environmental impacts. The activists claimed that Glamis's use of cyanide for leaching gold out of ore was contaminating groundwater and ruining small farmers' chances of making a living.

As in the cases of military and agricultural waste, responsibility for mining and its attendant wastes often spans across national borders. Central American governments have been unable or unwilling to

prosecute waste management oversights, and the home countries of multinational corporations often lack the legal structures to tackle these problems.

On a smaller scale, artisanal gold miners throughout the region use mercury to extract small amounts of gold from ore they find in streams, rivers, and abandoned mines. Activists and leaders in the gold-mining regions of Nicaragua, Guatemala, Costa Rica, and Panama have warned that mercury, a neurotoxin, will do long-term damage to brain and fetal development in infants and children as well as to the motor skills of adult and adolescent miners.

Industrial Waste

Though agriculture, forestry, and tourism comprise a great portion of Central America's economy, heavy industry has grown since the 1990s. In Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica, the Dominican Republic-Central America Free Trade Agreement (CAFTA-DR) has made free trade zones, or *zona francas*, important sources of low-income employment in the manufacture of goods for the global market, especially apparel. The CAFTA-DR provides some environmental and labor protections, but unions and community groups have found it difficult to organize workers and to confront the ecological damage caused by the chemical dyes, wastewater, and airborne emissions that apparel plants emit.

Before CAFTA-DR, industrial waste had already taken a toll on the region. In 1992, the presidents of Central America's countries voted to impose a ban on the importation of toxic waste to the region after activists successfully argued that waste importation was damaging the environment. Thanks to imported and domestic waste, Nicaraguans witnessed the nearly total destruction of the fishery and ecosystem of Lake Managua, Central America's second-largest body of freshwater. In the early 1970s, the U.S.-based Pennwalt Corporation opened a caustic soda and chlorine plant on the shores of the lake. By 1981, a U.S. research team found that 37 percent of Pennwalt's workers suffered from mercury poisoning. Mercury from the caustic soda production process continued leaking into Lake Managua through the 1980s, causing irrevocable damage to freshwater marine life and the local fishers who depended on it. When the Pennwalt plant opened in the 1970s, U.S. factories had already stopped using mercury in caustic soda and chlorine production. In Nicaragua, however, workers at Pennwalt grappled with long-term and often irreversible health problems caused by exposure to mercury—the same health problems that in the United States precipitated the first enforcement of the 1971 Occupational Safety and Health Act. Pennwalt continued operating until a series of chlorine leaks in the early 1990s sparked protests from local residents. In what became known locally as "El Caso Pennwalt," the company failed to rectify the chlorine leaks, and the plant closed.

Municipal Garbage

With its proximity to the larger economies of Mexico, the United States, and South America, Central America's access to disposable consumer products, appliances, and packaged foods outpaces its otherwise high levels of economic poverty. Rapid urbanization across the region has not come along with rapid development in urban infrastructure. The garbage dumps of Guatemala City, Tegucigalpa, and Managua are home to hundreds of families who make their living scavenging for waste, and the global recycling industry has sparked an informal economy for aluminum, plastic, and paper. Children comprise a large part of the workforce in this garbage economy, and all workers are exposed to the fumes of burning refuse, skin and eye diseases, malnutrition, and toxic chemicals.

No city in Central America has a sanitary landfill. Cities and towns deposit the majority of their waste in rudimentary dumps, from the massive pit in Guatemala City to Managua's "La Chureca," the region's oldest dump, sited on the shores of Lake Managua. International development organizations have proposed projects to construct sanitary landfills in the region, but these plans continue to face opposition from dump dwellers and their advocates, who fear the possibility that dwellers may lose both their homes and their livelihoods if dumps close.

Despite its mineral wealth, physical beauty, and unparalleled biodiversity, Central America remains the poorest region in the Western Hemisphere. In fact, it contains two of the hemisphere's three poorest countries (Nicaragua and Honduras). Agricultural transitions, deforestation, and the promise of

work in free trade zones indicate that the region's cities will continue to grow. This urbanization, coupled with increased access to disposable consumer goods and packaged foods, indicates that Central Americans will likely struggle with political, economic, and environmental health challenges related to the rapid expansion of consumption and waste for years to come.

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See Also: Developing Countries; Farms; Mineral Waste; Pollution, Land; Pollution, Water; Toxic Wastes.

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Certified Products (Fair Trade or Organic)

Claims made for certified products address issues surrounding human rights, fair wages, safe working conditions, animal welfare, and/or environmental stewardship. Products typically receiving certifications include food, fiber, and forest products. Timber products are certified through entities such as the Forest Stewardship Council (FSC) and are sold in lumberyards or home improvement stores. Not all FSC-certified products are labeled as such, and some require further research by the consumer. Fair Trade as well as Shade Grown certifications attest to the social justice and environmental health aspects of food production. In terms of Fair Trade coffee, consumers pay a price premium in exchange for the knowledge that their purchase is providing a price to coffee producers that is considered more equitable than they otherwise would get. Although this may yield greater revenues for some coffee growers, not all growers are situated, either physically or socially, to take advantage of these markets. Further, growers, usually through a cooperative, must meet certain standards of large-scale coffee marketers in order to have their coffee bought at a premium. As with all commodities, the premium price for Fair Trade coffee is subject to shifting market demand and competition for market share from other regions. Shade-grown products have been shown to be more expensive to maintain in some situations, suggesting scalar issues. That is, larger producers may be better situated to adopt more ecologically sustainable practices, eventually leading to certification, than small-scale producers would be able to take on. In this sense, some small-scale producers are effectively priced out of the market.

Certifiers make the claim that their certified products authentically represent a suite of socially and ecologically sustainable practices embodied in the product and its presentation. At the consumer level, these seals or marks and the claims they make concerning the process and/or product are scrutinized in relation to noncertified or alternatively certified products. These certifications and the subsequent labeling and marketing serve an educational purpose, informing the consumer about where a particular product came from, how it was produced, by whom it was produced, under what conditions it was produced, and what inputs were used to make the product and sometimes its package. This information is provided with the intent of weaving a narrative that calls the consumer to action, that is, to purchase. At the same time, the consumer must believe that the certifying group or agency has the power to uniformly enforce its standards upon all the producers of the product. In instances such as prepared organic foods, the consumer is called to trust a series of unknown producers, processors, and distributors over a complex supply chain that all the products meet the minimum standards.

These certified products have, on the one hand, been heralded as consumer activism, where consumers can vote for a better world through their wallets. On the other hand, they have been vilified as a means to further distinguish wealth disparities

via consumption and a shallow sense of environmentalism, wherein nothing need be sacrificed, only consumed with greater prudence. In this respect, the slow food movement, organic foods, and community-supported agriculture have all been attacked as gustatory elitism.

The organic food market in the United States has been one of the fastest-growing sectors in U.S. agriculture over the past decade. This has been recognized as a lucrative market where businesses, including large corporations, can do well financially while also doing good for the environment. The majority of organic products in the United States reach the mouths of consumers in much the same way as their nonorganic counterparts: through highly centralized production, processing, and distribution facilities. In some instances, organic farms of today more resemble industrial agricultural operations than they do diversified farms, which attempt to balance economic and ethical considerations. Nevertheless, a shift to organic management regimes by definition means a prohibition on the use of chemicals that have historically been overused and misused in industrial agricultural production, resulting in pollution of land, water, and air. Further, chemical residues impact not only the physical environment but also the biological environment, including the resultant human health impacts.

The process of creating policies and practices concerning certification in terms of either Fair Trade or organic products can be very contentious as both multiple stakeholders vie to shape standards. As a case in point, the establishment of the National Organic Standards was marked by fierce debate as to what would be permitted to be considered organic. The controversy surrounded the product and process of organic food production. Notably, an outpouring of public comments in opposition to sludge as fertilizer, genetically modified organisms, and irradiation of foods were effective in eliminating the proposed elements as part of contemporary organic standards in the United States. Despite this victory, critics of the current organic certification and management regime point out that the legislation has served to consolidate the organic industry in the United States, although small farmers continue to work to develop innovative product, process, and marketing strategies using sustainable approaches and agroecological principles, regardless of whether or not they are certified organic. In some respects, farmers chose to forgo certification due to the expense involved, or adopted alternative labels that convey the high quality and ecological sustainability of their farming operations.

Those who have marketed certified products continue to advocate their social and ecological viability. Consumers purchase these goods for a variety of reasons that may or may not directly correspond with the intent of the producers. The ecological and social justice implications of certified product production, distribution, and consumption all deserve future study.

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See Also: Capitalism; Carbon Dioxide; Commodification; Consumption Patterns; Farms; Food Consumption; Organic Waste; Personal Products; Pollution, Land; Pollution, Water; Recyclable Products; Slow Food.

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Children

Children ages 0–16 are one of the largest demographic categories of consumers in society. Their role is increasingly important, because their expenses have increased and their influence over parental spending has expanded. In the process of children's graduate consumer socialization, especially through ages 6–16, their independence as decision makers

progressively grows, characterized by a dynamic cognitive and social development.

There is, however, an imbalance between children's needs and consumption in different parts of the world due to varied standards of living. In many countries, poverty prevents children from being satisfied even with minimal products of primary needs. In contrast, in more developed countries, consumption often exceeds the needs of children, although hunger remains a problem for some segments of society. For instance, in 2007, over 13 million children age 18 and younger lived in poverty in the United States.

Children as Consumers

One classification includes five stages of the development of children as consumers:

1. Ages 0–2: accompanying parents and observing
2. Ages 2–3: accompanying parents and requesting
3. Ages 3–4: accompanying parents and selecting with permission
4. Ages 4–5: accompanying parents and making independent purchases
5. Ages 5–6: going to the store alone and making independent purchases

P. M. Valkenburg and J. Cantor offer a four-stage development from a psychological point of view:

1. Infants and toddlers (ages 0–2): feeling wants and preferences
2. Preschoolers (ages 2–5): nagging and negotiating
3. Early elementary school (ages 5–8): adventure and the first purchase
4. Later elementary school (ages 8–12): conformity and fastidiousness

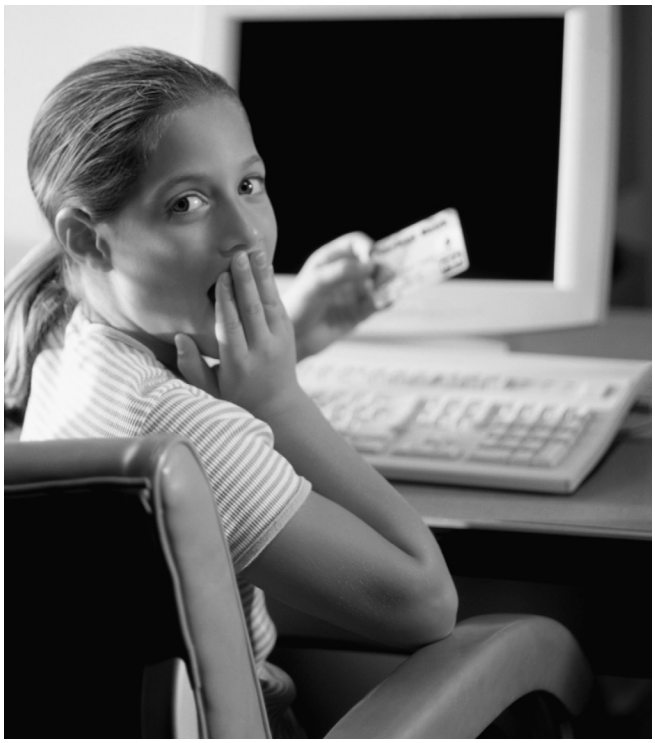
The categories of children's consumption include food, toys, games and other entertainment products, clothes, accessories and cosmetics, children's books, school and educational accessories, children's furniture and equipment, children's medicine, and other children's items. There are also adults' categories that have been consumed by some children at the expense of their health (such as tobacco).

Developing sound food habits for good health, recognized as a preventive health, has become a main task of modern parents, children, and society in general. One serious problem is the disproportionate consumption of condensed milk that makes children vulnerable to dehydration and death from diarrhea. There are many social programs throughout the world that help families and single parents' children get enough food, including milk.

There is a tendency toward overconsumption by children in some countries in the world, including the United States, which results in serious obesity problems. Plate-waste is a specific issue, since children leave a great deal of food on their plates, especially during school lunches. Many projects and programs try to both reduce the wasting of food through recycling and to decrease the obesity problem. The Robert Wood Johnson Foundation spends $100 million per year toward reversing childhood obesity—the single largest effort of this type in history.

Toys and games play an essential role in children's life and are also one of the most successful types of merchandise all over the world, with an annual profit of around $21 billion. Electronic games and other entertainment products have an ambiguous role, since electronic games are often thought to have ill effects. A successful marketing mechanism that develops a culture of extensive consumption is the promotion of collectible toys, including Barbie dolls, Dora, and numerous other brands. In contrast to toys and other small products, parks like Disneyland in California and Universal Orlando in Florida create an opportunity for creative entertainment that may lead to extensive consumption.

Clothes, accessories, and cosmetics are socially sensitive. This is the field of social life where children at their earliest ages learn about inequality of wealth in society and begin to construct their explanation models with age-related variations. The influence of fashion and pop stars has become typical for large segments of the global child community. China's children's industry, the largest in the world, is known as a fashion industry. The "sexualization of children" is also a reason for the development of



Children ages 0–16 are one of the largest demographic categories of consumers in society, and their influence continues to grow. The heavy marketing of collectible toys such as Barbie and Dora dolls has fostered a culture of extensive consumption among children.

a special attitude toward clothing and makeup. The prevalent marketing push toward profits attacks, in some cases, the world of children's innocence through sexual symbols and provocative imagery that in turn contributes to an underground culture of child pornography; this is one of the most devastating results of the consumer culture in the information age. Children's cosmetics vary from creative cosmetics for birthday parties to full imitations of adults' makeup.

Children's furniture and equipment include room furniture (such as beds, dressers, and shelves), garden equipment (such as shovels), baby carriages, miniature cars, bicycles, skis, and other sports equipment.

There are conventional and complementary and alternative medicines (CAM) for children. Data from the U.S. National Health Statistics Reports in 2008 show that children whose parents use CAM are almost five times as likely to use CAM compared to children whose parents do not use CAM.

Most children's consumption categories belong to two types of subcultures: primary consumers and secondhand consumers. Reusing children's and adult clothing, furniture, and recreational items is a policy developed through different commercial and not-for-profit organizations worldwide, and it results in billions of dollars in business.

There is a special category of children-consumers who belong to families with low incomes. Social programs worldwide help these children to grow healthy through a series of initiatives. For instance, in Utah and some other states, special programs provide milk to any child raised in a low-income family.

Children and Waste

Waste is a result of regular consumption or overconsumption. There is a difference between garbage and waste, although garbage is a part and an aspect of waste. "Reduce, reuse, and recycle" is a policy of the green culture that has been addressing children through a variety of programs. For many reasons, the children of the world not only increase the quantity of garbage, because of expanding consumer patterns, but are also exposed to greater amounts of human garbage that in some cases is deadly. In cities like Cairo, Egypt, children comprise up to 50 percent of the labor resources involved in waste cleanup in the streets. There is a gender division: boys pick up the garbage, while girls help the women in sorting the garbage. Children and adults who live or work near hazardous landfills are at greater risk for disease and suffer adverse health effects, including cancer and damage to the fetus in pregnancy.

Electronic waste (e-waste) is one of the greatest problems from a global perspective. For instance, recycled computers have been sent from rich to poor countries where children interact with them and sometimes throw the electronics onto fires. As a result, children breathe in highly carcinogenic fumes. Since the 1980s, cities like Guiyu, China, have been taking in e-waste from other countries for dismantling and safe processing. The lead poisoning level in children is 69 percent in such places. Items from the United States, the Netherlands, Germany, and South Korea were found at a dump site in Ghana's capital, Accra, where they also endanger children. Statistics of the United Nations Environ-

ment Programme estimate annual e-waste between 20 million and 50 million tons.

Another serious problem is poisoned water. According to a United Nations report, 1.8 million children younger than the age of 5 die every year because of poisoned water.

Cultural Diversity, Enculturation, Socialization, and Health

Cultural diversity among children's consumption and waste response depends on family, cultural traditions, and actual socialization. There are also differences in gender; female and male children have different needs and a varied psychology of consumption and waste response.

Consumer patterns influence the health of children. Overconsuming food or specific products may result in obesity. Poverty, hunger, or the use of drugs, alcohol, and tobacco may even cause the deaths of children. Children depend on an active system of consumption even before their birth. Many of them become victims of unhealthy pregnancy habits, including tobacco use by their mothers.

One of the traditional cultural patterns worldwide is shared-plate food and finger-feed. These create opportunities for the socialization of children, but they may also cause health problems because of deficits of important vitamins that benefit children or undeveloped personal hygiene.

Archaeological evidence indicates that at the beginning of sedentary economy and in the course of the advance of agriculture (the Neolithic Age and the Copper Age), plates with large food portions were popular, although small bowls also existed. It is very probable that shared-plate feeding was emblematic of these early human cultures. Accordingly, consumption patterns have been defining the style of human culture since the earliest stages of human civilization.

Childhood is an important period for preparing children for successful future economic, social, and cultural roles in the free market world. The process of socialization develops together with enculturation and reflects on the individual decision making of children. In particular, consumer behavior depends on the way in which children will be introduced to the problems of wealth. Although children's economic knowledge is socially differentiated, developing strong savings behaviors (including strategies and decisions) and saving beliefs (including attitudes and beliefs) is a cross-social ability. Such patterns of enculturation and socialization directly relate to children's health, since some new products of e-media, like video games, can be addictive.

Art is very powerful in enculturation. As an education tool, it helps children to access and develop their creativity. Many items that would normally end up in the trash can be turned into attractive, useful items through handcrafting. There is an excellent example of this in the Children's Garbage Museum in Stratford, Connecticut. Special artistic programs in the United States engage children in the problem of sustainable living.

Living in a diverse social environment, children's social sensibility as consumers depends on how they have been introduced to societal problems and how they develop as decision makers. The consumption models of children are in fact models of the future of humankind.

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See Also: Baby Products; Candy; Consumption Patterns; Cosmetics; Malls; Social Sensibility; Toys.

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Chile

Chile has garnered international attention for its free market economic policies, devastating earthquakes, and decades of political change. Its neighbors remember Chile's history of territorial expansion. All of these factors have affected its changing patterns of consumption and waste.

Chile's long, thin profile along the Pacific Ocean contains a highly urbanized population of about 17 million. The country had a purchasing power parity (PPP) of about $15,000 per capita in the late-2000s, which ranked about 76th worldwide. Income inequality was relatively great.

Water

Chile has served as a paradigmatic case for studies of water privatization, and this process has affected patterns of water consumption and sewage treatment. In the early 1980s, the military government established water rights as a private commodity in the constitution. This created perhaps the world's most free market approach to water rights. The entities that delivered water and sewage services were still public, but democratic governments from the late 1980s into the early 2000s also gradually privatized this sector. Foreign economic interests, such as a pension fund for Canadian teachers, have invested heavily in Chilean water providers. Government agencies increasingly regulate water quality, and policies promote the extension of services to underserved areas.

This system has provoked considerable debate in Chile and internationally. Water is piped to nearly 100 percent of the urban population, and sewage treatment has risen from about 20 percent in 1999 to 84 percent in 2008, making Chile a leader in Latin America. While low-income Chileans can qualify for subsidies, the rise in water prices that accompanied privatization has led to a marked decrease in water use per capita. However, many observers complain that the system favors wealthy sectors of the country to the neglect of others. For example, the rates of water connection and sewage treatment in rural areas are much lower. And, contrary to expectation, Chile's level of water losses, already high, actually rose after privatization.

Exports

Much of Chile's wealth has come from the export of commodities. The War of the Pacific (1879–83) in which Chile took its northern extension in the Atacama Desert from Peru and Bolivia, allowed Chile to dominate the extraction and exportation of nitrates, which were valued abroad primarily as fertilizers. Wood used in this industry came from nearby forests of the tamarugo tree, which were severely depleted: 21st-century government efforts to replenish this tree must contend with falling groundwater tables to feed nearby towns' consumption.

In recent decades, copper has overshadowed nitrates as Chile's main export, and Chile remains the world's dominant producer of each commodity. Copper mining is centered in the Atacama Desert and the north-central region. Pollution controls have become progressively stricter since the return

to democracy in the 1990s. Prior to that, legal environmental controls were weak or nonexistent, and mines' emissions of arsenic, cyanide, carbon monoxide, sulfur dioxide, and heavy metals into the air, ground, and water caused significant health problems among workers, nearby residents, and plants and animals. Despite marked reductions, waste from copper mining remains a significant environmental hazard.

Energy and Carbon

Chile's energy consumption has increased rapidly, along with its gross domestic product (GDP), since the 1980s. As with water, Chile has almost completely privatized its energy sector since then, and foreign investors control much of it. Access is almost universal. The vast majority of the supply has come from a mix of hydroelectric plants, coal, and natural gas. To reduce Chile's dependence on Argentina and on decreasingly predictable hydrology, the country is increasing its reliance on coal.

Chile has ratified the Kyoto Protocol, which does not require it to reduce emissions, and makes it eligible to host projects via the Clean Development Mechanism. In 2008, the government announced a plan to address climate change that focused on studies, organization, and planning, rather than on comprehensive provisions for reducing consumption or waste. Some of its more concrete provisions aimed at creating more secure supplies of water. Nonetheless, Chile has been the site of various greenhouse gas–reducing projects, including a campaign to promote compact fluorescent lamp (CFL) bulbs, methane capture at landfills, and wind farms.

To help account for an anticipated doubling of demand over the next decade, Chile has increased energy efficiency considerably, and overall electricity consumption has actually decreased in some years in the late 2000s. The government hopes that improvements in efficiency will account for 20 percent of the expected growth in consumption. These savings were achieved in part through building codes. Chile also has recently passed a requirement that large utilities—excluding hydropower plants—gradually increase their inclusion of renewable energy sources to equal or exceed 10 percent by 2024.

Overall, though, Chile's carbon footprint per capita grew rapidly over the 2000s, reaching about the worldwide average, in part because of industrial growth and greater dependence on coal. Calculations of its ecological footprint have ranked Chile anywhere from the most damaging country in Latin America—within the range of rich, European countries—to slightly lower on both scales.

Garbage

Each day, Chileans produce more than one kilogram of garbage per person. Most Chilean garbage goes to older sites that were not designed according to modern standards. In part, this is due to the low cost of dumping garbage. The federal government estimates that about 60 percent of garbage is deposited in landfills. Recycling is not widespread in Chile, and the federal government does not have a comprehensive recycling plan as of 2010, instead relying mostly on education and encouragement. Its goal for a public-private effort in Santiago is the recycling of 25 percent by 2020, up from about 10 percent nationwide. Programs such as methane capture have existed in scattered landfill sites, but the unfiltered trash reduces their effectiveness.

A massive earthquake in February 2010 created a set of challenges related to waste. Trash collection and recycling were interrupted, and environmentalists feared that leaks of sewage and industrial waste presented hazards for humans and other organisms. Most visibly, Chile had to remove vast amounts of rubble that remained piled along streets for weeks and—in some places—months after the main tremor. Ad hoc trash dumps also sprang up, replete with rats. Some cities created new collection fields for the rubble, without time to prepare them as they would a planned landfill. The cost of such a monumental endeavor, in the face of other costly priorities such as repairing roads and constructing temporary housing, kept local governments from tackling the rubble quickly. Some nongovernmental organizations proposed projects to create monuments out of rubble or to recycle parts from it.

Easter Island

Easter Island, ruled by Chile, has become the focus of a debate regarding consumption there in the few centuries before Europeans first landed on the island

in 1722. All of the competing scenarios require considerable conjecture. Some observers, most notably Jared Diamond, argue that the inhabitants, or Rapanui, gradually deforested the island for a combination of reasons, including to build boats and to transport the island's famous statuary using logs. According to other researchers, deforestation derived mostly from environmental changes beyond the islanders' control. Some evidence suggests that a period of lower temperatures and drought in the early 1600s—coincident with the Little Ice Age and similar to a very lengthy El Niño pattern for this region—caused the simultaneous extinction of not only trees, but also many types of bushes and shrubs that islanders would not have used for major projects. This historical debate has attracted considerable attention, in part because some observers have explicitly likened the Easter Islanders' situation before 1650 to that of all present-day humanity.

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See Also: Capitalism; Developing Countries; Mineral Waste; South America; Sustainable Development.

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China

Over the past few decades, the People's Republic of China (PRC) has transformed from a poor, socialist country that was devoid of consumer culture in the 1970s to one of the world's largest consumer markets in the 21st century. With a booming economy and fast-paced development, China was the world's largest consumer in 2010, and is an exporter of many products. The enormous size of its market, rapidly rising levels of domestic consumption, and accompanying social changes have attracted the attention of commentators around the globe. China also plays a key role in consumption in the West, exemplified by the "Made in China" label, which dominates department stores and supermarkets. However, consumption is not without discontent; social ills once assumed to be exclusive to Western society now bring unhappiness to the Chinese. There has also been a heavy burden on the environment, such as desertification, drought, flooding, and pollution, and these problems threaten sustainable development. Another issue is the increasing volume of waste in response to industrialization and urbanization and inadequate waste management, which has social, financial, and environmental implications.

China's Consumer Revolution

Consumption in China in the 21st century is a complete contrast to its recent past. The PRC was established in 1949 by Mao Zedong's Chinese Communist Party, and it was essentially a socialist society with no commercial consumer culture. In the socialist Mao era, goods and services were rationed and limited in variety. The service sector consisted of state-operated shops, as private firms were banned. Workplaces (known as *Danwei*) consisted of state-owned enterprises and public organizations (or, in rural areas, communes and production teams), which provided all basic necessities and other goods to members, including food eaten in centralized canteens, clothing, education for children, housing, and medical services. The work units also controlled events such as travel, marriage, and family planning. Most families had only enough money to meet their basic needs, and the majority of household income was spent on food.

Consumption in China from the 1950s to 1980s is often described in the literature by the products people at that time dreamed about owning, such as a bicycle, transistor radio, watch, and a sewing or washing machine. However, these items were expensive and were not commonplace, as households needed to save up or pool their incomes. Socialist ideology also dictated consumer fashions; for example, it was patriotic to dress in standardized clothing, such as the blue and grey cotton suits of the late 1970s, but ideologically improper

to wear items such as jewelry. The Mao era was also characterized by various social and economic movements such as the Cultural Revolution—the antithesis of a consumer culture—which brought momentous change and periods of turmoil.

Deng Xiaoping's rise to leadership in 1978, following Mao Zedong's death in 1976, was a major turning point in 20th-century China and completely changed the face of consumption. Deng abandoned socialism and a centrally planned economy in favor of a market economy. He instigated the "Open Door" policy that gave the country access to foreign goods, investment, and technology transfer. Reform policies included the liberalization of industry, which encouraged the growth of privately owned enterprises, and price liberalization, which replaced state-set prices with market forces. Deng's famous slogans included "To get rich is glorious," "poverty is not socialism," and "take the lead in getting rich." The government implemented the Four Modernizations Program that emphasized developments in agriculture, industry, education, science, technology, and defense. As a result of these changes, China, in the post-Mao era, is transitioning to a modern nation. The country's economic prowess is reflected in almost all measures of development, especially gross domestic product (GDP), which has grown at staggering rates.

One of the most visible features of China's development, particularly during the late 1980s to mid-1990s, has been the emergence and growth of a consumer culture and society. China's opening up to the world led to the increased availability and diversity of products. Rising incomes and living standards led to increasing consumer spending power and preferences. The consumption structure has changed; the Chinese now spend much less money on basic daily necessities such as food, clothing, and durables for the home and more on items such as education, entertainment, housing, tourism, technology products, and medical insurance. Chinese consumers follow the latest fashions and trends in ways similar to consumers in other countries. With fast urbanization, an increasing number of new consumption sites, such as large department stores, shopping malls, and skyscrapers, are appearing in cities across the country.

A food stall in China. Consumption in China in the 21st century is a complete contrast to its recent past. In the 1970s, China was a poor, socialist economy with no consumer culture; now, it is one of the world's largest consumer markets.

Consumer society is stratified. There is a rapidly expanding middle and upper class, with strong consumption power, especially in major cities. Many leading suppliers of luxury goods, such as automobiles, clothes, fashion accessories, jewelry, and cosmetics, have entered the Chinese market to cater to the affluent. China has several hundred thousand millionaires who consume high-end purchases, such as Bentley limousines. However, China's consumer revolution is mainly an urban phenomenon and is less evident in the poorer, rural areas. There are also differences across the country that reflect regional inequalities. Consumption is more conspicuous in regions along the southern east coast, especially in the special economic zones (SEZs), which have received most investment economic growth. In contrast, the inland rural areas (central and western China) have received relatively little investment and remain underdeveloped. Despite the glamour

and glitz of major cities like Beijing and Shanghai, urban inequalities and poverty are rife, especially among rural-urban migrants working unofficially in urban areas.

Foreign products are popular in China, largely because of their perceived status and quality—a complete contrast to the Mao era when anything foreign was regarded as bourgeois. Chinese nationalism has, however, been reflected in some objections to foreign products. The country imports many goods and services from overseas, and Western-owned manufacturing companies have relocated to China, making their products and technology available.

The Chinese economy is dominated by overseas investment and trade, but the government hopes that domestic consumption will be a major source of economic growth in the future. This is in contrast to countries such as India, where domestic consumption has played a key role in growth—China is more dependent on exports. Numerous initiatives and policies have been introduced to entice domestic consumerism, such as higher income levels, holiday extensions, infrastructure development, and expansion of bank credit. China's accession to the World Trade Organization in 2001 opened up Chinese trade and services to the world market. In response to the global financial crisis, the government launched a 4 trillion yuan ($585 billion) economic stimulus package with the aim to stimulate the economy.

However, several factors in China tend to curb consumption, including competition repression in which state-owned enterprises and other government-sponsored firms lack competitors, which leads to higher prices for many goods and services; financial repression, such as when banks keep interest rates low, which reduces the income of consumers; underdeveloped social security and retirement schemes, which encourages the public to adopt high saving rates and consume less; and widening income disparities, particularly between urban and rural areas and between coastal regions and inland territories.

Consumption

China is a leading consumer and producer in a wide range of industries and services. It is also the world's largest exporter, and many products around the globe display the "Made in China" label.

China has the world's largest agricultural output, contributing 13 percent of GDP and employing over 300 million farmers. Rice is the dominant crop and is cultivated mostly in southern provinces such as Guizhou, Hebei, Yunnan, and Sichuan; wheat is also important, especially in the north. Other major food crops include beans, corn, millet, oats, peanuts, potatoes, tea, and various fruits and vegetables. Nonfood crops include cotton and tobacco. China's increasing affluence and growing population have led to increased demand for meat. Animal husbandry, livestock farming, and the Western intensive-farming model are increasing in popularity. China is the world's leading producer of pigs, chickens, and eggs; and it also has sizable herds of sheep and cattle. The country's aquaculture accounts for about one-third of the world's total fish production, concentrated in the middle and lower Yangtze Valley and the Zhu Jiang Delta. Since the early 1980s, the population's dietary patterns changed from staple foods to diverse meals with meat and dairy products.

Only about 15 percent of the country's total land area is suitable for farming. Yields are high because of intensive cultivation. Agriculture in China has always been very labor intensive, with limited agricultural machinery, although production has generally increased as a result of technological changes. Since the 1950s, and particularly since economic reforms in the 1980s, there has been a shift from an agricultural-based economy to industrialization. Large areas of farmland were converted for urban and industrial use; the proportion of the population working in agriculture declined; and a large number of farmers have pursued alternative livelihoods such as manufacturing and commerce.

China is the second-largest consumer of primary energy. Energy consumption has grown dramatically since 1980—largely in response to business and infrastructure development—and is likely to increase further over the long term. Most energy comes from fossil fuels such as coal and oil. Coal consumption is declining, and thousands of mines have closed. Output from China's oil fields is also in decline, replaced by an increasing number of imports. Hydroelectric resources account for about one-fifth of energy use,

mostly in the southwest. The Three Gorges Dam, located across the Yangtze River in Hubei Province, is the world's largest hydroelectric power station by total capacity. As of 2010, natural gas production accounted for only 3 percent of energy production, and nuclear energy 2 percent. China is also developing alternative energy resources such as geothermal, tidal, wind, and solar power.

China is a major industrial and manufacturing base. Industrial development has been given considerable attention since the founding of the PRC. During the 1950s and 1960s, the Maoist regime emphasized heavy industry, especially machine-building and metallurgical industries, and the economy grew much faster than before 1949. Prior to 1978, most output was produced by state-owned enterprises. The transition era from the 1980s onward saw the development of light industry; new industries such as chemicals, electronics, and pharmaceuticals; and high-technology industries that produce computers, electronics, and telecommunications. This has contributed to changing consumption patterns as the general public now have wide availability of goods.

Overall, industrial output has grown at an average rate of more than 10 percent per year. Industry is concentrated in the coastal provinces of Guangdong, Jiangsu, Shandong, Shanghai, and Zhejiang. The automobile industry has developed rapidly since the early 1990s. China is the largest consumer of automobiles and has domestic and overseas companies.

Tourism is one of the fastest-growing areas of consumption. The hotel sector and travel agencies are expanding rapidly. China has become important as both a tourism destination and tourism-generating country. If the predicted growth of Chinese tourists materializes, there is likely to be strong demand for tourism services both domestically and internationally, although the domestic tourism market currently constitutes more than 90 percent of the country's tourism traffic.

Waste and Recycling

Alongside increasing consumption, China is the world's largest generator of household and industrial waste. Over 1 billion tons of industrial waste and 200 million tons of household solid waste are generated annually. Household waste in China accounts for one-third of the world's total and is increasing at annual rates of 8–10 percent, projected to be at least 480 million tons annually by 2030.

Formal waste management started in the late 1980s and remains at a preliminary stage. The Department of Urban Construction (within the Ministry of Construction) is the national authority responsible for urban waste management; municipal and district governments are responsible for management at the local level. There is enormous variation in waste collection and treatment services between and within cities, ranging from rudimentary collection systems in the poorer suburban areas to adequate services in modern, high-rise apartment blocks in major cities. Most household waste is buried in landfills, and only a small proportion is composted or incinerated. Although some cities operate good sanitary landfills, the majority are poorly operated and, in many cases, are simple, open dumps. Common constraints of landfills in China include inadequate equipment and technology, minimal or no landfill lining and chemical treatment, insufficient compaction and waste covering, little gas collection, and poor management. Since the introduction of incineration technology in the late 1980s, the number of incinerators is increasing, mostly in big cities, and the government has introduced policies to encourage investment in them. However, there is a lack of advanced technologies and integrated waste treatment systems, although several new treatment facilities such the Beishenshu landfill and Asuwei power plant offer integrated methods.

The composition of solid waste from Chinese households is dominated by kitchen waste because Chinese food is rich in fresh fruit and vegetables. Food sold in markets is generally unprocessed and unpackaged. However, the proportion of waste glass, paper, plastics, and other recyclables is rising. Coal ash is another major component in household waste because many homes use coal for cooking and heating, although coal is increasingly being replaced by natural gas. The waste stream is inhomogeneous because only a small proportion is separated and, during waste collection, domestic and industrial waste are often mixed.

Recycling is less prevalent in China than in the West. The recycling industry as a whole is under-

developed, as there are few recycling companies, laws, policies, and regulations. Public recycling facilities are limited, although some cities such as Beijing are improving their recycling infrastructure. However, in China—where poverty is rife and waste is valuable—recycling is done by scavengers who sort through rubbish in streets, households, and even landfill sites to collect and sell recyclable products. The waste collectors are usually poor migrants from rural areas, and their work conditions are sometimes hazardous.

Every year, Western countries export millions of tons of waste to China, particularly plastics and paper, for treatment and recycling. It is transported by freight in empty shipping containers used for exporting Chinese goods. As disposal and landfill prices are high in the West, sending waste overseas, such as to China, is a cheaper option; another reason is to overcome stringent environmental and waste regulations. In some cases, Chinese companies set up offices overseas to buy waste, and they have been able to offer higher prices and accept higher quantities of waste than their counterparts in the origin country. However, the global recycling trade is not without criticism. Complaints include the environmental and social costs of shipping waste, no guarantee over environmental and other standards in China, reduced business and materials for recyclers in the country of origin, and claims that the West is dumping its rubbish on China. It also highlights failures in the recycling market in the West. Recently, China's recycling industry was adversely affected by the global economic crisis, as reduced consumer demand for products led to lower prices of recyclables; consequently, many Chinese recycling units closed.

Electronic waste (e-waste) consists of discarded electronic appliances such as computers, digital cameras, mobile phones, printers, refrigerators, televisions, washing machines, batteries, circuit boards, and electrical wiring. Most e-waste in China is from overseas, especially the United States, which exports more than 70 percent of its e-waste to China for recycling. The recycling of e-waste involves dismantling electrical appliances to extract valuable materials such as copper and gold. It is profitable, generating income for many urban and rural workers, and it dominates the economy and livelihood of entire villages and towns, such as Guiyu in south China, where 80 percent of families (more than 30,000 people) are involved. However, the processing of e-waste poses serious threats to public health and the environment. Pollutants and hazardous materials such as cadmium, lead, and mercury are discharged into the environment, and employees in China often work without any health and safety measures.

Society and Environment

China's consumer revolution is part of a broader social revolution that has transformed people's everyday lives. Since the 1980s, living standards and quality of life have improved substantially, and millions of people now have greatly improved lifestyles. However, China's development is not without drawbacks. Promoting economic growth, making money, and becoming rich have been the catchphrases in reform-era China—a mindset that has justified a host of unethical behaviors. Social development lags behind economic development, and there are widening disparities between different regions. A myriad of social ills hide behind the bright facade of data often used to glamorize the country's consumption and economic success. Social problems include corruption, crime, drugs, and prostitution. China's relentless pursuit of economic development has held greater precedence over other issues.

Consumer complaints are common and include fake products, poor services, product safety, and substandard goods. For example, in 2007, there was a series of scandals involving tainted food and products that led to recalls of Chinese exports. Well-publicized cases included tainted pet food imported by the United States and children's toys containing excessive lead levels. In 2008, there was a nationwide milk scandal in China involving milk and infant formula that had been adulterated with melamine.

Intellectual property piracy and counterfeiting is another major problem. The most common counterfeit and pirated goods are CDs, DVDs, cigarettes, and clothing; but counterfeiting is a problem in many industries, even the automotive and pharmaceutical industries. Counterfeit goods are appearing more and more in overseas markets. Counterfeit

products tend to have substandard quality, damage the reputation of legitimate brands, and pose risks to public health and safety. There are also connections between counterfeiters and organized crime rings. Counterfeiting does, however, provide jobs to millions of people in China and, in some towns, sustains local economies.

China's consumption and development have placed a heavy burden on the environment. Air and water pollution are serious problems. China is a major emitter of carbon dioxide, sulfur dioxide, and greenhouse gases. Large amounts of household and industrial waste are untreated, causing pollution and threatening groundwater quality. Other environmental problems include desertification, drought, floods, soil erosion, and a declining water table. These problems extend to other countries, as China's huge consumption has led to imports of natural materials from elsewhere. For example, imports of timber from Indonesia have contributed to serious deforestation. Various measures have been taken to tackle environmental issues, including energy-saving practices, such as controlling waste discharge, financing research and development programs, and increased spending in environmental conservation and protection. Relevant laws and regulations have been enacted. Public awareness of environmental stewardship has been rising, and public surveys have reported widespread concern for environmental issues and sustainable development across a broad spectrum of issues. Further, the Chinese public has responded disapprovingly and emotionally to high-profile cases of environmental damage publicized in the media. The increasing popularity of vegetarianism and organic food—though still small in absolute numbers—can be explained to some extent by concern for the environment. In 2008, the government prohibited all supermarkets, department stores, and shops across China from giving out free plastic bags in response to concern for the environment.

Although environmental protection is receiving more attention, the development-first orientation dominates. The large-scale destruction of nature poses a real threat to sustainable development in the country and the world. China's increasing consumption of everything—from new construction, energy demand, and more cars on the roads—raises concerns about its impact on the world's resources and whether China's goal of achieving Western consumption levels for its entire people is achievable and sustainable.

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See Also: Beijing, China; Consumerism; Developing Countries; Population Growth; Shanghai, China; Tianjin, China.

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Clean Air Act

The Clean Air Act (CAA) is a series of legislations passed between 1955 and 1990 for managing air quality by minimizing the air pollutants released from industries and motor vehicles so as to protect human health and the environment. The CAA is incorporated into the United States Code (USC) of Law as Title 42 (Public Health and Welfare), Chapter 85 (Air Pollution Prevention and Control). The CAA contains six separate titles (subchapters) for Air Pollution Prevention and Control, Emission Standards for Moving Sources, General Provisions, Acid Deposition Control, Permits, and Stratospheric Ozone Protection.

History of Air Pollution

Air pollution has been a concern in large cities for many years. As early as 900 B.C.E., air pollution was noted in Babylon in an asphalt mine as a "strange

smell in the air." Air polluted with dark smoke, fog, stench, and soot was described as unbearable in Rome, Egypt, and, later, in England over the following centuries. Various rules and regulations were imposed to control air pollution. For example, in the beginning of the 14th century, the king of England banned the use of sea coal to reduce smoke in London.

The Industrial Revolution in the 18th century caused fast population growth and economic development in the Western world. A high level of coal combustion during this period led to the rise of pollutants in the air, which became hazardous to human health, especially in large cities. Chicago and Cincinnati were the first U.S. cities to attempt to reduce air pollution by means of legislation in 1881. Over the next half-century, other cities introduced their own regulations to control smoke emission.

Finally, because of public outcry and the continuous deterioration of living conditions in cities, the federal government decided to intervene and introduced the Air Pollution Control Act of 1955 under President Dwight D. Eisenhower. This act provided federal funding for the scientific research of air pollution. The Clean Air Act of 1963 was the first federal legislation to control air pollution. In 1967, the Air Quality Act was expanded to monitor and control interstate transport of air pollution. The Clean Air Act continued to be revised and amended, resulting in major amendments in 1970, 1977, and 1990.

Joint Effort

The CAA is the result of a continuous and joint venture in managing air quality, involving many parties in the United States. Three executive agencies—the Environmental Protection Agency (EPA), the Council on Environment Quality (CEQ), and the Office of Management and Budget (OMB)—worked on the legislation with other federal, state, and local government agencies, such as Congress, state governors, county officials, mayors, city council members, state legislators, state and local air agencies, the courts, and other federal agencies. Major industry and trade organizations, small businesses, farms, scientists, engineers, academia, research organizations, the Clean Air Scientific Advisory Committee (CASAC), environmental and public health groups, and the people of the United States contributed to the legislation and implementation of CAA and its amendments.

Standards

In a major amendment in 1990, the EPA established the goals for National Ambient Air Quality Standards (NAAQS). The acceptable limits of the six principal pollutants (carbon monoxide, lead, nitrogen oxides, sulfer dioxide, particulate matter, and ozone), measured in parts per million (ppm) or by volume, (mg/m3) of air, for primary and secondary standards are defined by the CAA. The Primary standards, are set to limit air pollutants to protect public health, including "sensitive" populations, such as asthmatics, children, and the elderly.

The secondary standards set limitations to air pollutants for protecting public welfare, including protection against decreased visibility as well as damage to animals, crops, vegetation, or buildings. Every state creates its own EPA-approved State Implementation Plan (SIP) to attain and maintain the NAAQS standards. The areas that are unable to meet the NAAQS standards are classified as Non-attainment Areas and are required to follow strict guidelines to achieve the design limits of the air pollutants by the deadline set up by the EPA. The worse the pollution problem, the more stringent the control requirements imposed by the EPA.

Effects

A committee on air quality management in the United States concluded that the implementation of CAA-specified regulations substantially reduced the emissions of several pollutants from both moving and stationary sources. However, emission control of many older and higher-emitting facilities was yet to be achieved as of 2010. The "cap and trade" policy has also helped to reduce pollution from major industries. Air quality monitoring networks have confirmed a decrease in air pollution, especially in urban areas. The direct cost of implementing air pollution control regulations has been more than $20–$30 billion per year. However, the economic value of the benefits to public health and welfare far exceeds the cost of implementation.

Future population and economic expansion will impose a challenge to the progress that has been made in improving ambient air quality. However, the CAA will continue to require strict vigil in improving and maintaining air quality with the help of new and innovative technologies, including production and implementation of alternative energy and zero waste technology.

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See Also: Acid Rain; Carbon Dioxide; Coal Ash; Emissions; Environmental Protection Agency (EPA); Pollution, Air.

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Clean Water Act

The Clean Water Act (CWA) is the basic structure that regulates the quality of groundwater in the United States. In particular, this act regulates the discharge of pollutants into water. This important piece of legislation has had a long history of political and public controversy, and CWA legislation has proven particularly difficult to enforce.

History

From the late 19th century, the U.S. federal government recognized the necessity of regulating national waterways, but it was not until the mid-20th century that the U.S. government really faced the threat that polluted water posed to public health. The pollution of U.S. waterways steadily increased because of the growth of cities and the expansion of heavy industries. In 1948, the first major U.S. law that addressed issues of water pollution was drafted by Congress. The Federal Water Pollution Control Act of 1948 (FWPCA) set out the legal authority of the federal government to regulate water quality. Under the FWPCA, the Office of the Surgeon General as well as other federal, state, and local entities were authorized to create programs to eliminate and reduce the pollution of interstate waters. The FWPCA provided funding to state and local programs limited to interstate waters. In 1956, the FWPCA underwent amendments that increased the power of the federal government to intervene when public safety was in question. In 1965, President Lyndon B. Johnson pledged that the nation's dirtiest rivers would be cleaned up by 1975. These powers were expanded further with the introduction of the Water Quality Act of 1965.

The main issue was that because of a lack of technology to monitor water quality, it was difficult for authorities to prove that a violator had caused a specific violation. The Federal Water Pollution Control Act and its many amendments were not effective enough in stopping water pollution; it was necessary to overhaul this hodgepodge of laws and create a unified program of regulations and fines that would cut water pollution off at the source. The fight against water pollution lagged behind the war on air pollution—the Clean Air Act was passed in 1970.

By the 1970s water pollution had reached a crisis level in the United States. On June 22, 1969, the Cuyahoga River in Cleveland, Ohio, burst into flames; oil and fuel from industrial waste that had been dumped into the waters was the cause.

This was not the first time—that particular body of water had suffered fire over the previous three decades—but it was the first time such a fire generated national outrage. What had changed by 1969 was the nation's diminished tolerance for environmental pollution, not only because of concerns raised by Rachel Carson in her 1962 book *Silent Spring,* but also because of a growing environmental movement in middle-class communities across the United States.

President Richard Nixon stated that the 1970s would have to be the era in which Americans would pay for their past debts by reclaiming the purity of air, water, and environment. Nixon's pledge gave Americans great hope that the federal government would take environmental issues more seriously. Nixon ended up vetoing the proposed Clean Water Act on economic grounds, but Congress was quick to overturn the veto. This political exchange between Congress and President Nixon begged the question of who was going to pay the hefty short-term price for the long-term improvement of America's waters?

Goals and Implementation

In 1972, the Clean Water Act (CWA) was introduced. The CWA differed in scope from previous legislation; it aimed not only to end the violations that had caused these extreme levels of pollution, but it also aimed to restore the quality of waters in the United States. The goals of the CWA were to have zero discharge of pollutants into navigable waters, have water quality that can sustain aquatic life and in which people can swim, and prohibit the discharge of toxic amounts of toxins. This law states that the nation's waterways are not to be used as dumping grounds.

The CWA proposed a permit system for regulating pollution at the source. These "point sources" included industrial facilities (such as manufacturing, mining, and oil and gas extraction, as well as service industries), municipal governments (including military bases), and agricultural facilities. These point sources needed to obtain a permit from the National Pollutant Discharge Elimination System (NPDES) managed by the Environmental Protection Agency (EPA) in conjunction with state agencies.

In 1977, Congress expanded the reach of the EPA, which was now asked to control the release of toxins into sewers and surface water. Frustrated by the slow progress in cleaning up U.S. waters, Congress made further changes to the Clean Water Act in 1987. This included programs to clean up site-specific areas, such as the Great Lakes via the Great Lakes Critical Programs Acts of 1990. In addition, nonpoint source pollution regulation programs were added, specifically addressing the pollution caused by stormwater runoff from industry and farms.

Overdue Revision

As of 2010, the Clean Water Act has not been revised since 1987, and many Americans feel that a large-scale reassessment is long overdue. The U.S. Supreme Court's uncertain definitions of which waterways are protected by the Clean Water Act have continuously undermined the EPA's attempts to impose penalties and fines. Many businesses have declared that CWA laws no longer apply to them, and pollution rates have actually risen. The Clean Water Act has largely failed to fulfill its mandate of ending pollution and protecting the nation's waterways. Regulators do not have the jurisdiction to prosecute some of the nation's biggest polluters, and it is estimated that more than half of major pollution cases in the 21st century have been shelved or discontinued.

The 2010 Gulf of Mexico oil spill brought the Clean Water Act to the public forefront once more as investigations were being opened against British Petroleum and their violations of the CWA, which carry criminal and civil penalties and fines. Many critics have claimed that the interests of big business and bipartisan politics have undermined a real overhaul of the CWA and any attempts to create strong federal policy that could effectively stem the pollution of national waterways and protect the nation's water supply.

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See Also: Clean Air Act; Industrial Waste; Pollution, Water; Public Water Systems; Safe Drinking Water Act; Sewage Collection System; Sewage Treatment; Toxic

Substances Control Act; Waste Treatment Plants; Water Consumption; Water Treatment.

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Cleaning Products

There are cleaning products explicitly designed for toilet bowls, drains, showers, carpets, glass, tables, computers, toys, hard/soft surface floors, and appliances, just to mention a few. The range of uses for cleaning products is wide and their specificity is remarkable. They come in virtually any size and presentation as wipes, liquids, polishes, aerosols, and foams, and with or without disinfectant. Products meant to ease the daily duties of keeping households tidy are ubiquitous.

Most cleaning products are available for sale to the general public without any restrictions. As asserted by researcher Janice Hughes, detergents, degreasers, stain removers, and pesticides have made homes miniature chemical factories, since chemical levels can be up to 70 times higher inside the home than out. In fact, women who work only in the home have a 55 percent higher risk of getting cancer than do women working outside the home. Information regarding actual or potential risks to health or the environment is not necessarily on the label. Some manufacturers avoid publishing the risks by arguing that they have the right to keep their formulas a competitive secret. This commercial practice of not revealing some ingredients entails the possibility of concealing potential dangers to individual health and the environment. Concerned users can ask the manufacturers for Material Safety Data Sheets (MSDS) that contain detailed information about the ingredients used.

There are a number of polluting substances involved in the production, use, and disposal of cleaning products that imply some sort of environmental or health risk. For example, a recent study reported that about 200 xenobiotic organic compounds (chemicals not produced naturally by organisms) were found in grey wastewater from bathrooms. Those chemicals included fragrances, preservatives, phthalates, pharmaceuticals, and flame retardants. Several of those compounds could be associated with cleaning products consumed in the households.

Risks

Risks associated with substances included as ingredients of cleaning products are diverse. Some of the substances present in cleaning products that pose risks for users are not even active ingredients. For example, phthalates, which are suspected to have adverse hormonal effects, help to make dyes and fragrances more fluid. Other chemicals simply keep a product stable on the shelf, and others, such as glycols, act like antifreeze agents.

For most users, the risk of cancer or the ability of certain compounds to disturb the growth and development of an embryo or fetus (teratogenicity) are the biggest concerns, but some products are potentially harmful in different ways. Denatured alcohol is commonly used as a degreasing agent as an alternative to soap, detergent, or other degreasers. Denatured alcohol is also a popular disinfectant not listed as carcinogenic by regulatory bodies like the Occupational Safety and Health Administration (OSHA), the National Toxicology Program (NTP), or the International Agency for Research on Cancer (IARC). Nonetheless, it poses a fire hazard, particularly if poured onto electrical appliances. There is also a risk of toxicity if denatured alcohol is used in closed environments.

The range of uses for cleaning products is wide and their specificity is remarkable. They come in virtually any size and presentation as wipes, liquids, polishes, aerosols, and foams, and with or without disinfectant. However, this variety comes with risks. For example, phthalates, which are used to make dyes and fragrances more fluid, may have adverse hormonal effects. Many other household cleaning products contain harsh solvents and chemicals that destroy the natural processes involved in wastewater treatment.

Environmental and health risks for households necessarily include their associated goods like the family car, where members spend a substantial part of their lives. Cleaning products for cars are big sellers, but many of them involve well-known risks. Aliphatic hydrocarbons, naphthas, and petroleum distillates in general are used in some car waxes, furniture polishes, and general car cleaning products. These have been associated with neurotoxic reactions. Some of them may cause irritation to the skin, digestive system, throat, and lungs when inhaled. A common product used in car cleaning products (particularly in cleaners and waxes) is formaldehyde. This product is carcinogenic, neurotoxic, and poisonous.

Pet Care Products

Products for the care of pets are not exempt from risks. Allethrin, a synthetic pyrethroid (a form of a chemical found naturally in the chrysanthemum flower), is used in some pet flea-control products. It can cause damage to the immune system, with hay fever–like symptoms and also sudden swelling of the face, eyelids, lips, mouth, and throat tissues. Pyrethroids like Allethrin are generally harmless to human beings in low doses but they can be dangerous to sensitive individuals, fish, and other aquatic organisms. Studies show that in very small amounts (as low as two parts per trillion), pyrethroids are lethal to most beneficial insects such as bees and dragonflies. They are also toxic to invertebrates that constitute the base of many aquatic and terrestrial food webs. A particular matter of concern is that pyrethroids can pass through secondary treatment systems at municipal wastewater treatment facilities. Another product used in pet flea control is D-limonene, a known neurotoxin, which is also an eye and skin irritant. Studies have suggested that this substance is associated with cancer and is also teratogenic.

Flea collars are not necessarily safer. Diazinon, a common compound used in many of these devices, has been attributed with allergenic and neurotoxic characteristics. It has been found that diazinon is toxic to the human fetus and to birds.

Bathroom Cleaners

Products for bathroom and toilet cleaning are particularly dangerous to individual and environmental health. For example, bathroom cleaners often contain sodium hypochlorite, a corrosive that irritates or burns skin and eyes, and causes fluid in the lungs, which can lead to coma or death. Acid blue 9, also known as brilliant blue FCF or disodium salt, is used in some toilet bowl cleaners and deodorizers. It has been associated with cancer. Sodium bisulfate, a very common ingredient of toilet bowl cleaners and deodorizers, can cause asthma attacks, particularly in children. Some drain openers use aluminum, which has been reported as a cause of lung disease if inhaled and has also been related to Alzheimer's disease. Dichlorodifluoromethane, a neurotoxic and eye irritant substance, can also be found in the ingredients of some drain openers.

Some brands of the apparently innocuous toilet deodorizers contain paradichlorobenzene, a well-known carcinogen that causes liver and kidney damage. Ammonia and derived compounds like ammonium chloride or ammonium hydroxide are used in toilet bowl cleaners, deodorizers, and some air fresheners. They are generally safe when highly diluted but otherwise can cause eye irritation, cataracts, and corneal damage.

Combining Substances

One point of interest for researchers is the combined effect of toxic substances and in combination with substances already present in the environment. For example, diethanolamine, a mild skin and eye irritant used in a wide range of household products, reacts with nitrites (added as preservatives to some products or present in the environment as contaminants) to form highly carcinogenic nitrosamines. Air pollution resulting from the use of cleaning products is a matter of concern for researchers and policy makers. Research shows that several cleaning products and air fresheners contain substances that can react with other air contaminants to yield potentially harmful secondary products. For example, certain resins can react rapidly with ozone in indoor air, generating pollutants such as formaldehyde.

A good source for online information on potentially harmful products is the Household Products Database. It is administered by the National Library of Medicine and offers compiled data from the MSDS, product labels, and manufacturer Web sites for more than 4,000 products. A useful component of this database is its reference to HMIS® coding, the Hazardous Materials Identification System, a registered mark of the National Paint and Coatings Association (NPCA) but used by all manufacturers to comply with the requirements of OSHA's Hazard Communication Standard. The HMIS coding guide of colored bars, numbers, and symbols to convey the severity of hazards of chemicals is portrayed in every record of the Household Products Database. Ratings assigned to a product do not necessarily represent the outcome of an objective, third-party evaluation. Those ratings were determined for each brand by its manufacturer and documented in the Material Safety Data Sheet (MSDS) published by the manufacturer. Most of the ratings for health, fire, or reactivity dangers are based on short-term, acute reactions to the materials and not on long-term effects.

Alternatives to commonly used cleaning products are green products. Most manufacturers of traditional cleaning products now offer their own "green" brands. As a general practice, green cleaning products avoid the use of chlorine and phosphates. The latter are strongly associated with ocean pollution. Green products captivated a substantial part of the market in the first decade of this century. However, the market for most natural cleaning products has experienced a reduction as recession took hold, particularly in the United States. This means that, in terms of cleaning products, consumers are concerned about their own health and the environment only if they can buy products at the same price (or even less) than those that are harmful. Unless green products are guaranteed some sort of subsidy, it is going to be difficult to change traditional practices on the consumers' side.

In summary, small amounts of cleaning products seem to be harmless for both users and the environment. But real life behavior seems to favor large doses of several different products in a household, creating a harmful environment with unknown consequences for society and the environment as a whole.

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See Also: Aerosol Spray; Household Hazardous Waste; Pesticides; Pets; Toxic Wastes.

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Cloaca Maxima

The Cloaca Maxima, literally meaning "greatest sewer," was the largest sewer system in the ancient world. According to the Roman historian Pliny, this wonder of the ancient world was constructed in the 6th century B.C.E. by the two Tarquin kings and was a permanent reminder to the Romans of their ancient history. Pliny emphasized the Cloaca's durability as well as its savage discipline of construction; sewer workers—mainly forced labor drawn from Rome's poorer residents—who committed suicide were said to have had their bodies crucified as an example to others.

It is probable that the Cloaca was originally an open drain, formed from streams from three of Rome's hills, which were channeled through the main Forum and then on to the river Tiber. This open drain would then have been gradually built over, as space within the city became more constricted. The sewer was originally meant to drain land only, with the city's other waste matter being flushed into the Tiber. However, as Rome's population grew, the sewer increasingly became a dumping ground for unwanted wastes and became choked with filth. In 33 B.C.E., the emperor Agrippa demonstrated how he had unblocked the Cloaca Maxima by riding through it on a boat. In the 21st century, this foundation layer of Rome's history remains open to curious tourists, and the original outfall of the sewer into the Tiber is still preserved.

Although widely documented in ancient writings, the Cloaca Maxima was only "discovered" more widely in the 18th century when Rome was undergoing renewed archaeological investigations. From 1748 to 1774, the artist Giovanni Battista Piranesi (1720–78) published an extensive series of views of Rome focusing on its ancient archaeological remains that included the Cloaca Maxima. Piranesi's son Francesco collected and preserved the views and published them in 29 volumes from 1835 to 1837. Thereafter, the Cloaca Maxima became widely known in Europe and was to attain enormous importance as a prototype for the new drainage systems being planned in major European cities, particularly London and Paris, both of which vied to become the "new Rome" in the 19th century.

Applications

In the 1860s, London's sewer system was being transformed by the engineer Joseph Bazalgette (1819–91), with new intercepting sewers constructed to prevent waste matter from polluting the river Thames. During its construction, comparisons to ancient Rome and its sewer were consistently evoked. The journalist Henry Mayhew (1812–87) described London's sewers as second only to the "giant works of sewerage in the eternal city," while Bazalgette used the Cloaca Maxima as a prototype for London's sewers in his lectures on his new drainage system.

When London's new sewers were completed, the press were almost ecstatic in their praise. In a ceremony held in 1865 to mark its formal opening, some newspapers compared the new sewers with the wonders of the ancient world. According to the *Daily Telegraph*, the main drainage system was a project alongside which even the pyramids of Egypt and the sewers of Rome "paled into comparison." The *Marylebone Mercury* made similar comparisons: the main drainage system was described as the "representation of a mighty civilisation," a civilization nobler than ancient Rome because it lacked its "despotic power." Underlying these comparisons was the view that London's new sewers were a permanent monument to the future when the city—especially compared with its main rival, Paris—would become the cleanest and most magnificent city the world had ever seen. If the content of London's new sewers was "not a bit better" than that in the sewers of Paris, their technological and

political basis most certainly was. Under Napoleon III and Baron Haussmann in the 1860s, Paris was undergoing a more radical transformation than London. New boulevards were driven through the medieval city, and new sewers were constructed beneath them. While some criticized London's government for not "Haussmanizing" London enough, most celebrated the city's new sewers as making the city above comparison with any other European capital. If Bazalgette had done "what Tarquin did for Rome," he did it without the "despotic power" of the latter. The fact that Napoleon III was also self-consciously modeling his new Paris sewers on this Roman precedent also points to an implicit criticism of his despotic methods.

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See Also: History of Consumption and Waste, Ancient World; Pollution, Water; Sewage; Sewers.

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Coal Ash

Coal ash is the noncombustible waste product left over from the burning of coal. It consists of airborne particles called "fly ash" as well as heavier particles called "bottom ash" that settle on the floors of coal-fired furnaces. Fly ash, which was once released into the atmosphere by coal-burning electric utilities, is now typically "scrubbed" from exhaust gases through a variety of mechanisms (such as bag filters, cyclone separators, or electrostatic precipitators) installed within smokestacks. Once the dry ash has been recovered, water is typically added to form a slurry, allowing for pipeline transport and reducing the potential for the finely grained ash to become airborne after capture. The coal ash or slurry can then be disposed of in a landfill; however, since such a solution entails not only transport costs but also the additional expense of paying the municipality in charge of the landfill, it is more frequently pumped into nearby impoundment ponds already owned by the utility. The coal-burning industries of the United States produced an estimated 131 million tons of coal ash annually as of 2010. Since the total weight of ash produced increases with each passing year—a phenomenon attributable to new coal-fired plants being brought into operation to meet increasing electricity demand as well as to improvements in scrubbing technology—the disposal of this waste material presents a serious and growing matter of ecological concern.

Composition

While precise percentages tend to vary depending on the composition of the coal that is fed into the boiler, coal ash consists primarily of silicon dioxide (SiO_2) and smaller portions of aluminum oxide (Al_2O_3) and iron oxide (Fe_2O_3). Although coal ash's principal compounds are largely benign, it also contains trace amounts of heavy metals and hazardous compounds such as arsenic, cobalt, lead, mercury, uranium, dioxins, and polycyclic aromatic hydrocarbon (PAH) compounds.

The disposal strategies for this waste, which include not only impoundment but also reuse in both industrial and commercial products, makes the risks posed by these trace elements a source of public controversy. Though the coal industry insists that the coal ash is perfectly safe and that traces of these hazardous elements exist in practically everything, environmental advocates are far less sanguine, pointing out that these naturally occurring toxic elements become concentrated in unregulated, unlined holding ponds, allowing hazardous pollutants to leach into public water supplies.

Health and Safety

Considering the incredible amount of coal that electric companies consume—estimates suggest that the average American's individual consumption of electricity requires the burning of a little more than 20 pounds of coal per day—the sheer volume of coal ash produced, apart from its potential toxicity, has become an equally pressing public safety concern. Potential problems with impound ponds were publicized in the wake of a massive coal ash spill in December 2008 at the Tennessee Valley Authority's Kingston Fossil Plant. A breach in the retaining wall of the pond ended up releasing over one billion gallons of coal ash slurry into a nearby river, killing fish and wildlife and damaging homes in the vicinity. Cleanup efforts are expected to cost more than $1 billion, making it one of the largest and most costly industrial accidents in U.S. history. The disaster has galvanized calls for the Environmental Protection Agency (EPA) to classify coal ash as a hazardous waste and subject its disposal to stringent federal control. Industry stakeholders, however, continue to emphasize the unnecessary economic consequences of such legislative action. The EPA has since responded with a "co-proposal" laying out a highly contingent and convoluted set of federal regulations that effectively hedges on the issue of coal ash's legal status.

Recycling

Also invested in this debate are industries that attempt to recycle coal ash into salable material. Ever since the 1930s, when coal ash began to be recovered in significant amounts, scientists and technicians have investigated ways to salvage the by-products of coal-fired electricity production for profitable use. Coal ash has been tried and rejected as a suitable substitute for a wide and incongruous variety of products, including pesticides and toothpaste. Similar in chemical structure to clay, it has been used with slightly better results as a filler material for rubber, paint, putty, roofing material, roads, and ceramics. Its greatest commercial success as of 2010 is as an ingredient in Portland cement. Coal ash, a variety of pozzolan, has been touted by industrial interest groups as an environmentally friendly substitute for cement in that the carbon footprint from producing new cement can be diminished substantially by mixing in portions of coal ash, which exists already in abundance. Nevertheless, coal ash's origin as the by-product of a carbon-intensive process of energy generation complicates claims about the carbon neutrality of industrial products that use coal ash as a filler material.

Other Criticisms

Concerns about the toxicity of materials made with coal ash also complicate its alleged environmental virtues. Opponents claim that products made from refashioned coal ash will follow the same cultural trajectory as asbestos—a product that has been vilified for its carcinogenic properties after being celebrated for so long as a miracle product. In spite of these critics, coal ash is becoming a more popular ingredient in civil and commercial construction efforts around the globe with concrete made from this coal ash mixture being used in high-profile construction ventures such as the Burj Khalifa in Dubai, the world's tallest building in 2010.

Coal ash thus remains, in both its material and legal aspects, a highly ambivalent substance. Environmentalists see its abundance and potential toxicity as further evidence for the ecological malfeasance of the energy industry, while industry stakeholders maintain that the benefits of reliable, affordable energy inevitably must outweigh public anxieties concerning what is arguably a relatively harmless and potentially useful by-product of modern existence. With the federal government reluctant to arbitrate this stalemate, coal ash promises to remain one of the more prominent and enduring waste concerns in the 21st century.

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See Also: Clean Air Act; Environmental Protection Agency (EPA); Power Plants; Scrubbers.

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Colorado

Named by the Spanish for its red-colored earth, Colorado is a state of diverse geography and complex climate, consisting of mountains, foothills, high plains, and desert. Originally a mining economy in the mid-19th century, the development of irrigation brought agriculture to the fore. The federal government is a major part of the state's economy, with the North American Aerospace Defense Command (NORAD) and the United States Air Force (USAF) being just two of the federal agencies based in Colorado. This is partly due to the capital city, Denver, being equidistant both between Los Angeles and Chicago and between Seattle and New Orleans. As of 2009, 61.9 percent of the population live in the Denver-Aurora-Boulder Combined Statistical Area.

The 16th Nationwide Survey of MSW Management in the United States found that in 2006, Colorado had an estimated 8,690,005 tons of municipal solid waste (MSW) generation, placing it 16th in a survey of the 50 states and the capital district. Based on the 2006 population of 4,766,248, an estimated 1.82 tons of MSW were generated per person per year (ranking fifth) and 8,208,407 tons were landfilled (ranking 10th). Colorado did not report its number of waste-to-energy (WTE) facilities (presumably none) or any data regarding landfills. Colorado recycled 481,958 tons of MSW, placing the state 32nd in the ranking of recycled MSW tonnage.

In the early 21st century, Colorado faces several challenges relating to consumption and waste. Air pollution has been an issue in industrial Pueblo since the advent of the steel industry there in the 1880s. Air quality in the Denver metropolitan area is threatened by suburban sprawl, the high altitude, and the region's dependence upon automobile transportation. Water consumption in the state is divided between residential and agricultural uses; much state politics revolves around water rights. The city of Boulder, northwest of Denver, has adopted a policy of controlled growth expansion as well as initiatives to manage urban wildlife. Despite these efforts, sprawl in the region has been substantial since the 1980s, as communities such as Broomfield and Lafayette have become homes to commuters to Denver.

Cowboy Wash

One of the most controversial refuse finds ever found, and certainly the most notorious human coprolite, is the Cowboy Wash cannibal coprolite. The cannibalism argument is one of the most heated debates in southwest American archaeology. At a number of Anasazi sites in the Four Corners region, there are nonburial sites where human remains were excarnated, butchered, and burned between 1125 and 1175 C.E., including Aztec Wash, the Grinnel Site, and Hanson Pueblo. Cannibalism and extreme violence are interpreted at around 100 sites in the southwest since the discoveries at Cave 7, Utah, and Mesa Verde, Colorado, in the 19th century. While osteological studies show the bones from these sites were processed in a way consistent with food preparation, opponents of the cannibal theory have forwarded such interpretations as secondary interment, necrosadism, and the ritualized execution of witches. Processed and randomly discarded human remains pointed to cannibalism but there was no archaeological proof that it had actually taken place.

Cowboy Wash was excavated in 1996 by a mixed team of Anglo-American and Native American archaeologists. The excavation was part of a study of 17 Anasazi sites on the southern footslopes of Sleeping Ute Mountain, during which 105 structures, including 36 pithouses were excavated, dating from 450 to 1280 C.E. The site (5MT10010) at the southern base of Sleeping Ute Mountain consists of three pithouses (features 3, 5, and 15) and several other structures believed to be the settlement of an extended family of 15–20. The site was abandoned suddenly around 1150 C.E., with personal belongings left behind; the site was never reused, which is very unusual in an area where even building material is salvaged and reused. Valuable tools, pottery, and ornaments were found in direct association with bench and floor surfaces with no sediment between, indicating they were undisturbed.

Microstratigraphic evidence showed the roofs had decayed in place rather than being salvaged or burned as is the custom at almost all other sites in the area.

Bones and bone fragments were discovered scattered around floors and stacked on surfaces in two pithouses (features 3 and 13). Over 1,000 bone finds were recovered, representing a minimum number of individuals (MNI) of four adults, one adolescent, and two children. Almost all the bones were disarticulated, many bones were missing, including vertebrae, and all head, face, and long bones were broken. The bones had butchery marks where muscles had been cut, skulls and other bones were burned, and long bones were broken down to "cooking size." Some of the bones display "pot polish" on the ends where they have been rubbed smooth by friction, possibly with the inside of a cooking pot. Stone tools of types used in butchery were found around the hearth in feature 13, and in feature 15 there were fragments of cooking pots.

All of the evidence pointed to cannibalism but there was no actual evidence of the stage where the human remains were consumed. Human tissue can be butchered and cooked but proof of consumption, the final stage in an act of cannibalism, is the only way that cannibalism can be physically proven to have taken place and is irrefutable evidence of cannibalism.

Further Analysis

Three classes of find were tested using biomolecular techniques, cooking vessel fragments associated with the burned bones, stone tools from the apparent butchering area, and, crucially, a human coprolite. Seemingly contemptuously deposited in the remains of the hearth of feature 15, this is the only known coprolite from a structure hearth in the southwest. Protein residue analysis was used on the stone tools and the cooking-vessel shards; this technique examines residual blood and tissue adhering to pots and tools used to process animal remains. Two stone tools tested positive for human blood residue, and the cooking pot shards tested positive for human myoglobin. The last step of the cannibalism process was proven when the coprolite was analyzed and indicated that human remains had been eaten and excreted.

The coprolite that had been deposited into the cold ash of the hearth was of a size and shape consistent with human origin, and had a dry weight of 30g. Macroscopic analysis showed no apparent plant remains, very unusual for a human Anasazi coprolite. Microscopic analysis found it consisted entirely of meat, with virtually no starch crystals or plant evidence present except for windborne pollen. The proteins in the coprolite were then examined to find a human protein that was not found in blood and therefore possibly from any internal bleeding, or a protein that had been shed from the intestinal lining. The protein also had to be one that did not come from the human digestive system as this could also have come from the consumer. Myoglobin, a protein found only in skeletal and cardiac muscle, was tested for using immunoelectrophoresis and the enzyme-linked immunosorbent assay (ELISA) test.

Immunoelectrophoresis is a test used to identify proteins by their electrophoretic and immunological properties; it can also be used to extract DNA. Gel electrophoresis, around which the technique revolves, exploits the separation of molecules due to differences in size, charge, or other physical properties. When current is passed through a gel, the immunoglobin molecules move toward the oppositely charged electrode. Because the different molecules have different characteristics, they will migrate through the gel at different rates. Heavier, low-charged molecules will move slower than smaller, highly charged molecules. The migration therefore separates the different molecules. In immunoelectrophoresis, the molecules of individual immunoglobins, now separated, can be identified by immunological methods and their presence and quantity noted. The chemical composition of myoglobin differs between animal taxa, so the ELISA assay test can identify human myoglobin from the myoglobin of other species. The ELISA uses specific antigen-antibody reactions to test for antigens or antibodies by attaching an enzyme that produces a color to the antigen or antibody specific to the target substance. The sample is attached to small wells on an ELISA plate, the antigen or antibody is added, and then the plate is "washed." If the antigen-antibody reaction has occurred, this can now be demonstrated by the enzyme's changing color. In the Cowboy Wash case, an anti-human antibody was used, which reacted with the human tissue in the sample.

The coprolite tested positive for myoglobin, proving that cannibalism had occurred. As the results were so controversial, modern stools, ancient coprolites, blood-positive stool samples, and nonhuman myoglobin samples were tested as controls, and none tested positive for human myoglobin, giving conclusive proof. The interpretation was unpopular with some scholars and Native American groups and it was suggested that the coprolite was actually of coyote origin. However, the coprolite did not contain fur or bone fragments usually found in canine feces, and on rehydration did not have the characteristic lubricating coat that allows canines to safely digest pieces of bone.

The reason for acts of cannibalism at this time remains unknown. The 1125–75 C.E. period was one of change and turmoil in the southwest. One theory is that cannibalism was used as a terror tactic to establish religious or political control over a population. Other hypotheses include starvation brought on by drought and invasion by an outsider group.

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See Also: Archaeological Techniques, Modern Day; Funerals/Corpses; Human Waste.

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Commodification

The term *commodification* is used in different ways in mainstream business theory, Marxist economics, and anthropology. All of the senses of the word are, however, relevant to the subject of consumption and waste. As a historical process, commodification has been associated with the rise of globalized industrial capitalism and consumer culture. In facilitating high levels of mobility and consumption, commodification has contributed to contemporary environmental challenges. It is a pervasive aspect of 21st-century society in which the market is increasingly prevalent in daily life and even waste itself is commodified.

In Business

In the language of business economics, the term *commodification* (or *commoditization*) has been in use since the early 1990s, referring to the standardization of formerly differentiated versions of a product so that consumers no longer perceive any differences in value among them. According to business theory, this transformation is associated with an increasingly competitive market for goods and services and normally leads to decreased prices. The result is a commodity that is relatively fungible in the sense that every unit of the commodity is considered to be equivalent to every other one for the purposes of economic transactions (as, for example, every dollar has the same value and exchangeability as every other dollar). An example from the arena of agriculture is that of corn (or maize). Dozens of cultivars of the *Zea mays* species were developed by indigenous American horticulturalists, suitable for various growing conditions and culinary uses. Seeds were saved from each crop to plant the next generation, and the product was produced, traded, and consumed within face-to-face social networks. The commodified version of corn designed for industrialized agriculture includes a small number of similar cultivars grown from commercially hybridized seeds that do not breed true but instead must be purchased anew each planting season. The product is highly standardized and fungible, forming a great stream of undifferentiated "commodity corn" severed from the identity of individual producers, which is mostly channeled into feedlots for commodified meat production and into the myriad intakes of the processed food industry.

In Marxism

The second meaning of commodification comes from Marxist economics, where the term has been

used since the mid-1970s, referring to the transformation of goods that were not formerly considered in terms of their monetary value into products that are bought and sold on markets as commodities. This process of imbuing goods with exchange value has been associated with the expansion of market trade into areas with previously nonmarket economies and noncommercialized social relationships. For Karl Marx, the prime example was when the labor of an actual worker is abstracted into a manufacturing input that is measurable in hours.

Under conditions of "alienated" (commodified) labor, the worker exchanges for a wage the power to determine what they will produce, how and when they will produce it, as well as ownership and control over the product of their labor. The Industrial Revolution has been associated with commodification, both in terms of alienated labor (as with the transition from artisanal production to work on assembly lines) and in terms of the development of undifferentiated, depersonalized products. Commodification can be thought of as the difference between a landscape artist painting for pleasure and expression and one filling an order on a deadline for two dozen sofa-size pieces with stags, sunsets, and mountain lakes. The more-commodified paintings are designed to suit consumers' tastes and are sold through impersonal transactions to people the artist never meets, their value expressed as a money figure.

Building on the Marxian concept, anthropologists have developed an approach to commodification that emphasizes the ways incorporation into markets changes the meanings as well as the social relations surrounding objects (which may be material goods, services, or abstract items). In concrete human communities, objects are understood ethnographically in terms of the ways they are defined and used within specific social and cultural contexts. It is this context of social relations that structures the access persons and households have to particular items. When objects are commodified, they become detached from this immediate context and lose their original meaning. Traditional forms of access to them are replaced by generalized exchangeability. Disembedded from the local community and its ways of categorizing and evaluating things, the commodity is reconceived in terms of an unlimited sphere of exchange and universal measures of value. It may now be appropriated in other contexts and its meaning redefined for and by consumers.

This process can change both the meaning and the form of the commodified things, as they become products marketed to consumers. An example would be the case of a traditional community festival that becomes a tourist attraction. Marketing this item of living culture transforms it into an object performed for outsiders, frozen into a form attractive to consumers, its timing perhaps altered to coincide with tourism seasons. Cultural critics have identified the accelerating pace and scope of commodification in society (including the growth of markets for human embryos, organs, and other tissues) as a dehumanizing trend. Others have pointed out the positive and liberating results of commodification, as it creates new markets to generate new economic activity and frees individuals to sell their skills wherever they choose.

Marketing and Globalization

Commodification in all of these senses is historically linked both to the rise of modern industrialism and globalized consumer culture and to the resulting dramatic increases in waste of all sorts. In the 21st century, commodities may be mass-produced using nonlocal materials and marketed worldwide so that similar products may be found almost anywhere. Marketing designed to stimulate the desire to consume commodities has accelerated the pace at which populations have embraced the lifestyle of consumption offered by industrial capitalism. In this sense, commodification has been a force for global cultural homogenization. On the other hand, ethnographic studies have underscored the ways people may reformulate the meanings of such products in the process of consuming them, appropriating commodities as resources for constructing identities and recontextualizing them in heterogeneous ways.

Effects on the Environment

The worldwide growth of industrialized commodity consumerism has generated environmental challenges. The expansion of commodification in order to profit from continuously stimulated consumer

Hybridized corn varieties bred for high-production agriculture must be repurchased each planting season. The standardized final product forms a stream of commodified corn that is nearly indistinguishable from producer to producer.

markets has occurred with insufficient regard to the resulting wastes from the extraction of raw resources; the transportation of inputs, products, and shoppers; industrial manufacturing processes; and nonbiodegradable packaging materials and material products themselves that are sometimes designed to be used briefly, then disposed of and replaced. Commodification characterizes the social relations and products at every stage along the way. The lifestyle of commodity consumption is filled with material possessions, most of which end up in landfills and garbage dumps. Even these may be privately owned properties, and the services they provide are also commodified. Waste itself is recommodified when it is sold for manufacture into products made from recycled materials. Such is the pervasive and systemic process of commodification in modern industrial society that even the legal right to pollute is being commodified, as a market develops for buying and selling carbon credits.

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See Also: Capitalism; Consumerism; Post-Consumer Waste; Socialist Societies.

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Composting

Composting in solid waste management systems is the decomposition and stabilization of the organic fraction of municipal solid waste (MSW) carried out by a microbial community under controlled, aerobic conditions. Though composting has been practiced by people since they first settled in agricultural communities, it is now emerging as a centralized waste management method that both reduces the volume of waste that must be disposed and creates useful products. Most biogenic matter can be composted; its degradation occurs in four stages and is carried out by an ecological succession of microbial communities. The resulting product (compost) can be used as a soil conditioner, fertilizer, mulch, or a replacement for peat.

Overall Process

Composting is a naturally occurring biological process undertaken by a succession of microbial communities, and it is used by people to manage the organic fraction of waste. The aerobic degradation process can be written as

$$C_aH_bO_cN_d + 0.25\,(4a+b-2c-3d)\,O_2 \rightarrow a\,CO_2 + 0.5(b-3d)\,H_2O + d\,NH_3.$$

Overall, a consortium of microorganisms breaks down organic matter in the presence of oxygen, reducing the volume and mass of waste by approximately 50 percent (on a dry-weight basis); the other 50 percent of the mass is released as carbon dioxide (CO_2), water (H_2O), and ammonia (NH_3). Composting is an exothermic process; it releases heat and raises the temperature of the substances being degraded. The process is considered complete when only stabilized organic matter—matter that has low biologic activity that can be stored without giving rise to health or nuisance problems—is left over.

Objectives and Uses for Compost

There are four main objectives to composting as a waste management method: to reduce the volume of waste, stabilize waste, sterilize waste, and produce a valuable product from the waste. Composting greatly decreases the mass and volume of waste to be managed, which translates into a reduction of costs for managing that waste. Stabilization of waste allows for safe storage of the waste; if not composted, stored organic waste is likely to emit odors and to contain pathogens. The high temperatures reached in the composting process (upward of 65 degrees Celsius) destroy most pathogens and weed seeds contained in the organic waste. Finally, the main objective of composting is to create a valuable resource. Compost can be used as a soil conditioner, fertilizer, mulch, or a replacement for peat. Though compost's nutrient content is lower than that of commercial fertilizer, its nutrient release is slow and sustained.

Most plant matter, animal tissue, and microbial components can be degraded in an aerobic composting process. Cellulose is the most abundant component of plants and is found in most organic wastes; under aerobic conditions, many fungi and microbes are involved in cellulose degradation. Lignin, a structural component of plants and a major component of wood, is degraded much more slowly. Organic matter such as plastic and leather are difficult to break down, while inorganic substances such as glass or metal are relatively inert.

Biology and Chemistry of Composting

Composting involves an ecological succession of microorganisms with a presence depending on environmental conditions. Bacteria, archaea, fungi, protozoa, and worms are all involved in the aerobic degradation of organic waste. Microorganisms use the carbon in organic waste to produce energy and to synthesize cellular components. In addition to carbon, microorganisms need other macronutrients (N, P, and K) to thrive as well as several other micronutrients (Co, Mn, Mg, Cu, and Ca). A ratio of carbon to nitrogen of 20–25:1 is considered ideal for composting. An effective substrate for composting will balance carbonaceous wastes (such as dry leaves, hay, and paper) with nitrogenous wastes (such as grass, food waste, and sludge). To create an environment in which microorganisms are able to degrade organic waste, the moisture content must be between 12 percent (the minimum required for biological activity) and about 65 percent, the level at which oxygen availability becomes too low. The ideal moisture content for composting is 45–50 percent. The pH levels must hover around neutrality; bacteria prefer 6–7.5, and fungi prefer pH levels between 5.5 and 8. Temperature naturally varies throughout the composting process, but fluctuates between the mesophilic (25–40 degrees Celsius) and thermophilic (45–60 degrees Celsius) ranges. These ranges are shown in Table 1.

Table 1 Key Variables for Composting Material

Substrate Variable	Ideal Range
Moisture Content	45%–50%
C:N	20–25:1
pH	6–7.5

Composting is defined by four main stages, each with distinct microbial populations that carry out the degradation of waste under the reigning conditions of each stage:

1. *Mesophilic stage*. As soon as composting conditions are established, microbes begin to proliferate. Bacteria and fungi break down the easily degradable, energy-rich substances, and their activity causes the temperature to rise. Worms and millipedes may act as catalysts.
2. *Thermophilic stage*. Rising temperatures promote the persistence of organisms adapted to hotter conditions; these thermophilic

organisms continue to consume both the organic substrate and the mesophilic organisms. Most of the remaining biodegradable organic matter is consumed in this stage.

3. *Cooling phase*. When easily decomposed material becomes exhausted, thermophilic organisms begin to decline in number. As their activity slows, the temperature of the compost decreases, and mesophilic organisms recolonize the composting mass. This phase is dominated by the presence of fungi and bacteria that can degrade materials that are more difficult to break down, such as starches and cellulose. The time it takes for a compost pile to progress through the first three phases is a few weeks.
4. *Maturation phase*. All of the easily degradable material has disappeared by this stage. Microbial populations decline, and the compost pile begins to stabilize. The maturation phase can take between several weeks and a year.

In the mesophilic stage, fungi and bacteria aid in breaking down plant materials that are difficult to degrade, such as starches and cellulose. The three other stages are thermophilic, which raises temperature; cooling; and maturation, when the compost stabilizes.

Compost Systems

In practice, compost systems may be either closed or open and may occur on small or large scales. Open composting can take place in windrows (heaps that are turned either manually or mechanically) or can take place in static piles through which air is blown. Closed composting occurs in a vessel, which may take many forms, but must be aerated through tumbling or rotation. Open composting requires a large land area. Small-scale composting can occur at the household-level, and large-scale composting occurs at the municipal or regional scale.

Proliferation of Composting

Composting is growing in importance as an MSW management strategy. In the United States, the number of composting programs has increased from 700 in 1988 to 3,800 in 1998, and more than 20 states have banned the disposal of yard waste in landfills. The European Union's Landfill Directive 1999/31/EC requires member states to reduce the amount of biodegradable waste that is landfilled to 35 percent of their 1995 levels by 2016. Centralized composting programs are less common in developing nations, though household-scale organic waste management strategies may be more common. Despite the widespread availability of substrate in the organic fraction of MSW and the growth of centralized composting programs in industrialized nations, the percentage of MSW that is composted is small for most nations, with values ranging from 1 percent in the United Kingdom to about 9 percent in the United States to 22 percent in the Netherlands.

Constraints on the Use of Compost

Producing good compost from MSW faces some challenges. What people throw away is heterogeneous, but the separation of waste into organic and inorganic fractions is necessary for the production of compost. If this separation happens after collection of mixed solid waste, there is a risk that heavy metals, toxic organic compounds, or inorganic materials present in the MSW will contaminate the organic waste. Inclusion of these substances in a compost pile threatens the biodegradation process and makes the use of the resulting compost difficult and hazardous. Compost faces large market barriers; while the production of compost requires energetic and monetary resources, the market value of the product tends to be low. This discrepancy discourages widespread composting.

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See Also: Biodegradable; Food Waste Behavior; Microorganisms; Organic Waste.

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Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund)

More than a century after the Industrial Revolution, economic growth and wealth creation in the United States remained closely tied to industrial output. As recently as the 1960s, fully one-third of the country's workforce was engaged in manufacturing activity. In subsequent decades, however, the United States underwent a transition to a post-industrial, or service-based, economy. In the early 21st century, manufacturing provides employment for only about one in ten workers, and the country has become littered with literally hundreds of thousands of abandoned industrial sites. Including machine shops, steel mills, automobile factories, old mines, and others, the variation of these contaminating sites is likewise extensive. Although the doors to these sites may have closed, many continue to pose significant environmental and health risks to the surrounding community through the risk of contamination. The most notorious chemical contamination occurred in the Love Canal neighborhood of Niagara Falls, New York. Receiving national attention in 1978, this incident spurred the federal government to enact the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund). This act stands as the most important federal response to the dangers of the uncontrolled release of hazardous chemicals into the environment.

Goals, Priorities, and Classifications

The goals of the CERCLA legislation are to identify those sites associated with hazardous contamination and to assign the costs of cleanup to the responsible parties. Eligibility for federal funds for cleanup requires that a site be designated as a "national priority." Congress initially required the Environmental Protection Agency (EPA) to identify 400 sites for listing on the National Priorities List (NPL). The sites listed on the NPL are only those of the absolute highest priority and do not include the many thousands of sites associated with far lower levels of contamination. As of July 2010, the number of sites on the NPL had subsequently ballooned to 1,277, more than tripling the original list. Furthermore, only 343 sites had been identified as needing no further response and were deleted from the NPL. While the NPL has received the most attention, CERCLA empowers the EPA to pursue remediation action at any contaminating site. Perhaps the greatest difficulty in satisfactorily addressing these potentially hazardous sites is confusion over the requirement that the site be cleaned, with the question arising: just exactly how clean is "clean?"

This confusion led to the 1986 Superfund Amendments and Reauthorization Act (SARA), which established criteria that the EPA was to consider when determining an appropriate course of action for the remediation of each site. While providing some clarity, SARA did not, however, establish a national set of standards for the cleanup of polluting sites. Thus, there remains heightened concern over a lack of clarity regarding CERCLA standards and enforcement policy. The reason for this concern is that liability is both strict and retroactive.

In other words, parties may be held responsible for the costs of cleanup even if the contamination occurred before 1980 and was legal at the time. Likewise, parties that had nothing to do with the original use of the property and assume ownership of the property only after it has been abandoned may also be held liable for the cleanup. Apprehension over the possibility of being forced to pay untold dollar amounts in remediation has served as a deterrent to potential buyers of contaminated sites. While various amendments to CERCLA have been implemented in order to address this concern, estimates still place the number of abandoned Superfund sites in communities across the United States at more than 500,000.

Brownfields

People often notice abandoned properties in desirable locations, (for example, a gas station on a corner lot at a busy intersection) and wonder why no one has invested in that potentially prime piece of real estate. The reason could very well be that it is a Superfund site. Investors are frequently unwilling to incur the risk of being exposed to liabilities associated with the remediation of that site. The uncertainties and costs associated with the redevelopment of these brownfields are costing many older industrial cities potential tax revenue and job opportunities. Seeking to minimize costs, developers frequently look to open space at the fringe of urban areas as ripe for development. However, building on these greenfields contributes to urban sprawl and takes jobs and dollars out of the central city. Furthermore, there is also significant concern that these abandoned and potentially hazardous sites are disproportionately located in neighborhoods or communities with a high minority population. Associated with the concept of environmental justice, evidence suggests that the poor—and, in some cases, minorities—may not receive equality when it comes to environmental cleanup of Superfund sites.

Effects

Three decades after its passage, the relative merit of CERCLA remains uneven. While CERCLA has spurred investigation by the EPA into tens of thousands of sites thought to be releasing hazardous chemicals, and while billions of dollars have been spent on cleanup, there have also been a number of unintended consequences. Most acute are those concerns about liability that have brought to a halt untold numbers of projects aimed at the redevelopment of brownfields in central cities. While CERCLA has received legislative attention over the years, questions also remain regarding the appropriate level of federal funding. Superfund remediation did receive additional funding through the American Reinvestment and Recovery Act of 2009; however, only through a long-term and holistic strategy for the application of CERCLA will all parties involved in the remediation of Superfund sites truly benefit.

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See Also: Environmental Justice; Love Canal; Politics of Waste; Pollution, Land; Pollution, Water; Resource Conservation and Recovery Act; Toxic Wastes.

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Computers and Printers, Business Waste

Evolving from tabulation machines used to handle growing volumes of information in the early 20th century, computers became integral to the function of businesses large and small by the 21st century. Beginning in the 1950s, gigantic mainframe computers—primarily manufactured by International Business Machines (IBM)—handled information at large corporations; a decade later, advances in microprocessor technology allowed smaller businesses to purchase microcomputers or even desktop models to handle records. Today, businesses in both

developed and developing nations rely on mass-produced computers to handle their needs. Though increasingly large volumes of computers and printers are disposed of annually, they do not necessarily follow a linear trajectory from consumption to disposal and waste. Instead, business disposal practices increasingly involve further rounds of consumption through reuse and refurbishment prior to eventual disposal. Like other forms of cast-off electronics, the consumption and wasting of computers and printers used in business environments is a culturally distinctive practice that varies from place to place.

Disposal Options

In North America and Europe, business concerns about data security and liability arising from breaches tend to trump concerns about the environmental consequences of information technology (IT) disposal. These concerns have spawned an industry known as information technology asset disposition (ITAD). The ITAD industry offers a number of disposal options including reuse, refurbishing, re-marketing, data sanitization, and recycling of computers, printers, and other electronics. In 2010, nine leading ITAD firms in the United States had combined revenues of between $265 and $345 million annually. Fueling the growth of this industry are a number of information privacy laws that carry stiff economic penalties if companies are found in breach.

ITAD firms actively encourage reuse, remarketing, refurbishing, and the like for their business clients. ITAD company Websites market these services in a way that suggests that recycling should occur only when equipment cannot be repurposed or redeployed. The emphasis in the business sector on reuse and refurbishment thus marks an important contrast with the household consumer sector, which is encouraged to replace older computers and printers with new ones, even when they could be reused or repaired. Meanwhile, in Asia, Africa, and South America, computers, printers, and other business IT assets circulate within complex informal recovery economies that refurbish, repair, and remanufacture this equipment as well as disassemble them into their constituent components and materials, which are then fed back into the production economy. However, the disposal and recovery of computers and printers from business waste is far from being a closed-loop production system. Patterns of disposal and recovery raise a number of controversial issues that link economic questions with moral ones about poverty, survival, economic production, health, and the environment.

Criticisms

While there are key differences between the business sector and the personal consumption sector in terms of consumption and disposal practices, the disposition of electronics from either sector has similar effects. Attempts to mitigate the health and environmental effects of electronics disposal focus on formalizing recycling. These strategies include product take-back programs and industrial-scale material and energy recovery systems. In North America, Europe, and parts of Asia and Africa, these strategies are increasingly mandated by law. While such efforts may appear beneficial, there is a debate about their efficacy. Formal industrial-scale recycling can recover substantial amounts of material and energy. It can also reduce the need for mining new raw materials. However, it also leads to what some argue is a wasteful destruction of working computers and printers that could, under the right conditions, be fit for reuse by people and businesses otherwise unable to afford them. Moreover, relying on recycling to manage waste computers and printers from business environments cannot escape the problems of materiality. Recycling at an industrial scale typically requires transportation of equipment over long distances to recycling facilities, thus adding to the environmental footprint of disposed electronics. Industrial-scale recycling machinery requires substantial amounts of energy that must be generated in some manner, thus raising the likelihood of CO_2 and toxic emissions. Smelting for material and energy recovery from electronics can release toxic substances such as lead. Some argue that formalized recycling risks merely shifting the loci of toxic burdens of cast-off electronics rather than truly eliminating them. Others contend that the emphasis on recycling is a trap that risks foreclosing on options for the cleaner production of original products.

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See Also: Computers and Printers, Personal Waste; Culture, Values, and Garbage; Mobile Phones.

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Computers and Printers, Personal Waste

The personal computer developed later than the mainframes used by corporations in the 1960s but the introduction of the microprocessor in the 1970s made this technology compact and affordable to sell to millions of individuals. International Business Machines (IBM) introduced the 5100 as a desktop model in 1975; two years later, Apple entered the desktop market with the Apple II. IBM responded in 1981 with the PC, which ran on an operating system designed by Microsoft. The PC quickly became a mass consumer product in the developed world as manufacturers built machines using Microsoft's operating system. Apple followed with the Macintosh in 1984, serving a smaller but devoted market.

Desktop computers became commonplace in businesses, schools, and households over the next 20 years. Microsoft founder Bill Gates became one of the wealthiest people on Earth due to the omnipresence of the Windows operating system, and Apple became associated with an elite design aesthetic that the firm shifted from computers to telephones, music listening devices and, by 2010, the largest music-selling store in the world (iTunes). In August 2011, shares of Apple surpassed those of Exxon to make it the most valuable company traded on the NASDAQ stock market.

The broad market of personal computers running either Microsoft or Apple operating systems continues into the 21st century, but the machines that run this software are far more powerful than their 1980s counterparts. Under Moore's law (named after Intel founder Gordon Moore, who came up with the concept in 1965), processor capacity doubles roughly every decade, accelerating functional obsolescence. This affects all computer markets, but once the computer became a mass-consumer product marketed to households in the 1980s, functional obsolescence had profound effects on the waste stream. Beyond processors, innovations in design allowed the personal computer to evolve from desktop machines to laptops in the 1990s, and began blurring the line between computers, telephones, and television equipment in the early 21st century.

Studies suggest that North America and Europe will reach their peak production of obsolete computer equipment by 2020. In developing regions, on the other hand, volumes of obsolete computer equipment will reach a peak by 2030. However, as with the consumption of computers, printers, and other electronics, disposal practices also vary widely. Estimates put the useful life of computers and printers at two to three years in North America, down from four to five years in the 1990s. Elsewhere in Asia and Africa, however, the same equipment remains in use for a longer time period. The differences in lifespans of electronic equipment over time and between regions shows that there is more to obsolescence than purely technical change. At least as important is status-seeking behavior on the part of consumers, the latest styles.

Recycling

In North America and Europe, consumer attitudes toward obsolete computer equipment suggest that consumers are grappling with a complex

set of moral questions that belie stereotypes about a throwaway society. Though increasingly large volumes of computers and printers are disposed of annually, they do not necessarily follow a linear trajectory from consumption to disposal and waste. Instead, like other forms of cast-off electronics, they may continue to circulate in substantial recovery economies that include international commodity networks of trade and traffic.

North Americans and Europeans increasingly have access to formal recycling systems for computers, printers, and other electronics. Elsewhere in Asia, Africa, and South America, computers, printers, and other electronics circulate within complex informal recovery economies that refurbish, repair, and remanufacture the equipment as well as disassemble it. Their constituent components and materials are then fed back into the production economy. However, the disposal and recovery of personal computer and printer waste is far from a closed-loop production system. Patterns of disposal and recovery raise a number of controversial issues that inherently link economic questions with moral ones about poverty, survival, economic production, health, and the environment. For example, the burgeoning electronics recycling industry, a multibillion dollar activity, will continue to expand. At the same time, those parts of the industry operating in North America and Europe will see increasing competition from the developing world, in particular Asia, which is also the dominant location for the industrial production of new electronics. Regulatory regimes that seek to control international movements of obsolete electronics from developed to developing countries will need to evolve or risk irrelevance, since the highest volumes of obsolete electronic equipment will be produced in developing countries.

Effects on Environment and Health

The toxic consequences of disposing of computers, printers, and other electronics is an issue of increasing concern. Images of poor and marginalized people in various Asian and African countries picking through waste dumps in search of recoverable electronics or disassembling them by hand have provided a major impetus for legislation to control the international trade and traffic of cast-off electronics, including personal computers and printers. In many ways, these images have framed the public debate in North America and Europe about this particular slice of the waste stream and legislative attempts to control it. Such images have also spurred research by environmental nongovernmental organizations and academics concerned about the environmental consequences of electronics disposal. Such research has documented significant health and environmental consequences for people and places associated with the informal processing of these objects and materials. At the same time, studies of the material and chemical behavior of electronics disposed of in well-designed landfills suggest that they remain largely inert under those conditions and are not major sources of toxic releases.

Mitigation Strategies

More than a billion personal computers were in use worldwide by 2009, with China and the United States the largest markets for new machines. Entering the second decade of the 21st century, the definition of the personal computer is increasingly fluid, as desktop machines are sold not only along portable laptops but also smart phones, tablets, and other devices that rely upon microprocessors. All of these devices consume electricity and allow users to engage in consumption through on-line shopping. All are mass consumer objects subject to Moore's law and their inevitable obsolescence generates increasing volumes of electronic waste

For the most part, attempts to mitigate the health and environmental effects of electronics disposal focus on formalizing recycling. These strategies include product take-back programs and industrial-scale material and energy recovery systems. In North America, Europe, and parts of Asia and Africa, these strategies are increasingly mandated by law. While many laud these efforts, they are also subject to serious debate about their efficacy. Formal, industrial-scale recycling can recover substantial amounts of material and energy. It can also reduce the need for mining new raw materials. But industrial recycling in general, and of electronics specifically, involves energy and materially intensive processes. It often requires transportation over substantial distances from collection to processing facilities, which adds to its overall environmental impact. The industrial machinery used to shred

and sort computers, printers, and other electronics at an industrial scale requires substantial amounts of energy to run. Smelters involved in material and energy recovery from electronics can release toxic substances, such as lead, from their operations.

Some argue that formalized recycling risks merely shift the loci of toxic burdens of cast-off electronics rather than truly eliminating them. Others contend that the emphasis on recycling leads to a recycling trap—a situation where a multitude of options for the cleaner production of original products are bypassed in favor of recycling them as an alternative to disposal. Changes to production processes and product design that would reduce the environmental and health risks of electronics are thus delayed or deferred by an emphasis on recycling. As a consequence, a vast range of opportunities may be missed for implementing greater material and energy efficiencies to the production process; altering product design to make repair and disassembly easier; and using less- or no-toxic components in the manufacturing of computers, printers, and other electronics. Meanwhile, a recycling system is instituted to deal with personal computer and printer waste only after such waste has already been created and only tries to reduce or eliminate that waste at the last possible moment, before the products enter the waste stream.

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See Also: Computers and Printers, Business Waste; Mobile Phones; Recycling Behaviors; Toxic Wastes.

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Connecticut

The state of Connecticut is a leading innovator in waste disposal. Connecticut burns the highest percentage of garbage in the United States, such that over 60 percent of all waste collected is incinerated in an environmentally friendly manner. According to the Connecticut Department of Environmental Protection, state residents dispose of 2.7 million tons of trash annually. With a population of slightly over 3.5 million people, that figure equates to 1,500 pounds of waste per person per year, or nearly 5 pounds of garbage generated by each person every day. In order to responsibly deal with the collection and disposal of this garbage, the Connecticut Resources Recovery Authority (CRRA) was established to develop environmentally sound solutions to solid waste disposal and recycling management. The CRRA has promoted waste management standards that have made the "town dump" method obsolete in Connecticut. Moreover, through the foundation of two museums dedicated to garbage and its impact on the state as well as the nation, the CRRA continues to educate and raise awareness among a new generation of constituents. Contrary to these positive aspects of waste management in Connecticut, the relationship between organized crime and trash disposal was an example of an undesirable development of the garbage business in the state. Regardless of any negative attention garnered from such accusations and eventual convictions, energy consumption, waste collection, and disposal continue to be important issues to the state of Connecticut and for its residents.

Disposal Methods

During the 2008 fiscal year, 3,401,085 tons of solid waste were collected and disposed of in the state of Connecticut. From this total, only 163,543 tons

(4.81 percent) were deposited in local landfills. The Connecticut Department of Environmental Protection burned 62.06 percent, or 2,110,855 tons of trash. Of this portion, 544,709 tons of ash were deposited in landfills, and 48,070 tons of metal were recycled. Nearly 8 percent (261,255 tons) of the waste produced and collected in Connecticut was disposed out of state, and only about 25.45 percent (865,432 tons) was recycled. In comparison, according to an Environmental Protection Agency (EPA) report issued in November 2009, the national recycling rate—the amount of trash generated divided by the volume of material recycled and composted—is slightly over 33 percent. This apparent underperformance is surprising, since recycling is mandatory in the state of Connecticut. In accordance with the Connecticut General Statutes and the Regulations of the Connecticut State Agencies, items to be recycled include glass and metal food and beverage containers, corrugated cardboard, newspaper, white office paper, scrap metal, and waste oil, among other items. This means that residents, all public and private institutions, as well as every business including nonprofits are required to recycle. In addition, some municipalities have established ordinances that specify the recycling of other items, such as old magazines and junk mail. In fact, under state law, garbage haulers must report individuals who do not separate their trash or put out their locally provided recycling bins. The total amount of garbage for Connecticut's disposal statistics does not, however, include bottle deposits or the amount of auto scrap metal and storage batteries recycled annually.

Incineration

Until 1973, Connecticut waste management consisted of the "town dump" method wherein each municipality in the state had its own landfill to handle its locally produced garbage. The acting governor at the time, Thomas J. Meskill, established the CRRA to tackle the solid waste management issues afflicting the state. He also created the institution in order to develop and implement environmentally responsible methods of garbage collection and disposal. This quasi-public agency was designed to assist individual municipalities and serve their best interests in terms of waste management. In accordance with these objectives, the CRRA has built trash-to-energy facilities to burn garbage. The heat generated from this process is used to boil water and create steam that, in turn, spins turbines and produces electricity. Furthermore, the ash yielded by this process contains 75–80 percent less volume than the same trash if it were disposed of in a landfill. Therefore, the amount of space saved through burning trash is considerable when compared to more traditional methods of garbage disposal (such as landfills).

The CRRA serves 96 out of 169 cities and towns in the state, or about two out of every three residents. The agency oversees four large waste management projects across Connecticut, including ones in Bridgeport, Wallingford, the central counties, as well as the southeastern portion of the state. Four trash-to-energy plants have been built, and they process 2 million tons of trash per year. Collectively, the reduction of trash to ash produces 630 million kilowatt hours per year. This amount is enough electricity to satisfy the energy needs of 170,000 homes. The gases burned from the Hartford landfill alone can provide energy for 1,500 homes. In sum, Connecticut recovers 80 percent of its energy from nonrecyclable waste, thus saving the state 32 million barrels of oil since 1992.

Recycling and Hazardous Materials

In addition to burning the state's garbage, the CRRA manages the recycling facilities in those areas it serves. They process 130,000 tons of recyclables per year, including glass and plastic containers, steel and aluminum cans, and newspapers. Five hundred tons of containers and paper are recycled daily. Moreover, the CRRA deals with hazardous materials. Since 1999, 1.7 million pounds of recovered electronics have kept massive amounts of cadmium and other heavy metals out of the environment.

Education

In conjunction with the efforts of the CRRA, the state has founded two museums: the Trash Museum in Hartford and the Garbage Museum in Stratford. These institutions provide fun, educational, hands-on programs, activities, and exhibits for 50,000 visitors per year. The smaller of the two, the Trash Museum, occupies 6,500 square feet of space. Here, visitors can learn about the old "town dump" model and the solutions that Connecticut has implemented

since the 1970s, including plans to reduce and recycle, the construction of trash-to-energy plants, and more environmentally friendly landfills. The Garbage Museum in Stratford, on the other hand, features 15 interactive exhibits, including a 125-foot glass wall that overlooks an adjacent recycling plant. According to the Garbage Museum's Website, its mission is "to help teach youngsters how to reduce, reuse, recycle, and rethink throw-away lifestyles." The museum attempts to accomplish this goal in a variety of ways. Visitors are encouraged to not only observe the waste management process, but also participate through several learning labs, one of which allows visitors to sort trash. A featured exhibit called the Worm Tunnel is also located at the Garbage Museum. This giant simulated compost pile containing five-foot worms and other types of crawling insects simultaneously entertains children and teaches visitors about the compost cycle. The highlight of the museum, the "Trash-o-saurus," is a 2,000 pound, 24-foot-long, 11.5-foot-high dinosaur sculpture. It is designed to impress visitors and to draw attention to the fact that the entire statue is made of the average amount of trash a Connecticut resident disposes of per year. Although the Garbage Museum has attracted 306,000 visitors since it opened in 1993 and over 32,000 in 2008 alone, economic hardships have afflicted the institution. Until 2009, the Garbage Museum was funded by revenues from recyclables sales in the area cities that contribute to the regional recycling facility. However, with economic problems and the departure of six towns from the CRRA in late 2008, the museum administration is struggling in 2010 to balance operating costs with what little revenue it receives from its modest admission rate, tours, and program fees.

Crime

Although museums dedicated to garbage are one means to stimulate interest and to raise awareness of waste management, the trash business in Connecticut is probably recognized more in the national media for its involvement in organized crime. A 2006 federal investigation filed against the Genovese crime family of New York City implicated several Connecticut waste disposal companies in attempts to fix prices and rig government contracts. Crime syndicates are attracted to garbage collection because it is a legitimate service that is necessary to the public and easy to infiltrate. Members of the Genovese crime families were accused of monopolizing businesses by asserting "property rights" to particular locations and stops in the trash collection market. When competing companies attempted to offer lower rates, the crime syndicate responded with threats, violence, or arson.

Nevertheless, this negative publicity does not negate the positive steps the state of Connecticut has taken to optimize its waste collection policies and disposal processes. The efforts of the CRRA in particular have shaped the way Connecticut residents perceive and deal with garbage in their own lives. As waste and energy conservation becomes an important issue in society, Connecticut is a forerunner in waste management on the national stage through its unique methods of dealing with its trash. For example, in addition to the high percentage of garbage that is reduced to ash in incinerators, a handful of Connecticut municipalities have implemented SMART programs, also known as Pay-As-You-Throw (PAYT). This method of charging for trash collection, based on the amount disposed, is designed to provide incentives for residents to not only increase the amount they recycle but also envision ways to produce less waste. SMART is a low-cost strategy that can help achieve Connecticut's target of increasing the state's recycling rate to 58 percent by 2024. Therefore, Connecticut is part of a larger, nationwide drive to provide waste management solutions that are economical, fair to residents, and beneficial to the environment.

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See Also: Incinerator Waste; Incinerators; Recycling; Sustainable Waste Management.

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Construction and Demolition Waste

Construction and demolition waste or debris (C&D) is waste that results from the activities of construction, renovation, demolition, and (under some definitions) excavation. The objects of these activities include all features of the built environment, such as houses, buildings, industrial facilities, roads, and bridges The C&D waste stream is generally urban, bringing it into proximity with municipal solid waste (MSW) in terms of collection, processing, and disposal infrastructure. However, unlike MSW, C&D is nonputrescible, meaning it does not contain food or other organic constituents that would lead it to rot. For this reason, the collection and disposition of C&D does not have the same history or implications for public health that MSW does, and the regulatory structures for C&D collection and facility permitting are somewhat different from those for MSW. Like MSW, however, C&D is generally considered a nonhazardous waste, although it may contain certain hazardous components in small quantities from time to time, particularly asbestos and treated wood. Because of its generally inert status, C&D therefore falls outside the regulatory structures governing hazardous industrial wastes in terms of collection, transport, and facility siting.

C&D waste has existed for as long as human civilizations have been building permanent structures—a practice dating to the late Neolithic era (three to five millennia B.C.E.). Historians have documented the reuse of stone, bricks, and wood in deconstruction and construction over millennia as a matter of course, depending on material availability.

Quantities

Unlike MSW and some industrial processes, wastes that are generated as by-products of relatively steady, year-round activity, C&D waste generation fluctuates considerably with the economic conditions in a particular country or region. There is a close association between C&D generation and economic activity. Periods of building boom, moreover, presage periods of demolition decades into the future as structures age and require repair or demolition. Thus, increases in C&D in a particular year may represent echoes of a prior period of prosperity many years before, a phenomenon that has been studied and documented in European countries in particular. In rapidly developing countries, such as China, industrialization, increased consumption, and the expansion of the middle class has meant rapid escalation of C&D generation in the 2000s. Finally, C&D generation is influenced by disasters (which are by nature unpredictable and of varying magnitude) that result in destruction of the built environment.

For this reason, estimates of world C&D generation are not possible and national-scale estimates are highly specific year-by-year. According to the Environmental Protection Agency (EPA), the C&D waste stream in the United States as of 2003 was 170 million tons annually. The European Union (EU) reports a roughly estimated 450 million tons for all member countries, but the data quality, inclusiveness, and consistency varies greatly among nations and generally dates to the late 1990s. The Organisation for Economic Co-operation and Development (OECD) adds that Japan generates 123 million tons and Korea 38 million tons annually. Independent reports from China indicate that overall C&D generation is averaging 120 million tons annually and is growing every year, causing the Chinese government to regulate demolition permit issuance to stem the transport and disposal burdens facing Chinese cities. The Indian government estimates a rapidly growing C&D stream of roughly 20 million tons annually.

Composition

In contrast to widely fluctuating C&D quantities, the range of constituents of C&D remain similar across nations and time, although their relative fractions may differ. Inert materials, including concrete, stone, brick, and tile make up a great deal of C&D, which also may contain structural steel, wood, plaster, ceramic, carpet, sheet or plate glass, heavy duty cardboard, asphaltic roofing tiles, and, in some cases,

Inert materials, including concrete, stone, brick, and tile make up a great deal of construction and demolition waste, which also may contain structural steel, wood, plaster, ceramic, carpet, and plastic components. The percentage of demolition debris in the waste stream is difficult to calculate, but in 2003, the U.S. Environmental Protection Agency estimated America's annual volume at 170 million tons. The whole of the European Union creates an estimated 450 tons annually, and Japan's generation is estimated at 123 million tons per year.

plastic components. Asbestos (naturally occurring filamentous minerals that were, in the 19th and 20th centuries, used in Europe and North America for fireproofing and insulation) is a relatively small quantity of waste generated by renovation and demolition projects and in the 21st century is generally removed under highly-controlled conditions prior to any renovation and demolition activities. Other potentially hazardous constituents of C&D waste include wood treated with arsenic or other heavy-metal laden preservatives; plasterboard, which produces hydrogen sulfide gas when landfilled; and PVC piping, which may produce dioxin if incinerated.

Disposal

Disposal (including landfilling of inert constituents and combustion of wood, plastic, cardboard, and asphaltic roofing) is one frequent end for C&D. In the United States, it is estimated that 52 percent of all C&D generated is disposed of, largely through landfilling. Rates in northern Europe are markedly lower, with between 10 and 20 percent of all C&D generated disposed of. Rapidly developing nations such as China and India, in contrast, struggle with a lack of developed infrastructure for C&D disposal and dispose of the majority of C&D in landfills or waste piles.

Materials Recovery

The reuse of the inert quantities of C&D, ground into aggregate, is a well-established and widespread practice in the developed world, as is the recovery of structural steel from C&D, manually or by use of magnets, for recycling in most countries. In most cases, crushed concrete, stone, and bricks are used in place of gravel or sand in road building and drainage applications. Unlike steel recycling, a highly efficient process in which scrap metal is reintroduced into mill production, the crushing and reuse of inert C&D as aggregate is considered downcycling in that the end product does not conserve much of the energy or use value that went into making the substance in the first place.

Two 21st-century movements are under way in many countries of the world to address C&D waste in a more sustainable manner. The building deconstruction movement, which is active in North America, Europe, and Australasia and is closely tied

with the zero waste and green building movements, is an effort by nonprofit and for-profit social enterprises to change the way demolition and renovation are carried out. Building on long-standing practices such as the removal of copper piping, mahogany, and other highly valuable materials prior to demolition, this movement has organized labor forces, storage spaces, and markets around a wider array of salvageable elements, deconstructing fixtures, moldings, doors and windows, tiles, structural wood, and other elements before the wrecking stage begins. Such items that may be of higher quality than contemporary substitutes, depending on their vintage, are then resold to builders for integration into new construction.

A second set of developments are organizing around the constituents that make up concrete, a large fraction of C&D that is growing rapidly in a wide range of building applications. The production of Portland cement, the agent for binding aggregates into concrete, has considerable impacts in terms of carbon dioxide emissions. The fortuitous discovery that fly ash from coal combustion can substitute for large portions of Portland cement in concrete production has led to research and project development around the use of this industrial waste in the construction industries of nations the world over in which coal is used for energy production. Utilization of fly ash for this purpose has a dual benefit of diverting it from disposal while reducing the need to fabricate cement in kilns. Another set of technologies, termed *closed cycle construction*, is being developed to thermally and mechanically release aggregate from crushed concrete debris so that it is of a high-enough quality to be reintroduced into new concrete production. As opposed to use as low-grade aggregate, C&D concrete processed using this technology, which is often fueled by the combustion of wood, cardboard, plastic, and asphaltic components of C&D waste, closes the loop in the fabrication of concrete.

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See Also: Coal Ash; Downcycling; Economics of Consumption, International; Economics of Consumption, U.S., Landfills, Modern.

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Consumerism

Consumerism is a way of life rooted in mass production and the marketing industry. It includes a practice where social identity and prestige are constructed, experienced, and signaled through the purchase and possession of consumer goods and services. Consumerism is fueled by easy credit and by advertising designed to create desire for commodities by associating their acquisition with valued states such as happiness, peace of mind, attractiveness, gratification, affluence, and success. Consumerism is central to an economy in which people are preoccupied with material consumption to the point where the amount of goods acquired may be far in excess of actual need. Producers of commodities in industrialized societies profit by ever-expanding consumption, but meeting this growing demand has been using up natural resources at an unsustainable rate.

At the other end of the product life cycle, consumerism includes the practice of discarding broken, out-of-fashion, and even slightly used products, making room for new acquisitions. This has resulted in a huge and rapidly moving waste stream that itself has become problematic. Most social theorists agree that contemporary consumerism began at the dawn of the 20th century and gathered momentum with an expanding middle class in Europe and North America after World War II.

With modern globalization it has spread worldwide, wherever consumer products and associated images and narratives have penetrated societies whose traditional cultural economies have been disrupted by colonialist or neoliberal restructuring.

The term *consumerism* also has a number of more specialized meanings. In economic theory, it refers to the idea that continuously expanding mass consumption is beneficial to an economy. In a related usage, consumerism is the idea that the choices made by consumers should shape production and, by extension, the structure of the economic system as a whole. In economic policy terms, it is used to characterize policies that promote consumption. Finally, consumerism is a synonym for the modern consumer protection movement, which advocates the rights and interests of those who purchase products. In this context, consumerism promotes policies to ensure product safety, quality guarantees, and truthful advertising.

History and Significance of Consumerism

The origins of modern consumerism are linked to the invention of factory assembly lines at the turn of the 20th century. Mass production increased worker productivity to the point at which prices of consumer goods became affordable to most workers in industrially developed societies. It also created workplace and profit conditions conducive to labor union organizing. Industrial wages rose, boosting many into the new middle-class lifestyle of consumerism. In 1899, economist Thorstein Veblen identified a pattern of conspicuous consumption among middle-class people seeking to cement their social status through their consumptive behaviors.The expanded world of goods available in the industrialized world made such behavior possible.

Early in the mass consumption era, engineers began designing products in such a way that consumers would need to replace them periodically, either because they are used up or have become obsolete before wearing out. Consumerist policies promoted demand as a growth strategy in the 1950s, especially in the United States, where members of a growing middle class viewed their upward mobility in material terms, such as owning many household appliances, a single-family home, and an automobile. "Store-bought" clothing, processed foods, and manufactured chemical products acquired the glamour of modernity and high status. Attributing to such commodities the power to gratify, modernize, and uplift consumers became a common form of commodity fetishism. The novel luxury of buying such items off the shelf imbued them with special significance in the 1950s and early 1960s. This was a time when admiration for the scientifically up-to-date was a cultural norm, along with a rationale in which "second hand," "home grown," and "homemade" came to signify either the lingering frugality of Depression-era poverty or nostalgia for a romanticized pre-industrial past. The implicitly competitive character of consumerist status display was captured in the imperative of "keeping up with the Joneses."

Growing consumerism has been linked to other systemic changes, including the decline of mass transit, increased industrial pollution, suburban sprawl, an industrialized food system, and growing dependence on cheap fossil fuels and easily available consumer credit. By the 1970s and 1980s, rising lifestyle costs and personal debt made a two-wage-earner household common for middle-class American families.

With the rise of globalization, industrial corporations have managed to increase profits while keeping prices affordable by moving production to economically underdeveloped areas of the world where labor costs are low and regulatory regimes are lax. This has led to the decline of industrial employment in the most developed parts of the world, where nonunion service and professional jobs now predominate. Globalized communications have promoted consumerist values and lifestyles to a receptive worldwide audience aspiring to middle-class status understood in terms of material consumption. Products that facilitate media connectivity such as televisions, computers, cell phones, and other handheld devices are often among the first major purchases of such households. Using these products exposes a global population of would-be consumers to a stream of ideas, values, and images of affluent Western consumerist lifestyles, together with a steady barrage of commercial advertising specifically designed to stoke consumerist desires. This is one reason for today's high level of labor migration (both legal and illegal), as households deploy young adult members to work in parts of the world where higher wages make it possible for them to remit money and goods

to increase the material living standard and social prestige of the sending family. Studies tracking worldwide buying trends have shown that by the close of the first decade of the 21st century, more than two billion people have adopted consumerist lifestyles of exchanging labor for money to buy nonessential goods such as large houses, late-model cars, and processed foods.

Critiques of Consumerism

Economic efficiencies have made mass consumption possible, but their real purpose is generating profits rather than social good. Consumerism has been widely critiqued as having detrimental effects on personal autonomy, family and community values, psychological health, household finances, social capital investment, and the natural environment. These impacts are among the hidden costs of consumerism, along with waste that is not accounted for as such. According to its critics, the consumer culture that began with providing basic conveniences and well-paying jobs has grown into an oppressive hegemony that degrades human well-being as well as the planet's ecosystems.

Critics charge that consumerism transforms the natural motivation to acquire a sufficient supply of necessities into an artificially generated and insatiable quest for things and the money to buy them, and that this transformation distorts healthy social relationships. This is said to occur, for example, when people come to judge their own and others' personal value in terms of their buying power, a calculation that renders the poor worthless. Conspicuous consumption has become central to claiming a respectable level of social worth. This presents the marginally middle class with the difficult choice of either working extra hours in order to buy more and more esteemed goods, going into crippling debt, or doing without the status-conferring goods and suffering the consequent social inferiority. In consumerist culture, even close social relations are often mediated through spending money on non-necessities as a way of demonstrating love and acknowledging connection.

Consumers identify with their possessions and perceive them in part as representing who they are and who they aspire to be. Such displays communicate identity through richly nuanced symbolic associations of style and brand, so that consumers may quickly assess the socioeconomic and cultural status of others. The construction of one's persona through shopping choices can be thought of as a creative process. Thus, people may actively "consume" products in the sense of assimilating them to their own uses and reworking their advertised meanings into new and personally significant ones. This sort of consumption is limited by the available choices (those that producers deem most profitable) and social pressure to conform to the norms of popular culture shaped by advertisers. Some argue that keeping in step with changing fashions and sharing media-based experiences have come to occupy the place of socially integrating rituals and community engagement in less-consumerist societies.

Money cannot buy love, nor can it guarantee happiness. Psychological research shows that a strong consumerist orientation can promote unhappiness, because striving for money takes time away from the close relationships that are a foundation of happiness for most people. A number of studies have also confirmed that those who organize their lives around consumption goals that exceed their financial reach report significantly lower overall well-being as measured in quality of relationships, mood, self-esteem, and psychological problems. With real wages in decline, consumers in the early 21st century also face the frustration of exchanging precious time for money in order to buy things they no longer have time to enjoy.

The psychological critique of consumerism also argues that it interferes with the process of individuation by connecting it to media-based fantasies and advertising ideals. Many children now spend more time engaged with digital media than they do interacting directly with family members. As young consumers become more alienated from close social relationships, the self is increasingly constructed in relation to the personas portrayed in the media, rather than the real persons around them. For adults, the habit of buying things without knowing where, or how, or by whom they were made supports an infantile understanding of the significance of products they use every day. Similarly, when used products are routinely removed by garbage disposal services, consumers may just as easily shed their sense of responsibility for the consequences. To the

extent that affluent consumers no longer perform for themselves activities of domestic reproduction such as cooking, laundry, repair, and child minding, they surrender self-sufficiency and competence in these basic life skills.

Critical analyses of consumerism within the field of political economy also claim profoundly negative consequences. According to them, continuous restructuring of the world economy to produce goods for those with the money to buy them at sufficiently profitable prices has resulted in greater social inequality. A disproportionate amount of the resources that are essential to all people, such as fertile land, have been diverted into the production of commonplace luxuries such as tropical fruits for temperate-zone consumers, while peasant farmers dispossessed by agro-industry go hungry. The privatization of clean-water systems in underdeveloped societies keeps the consumer class healthy, while those who can't pay are exposed to devastating waterborne illnesses. Workers with few options suffer oppressively low wages and dangerous conditions in the duty-free industrial zones of hundreds of countries to manufacture clothing, toys, and electronics products that they cannot afford to buy.

Through these kinds of processes, consumerism increases social inequalities, making the lives of some very comfortable, while making it harder for others to meet their basic needs. Social equity also suffers when resources that could be used to support the public education, nutrition, health, and housing programs essential for marginalized citizens to have a chance at a good life are used instead to produce consumer items for the affluent. A final line of political economic critique characterizes consumerism as a hegemonic form of social control by which middle-class masses are pacified and rendered less prone to resisting the disproportionate power of commercial interests in public policy and the operations of the state.

An economic system predicated on continuous expansion implies ever-growing consumption, but environmentalists argue that the current rate and methods of production, use, and disposal of consumer products are degrading the natural systems upon which all life depends. Consumerism has been linked to most of the environmental problems seen today, including water and air pollution, depletion of nonrenewable resources, unsafe and costly waste disposal, and climate change. Critics argue that the high level of fossil-fuel-powered consumerism today ensures a lower standard of living for future generations.

Anticonsumerist Alternatives

Since consumerism began, some have resisted its power by pursuing alternative lifestyles. The "hippie" youth culture of the late 1960s and 1970s rejected consumerism by embracing the values of living simply and communally and of making things by hand rather than buying them. This ethical response to the perceived excesses of consumerism encouraged people to seek gratification in caring relationships, community involvement, and closeness to nature instead of material possessions.

More recent formulations of anticonsumerism are often phrased in terms of "sustainability," a term most often used to mean living in such a way that the living standards of future generations are not compromised. A standard adopted from Native American cultures into popular anticonsumerism is to consider the impact of decisions on others seven generations into the future. Living an anticonsumerist lifestyle today also entails practicing voluntary simplicity, such as cycling or using public transportation, even though one could afford the convenience of a personal automobile. Anticonsumerist activists today promote "community sustainability," an ideal understood as having three interlinked components: social equity, economic security, and environmental stewardship. The politically radical version of sustainability-based thinking argues that uncritical consumerism supports oppressive political economic forces that are antithetical to an ideal of living in sustainable communities. In its green-business version, sustainability thinking emphasizes cost savings through more efficient resource use and long-term, rather than short-term, management planning.

Most 21st-century environmentalism calls for reforming consumerist practices to reduce the harmful and wasteful use of natural resources through energy conservation, product reuse and recycling, and switching from fossil fuels to renewable energy sources. It differs from earlier anticonsumerist movements in the gravity of its

stated purpose, which is urgent action to avoid catastrophic disruption of the natural systems underpinning human civilization and all life on Earth. "Green consumerism" does not challenge the profit motive of business, but seeks to use ecoconscious consumption strategies to influence how products are made and the sort of consumer choices that are available. It requires purchasers to consider the environmental impacts of all aspects of product life cycles—the supply chains, working conditions, and waste involved in its manufacturing process, packaging, transportation, use, and eventual disposal.

The practice of buying more environmentally benign products has already gained broad acceptance and become a significant market force, for example, in the case of organically produced foods that have become much more available and affordable as a result. Buy-local and eat-local movements seek not only to reduce the fossil fuel pollution associated with transportation, but also to support the economic viability of local communities. The success of such movements indicates that cultural change in consumer habits is occurring. Such change may be crucial, since identifying conventional consumerism as a threat of great magnitude leads to the conclusion that the human future depends on reshaping human's way of life into one that is sustainable within the natural limits of the Earth.

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See Also: Commodification; Home Shopping; Household Consumption Patterns; Malls; Materialist Values; Overconsumption; Post-Consumer Waste; Shopping.

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Consumption Patterns

Consumption patterns characterize individual, group, and community use of the means and wealth for subsistence, enculturation, comfort, and enjoyment. They have quality and/or quantity characteristics anchored to different lifestyles. Specific factors characterize consumption patterns during different historical periods and in different regions. Increasing consumption has been a general trend in the evolution of human civilization. This has resulted in the modern and postmodern consuming society of the industrial and technological era, when consumption of many products has been higher than needed. The reason is the changing type of consumer: from a traditional consumer of fixed needs, toward a consumer of endless needs and wants.

The general classification of consumption patterns includes nine clusters with eight subclusters in the first group: food, beverages, and tobacco (bread and cereals, meats, fish, dairy products, fats and oils, fruit, and vegetables, beverages and tobacco, and other food products); clothing and footwear; housing; household furnishings and operations; medical care and health; recreation; transportation and communications; education; and other items. A variant is the classification based on nutrition, mobility, housing, clothing, health, and education as functional components of lifestyle.

Globalization and worldwide income growth have been increasing the similarities across countries in what consumers eat and where they shop. A crucial factor for change in the 21st century is the evolving of the sustainable style of life with attention to the environment and the increasing role of sustainable products.

Analysis suggests that low-, middle-, and high-income countries all respond differently to changes

in income and food prices. As a result of the global economic crisis, poor families in Asia, for instance, spend more than half their household income on food and are bearing the brunt of the economic burden. In many countries of the world, including in eastern Europe, the incomes of a significant percentage of the population are not enough for subsistence and people experience hunger. In this case, the consumption pattern of using the entire income for necessities can be observed. Another characteristic of the early 21st century is the changing social profile of consumers according to changing incomes. The Internet and the knowledge economy have been creating new wealthy segments while others, whose incomes were based on property and traditional sectors of the economy, have experienced a limitation in the consumption of luxuries.

Age preferences are well established in some patterns of consumption. For instance, pizza restaurants and burger bars are more popular among the younger generation, while older people prefer pubs and restaurants. However, children and adults of different ages are both consumers of new products such as video games.

Consumption patterns depend on traditions, cultures, a changing economic base, and many other factors including even ideology (e.g., religious beliefs). They are socially determined and abrupt shifts in attitude and practice that can be observed. Settlements of tobacco lawsuits followed by an increase in cigarette prices is a good example. Increased knowledge of nutrition changes food consumption patterns toward healthier food worldwide, especially in the United States. The turn toward preventive health as a leading social agenda expands the role of alternative medicine that, in many cases, can become the preferred service for many people. This creates a conflicting consumption pattern between traditional and conventional medicine. An example of a complementary pattern of consumption would be the combination of slow and fast food based on health criteria and on the limits of income. Low-income segments of society have often consumed substitutes for luxuries that create a pattern of consumption that includes secondhand products.

Fashion and tourism are among the leading factors in the development of consumption patterns as a communication of wealth, culture, and status (after Veblen's model). These patterns include not only materialism, but also the consumption of experiences, relationships, symbolic expressions, and many other aspects of the social environment related to novelty, enculturation, socialization, and the desire for pleasure.

From consumer and sociological perspectives, the term *consumption* has a negative nuance because of the period of overconsumption in the late 20th century, although consumption is inherent in human society since human culture started with pure consumption of the products of nature (hunter-gatherer societies). Accordingly, early 21st-century consumption is accepted as a main trait of human culture along with production, a coin with two sides. Most consumption patterns have positive values because of the increasing role of the sustainable culture ideology worldwide.

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See Also: Consumerism; Economics of Consumption, International; Economics of Consumption, U.S.; Overconsumption; Underconsumption.

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Copper

Copper, from the Latin word *cyprium*, is an orange-red ore that has been used by people for nearly 10,000 years. A penny may contain may be recycled ore as old as the first Egyptian pharaoh. Copper is an essential trace element necessary for healthy development in most living things, but it is also one of the most toxic heavy metals for living organisms.

Recycling

Copper is one of the most used and recycled metals, appearing in everyday products including cookware, electric wire, pipes, tubes, coins, automobile radiators, home fixtures, jewelry, as a pigment in paint, and as a preservative in paper, wood, and other products. Copper is infinitely recyclable, and there is as much copper recovered from scrap and recycled material as from ore that is newly mined. Recycled copper has a high value, with approximately 95 percent of the value of newly mined ore. This is beneficial, because mineral deposits like copper form so slowly that they are considered nonrenewable. Since global copper use is expected to continue to rise, the copper industry is dependent on the economic recycling of this heavy metal. In fact, copper's recycling rate is higher than any other engineering metal, according to the Copper Development Association.

Theft

The extensive utility of copper in electronics and machinery at times combines with its value on the global market to cause problems of theft and vandalism in the industrialized world. For example, as the value of copper rose between 2006 and 2008, communities across the United States experienced elevated rates of theft of copper pipes and downspouts from houses, abandoned buildings, and construction sites as well as copper wiring from traffic signals, industrial machinery, and agricultural machinery. While theft reports declined after a market collapse in autumn 2008, law enforcement officials in urban and rural communities alike have attempted to impose controls to keep dealers from purchasing stolen copper.

Production

The United States is second only to Chile as the largest producer of copper in the world. Copper towns began to appear in the United States around the same time in history as coal towns in the early 1900s as a result of mining advances that made possible the recovery of low-grade ore. The copper mining industry, like most mining industries, has a long history of worker inequality and community environmental injustice. There was little government oversight until the passage of the Clean Air Act in the 1970s. Even after the passage of this legislation, the mining industry received preferential treatment by most state governments because of the economic power they wielded. Since the 1970s, the combination of increased government regulation, industry improvements, and greater public awareness of environmental and health hazards has resulted in improved waste disposal and air quality processes.

Disposal

Disposal of copper waste varies with the form of the ore and the processes employed. There has been some debate about the most effective ways of disposing of the ore with the least amount of damage to humans, animals, and the physical environment. Chromated copper arsenate (CCA) has become a common wood preservative, which research has shown to leach over time when exposed to water. As increasing amounts of CCA-treated wood

require disposal, this leaching process, which can be harmful to human health, soil, underground water sources, and other aspects of nature, is of specific concern for landfill operators and environmentalists. The Environmental Protection Agency deems copper slags and copper flotation waste as hazardous waste. About 24.6 million tons of copper flotation waste are created annually from world copper production.

There are also opposing viewpoints on the best method to reduce leaching from copper slags and flotation waste, with some scientists recommending the use of palm kernel fiber, while others advance a process called "vitrification." In addition to copper slags and flotation waste, copper ore mining can generate waste rock piles, which are disposed of in mine dumps. These waste rock piles can create acid draining, depending on their interaction with sulfide, sulfur, oxygen, and moisture. Despite the hazards this ore can create if improperly disposed of, it is a needed element that has a long and varied history of use by humanity. The need for ore and the high level of recycling in the industry make it a green product that has a long life.

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See Also: Construction and Demolition Waste; Pollution, Water; Water Consumption.

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Cosmetics

Cosmetics reveal tensions in human society between the quest for aesthetic beauty and health and environmental risks that arise from their uses. The cosmetics industry has evolved into a practical knowledge and science for health and beautification. Cosmetics are a somewhat socially sensitive aspect of human civilization, and their use is influenced by a host of complex factors: economical, technological, cultural, ethnical, ideological, and biological. There are several categories of cosmetics: solids, semisolids, powders, and liquids. Functional classification of cosmetics includes antiperspirants and deodorants; bath and shower products; dental and mouthwash preparations; depilatories, masks, scrubs, bleaching kits, and other skin preparations or corrections; and face powders and creams, lipstick, rouge, blusher, and eye cosmetics. Soap is not considered a cosmetic product according to official standards.

Consumption

People have used natural pigments for beautification since the beginning of human civilization. The earliest and most impressive instances of using plant pigments as cosmetics come from Paleolithic cave paintings and decorated prehistoric ceramics. The ornaments depicted on the pottery can be seen also on the bodies of miniature ceramic figurines and on the walls of houses; for instance, in the Copper Age cultures of the Balkans. These early examples are evidence that people also applied decoration as beautification or with ideological meanings on their bodies. Ethnographic instances of tattoos indirectly confirm that human ideals

of beauty include body decoration. The Sitagroi, a female head of a figurine with linear painted ornamentation, is a possible replication of 5th-millennium-B.C.E. fashions of face decoration, and it is among the most beautiful examples of how people looked in the ancient past. Learning more is a question of increasing access to archaeological records and learning about early uses of natural fragrances or more natural means of caring for hair, for example. Generally, the development of different styles of prehistoric female figurines during the Neolithic and the Copper Ages (later 7th–early 4th millennium B.C.E.) reflects an evolution in women's beauty ideals, and these, in turn, indicate not only the existence of, but also the development of cosmetics and fashion styles.

Cosmetics became a hallmark of state civilizations during the origin of state societies in the later 4th millennium B.C.E. Egypt, Mesopotamia, Crete, and Mycenae offer exclusive instances of ancient makeup and fashion related to wealthy and ruling segments of society. Cosmetic jars excavated in the tomb of Tutankhamun (1341–1323 B.C.E.) contained skin cream composed of approximately nine parts of animal fat to one part of perfumed resin.

Cosmetics in the Middle Ages and Renaissance were used for beautification, but poisonous components, such as mercury and white lead (and likely unknown ingredients), often damaged the face. There was no toothpaste, although some herbs were recommended for maintaining white and pearly teeth. Because bathing was not considered of importance, perfume became increasingly necessary. Queen Elizabeth I introduced "sweet coffers" containing paint, power, and patches. Cosmetics were socially sensitive through the ages, promoted by some or blamed as a sign of lower social status or amorality by others. In the 21st century, the worldwide cosmetics market totals more than $140 billion (32 percent for skin care, 27 percent for hair care, 12 percent for toiletries, 17 percent for makeup, and 12 percent for fragrances).

There are three lines of development in this industry that influence the consumer pattern: the megamultinational businesses of global chains (such as L'Oréal, Elizabeth Arden, Revlon, and Cover Girl), growing new international companies, and relatively small national or international businesses. The Internet stimulates this sector's growth by offering an ever-increasing variety of standard cosmetics and green or all-natural cosmetics. Cosmetics are also a large part of home-based businesses of distributors that sell essential oils, such as Avon, Mary Kay, Yves Rocher, and Oriflame.

Cosmetics in the 21st century are permanent and temporary. Organic cosmetics have become popular, although chemical components still dominate the worldwide distribution of cosmetics, even from the most popular companies. The quality of cosmetics depends on brand recognition, price, availability, and popularity. Cosmetic products are socially distinct and reflect social differences. A specific field of cosmetics use is in the artistic world. In some countries, body painting and tattooing have developed from a fashion to a tradition and a specific subculture.

Health and Cosmetics

Cosmetics are anchored to ideas of people's physical and mental health. Thanks to cosmetics, cleanliness has become a hallmark of contemporary human civilization. Traditional medicine saves people's life, and some essential oils have claimed to dissolve certain types of cancer in the human body. Cosmetic surgeries reshape human faces, increase self-esteem, and even affect personalities. Cosmetics that have a therapeutic component, typical of pharmaceutical products, are named "cosmeceuticals"; for example, antiaging creams and moisturizers.

A specific category includes products with ingredients from the Dead Sea. Many skin care products have been produced with Dead Sea minerals because of their rejuvenating effect. During the early 20th century, skin bleachers, lead makeup, and burning hair straighteners were widely sold to and within the African American community. Beauty became a substantial industry, with Madam C. J. Walker of Indianapolis an important pioneer in developing products and salons between 1910 and her death in 1919. In the century since Walker built her empire, beauty standards within African American communities have, alternately, valued light or dark skin and straightened or "natural" hair, depending on sociocultural conditions.

Allergic reactions to cosmetic skin products are common and may cause serious health problems.

Bacterial and fungal infections and skin viruses, such as warts, are the most common nail infections as a result of use of acrylic nails. Some cosmetics may be toxic to children if swallowed.

Cosmetics Refill, Recycling, and Waste

Refillable cosmetic containers reduce the amount of energy for their production and shipment, while the refillable containers from recyclable goods, such as aluminum and postconsumer plastics, reduce waste. M.A.C. and other companies promote recycling programs and offer free cosmetics for a certain number of returned empty containers. Aveda, Stila, and the Body Shop make empty compacts that can be customized and reused with different eye shadow shades, blush, or powder.

Cosmetics usually do not list an expiration date, although opened makeup can be harmful if it develops bacteria. Cleaning makeup accessories and knowing the expiration date for different types of makeup are excellent ways to ensure the healthy use of cosmetics. The cosmetics recycling movement was not well defined or available worldwide by 2010. In 2009, the Origins company initiated a recycling program and began to collect all brands of packaging (such as empty bottles, jars, and tubes).

A number of the ingredients in cosmetics are considered hazardous waste. According to the Environmental Protection Agency, trash with cosmetics waste could cause contamination and become harmful to people and the environment.

The best way to reduce the negative consequences of waste is to try to reduce use both during the production process and as consumer products. Oriflame has introduced site treatment at two facilities to decrease their total effluent waste. Yves Rocher has installed linerless versions of Domino's M-Series print and apply labeler that "virtually eliminates" the wastage generated from their label printing.

Not completely used and unfit cosmetics are considered hazardous waste. These are cosmetics that are improperly sealed; damaged, expired, and improperly stored; improperly labeled; counterfeit, substandard, and adulterated; and prohibited or unauthorized. Solids, semisolids, and powders require landfill, incineration, or waste immobilization; liquids require sewer, high-temperature incineration, or treated waste; antineoplastics require treated waste and landfill, high-temperature incineration, or return to manufacturer; aerosols require landfill without waste inertization; PVC plastics and glass containers require landfill and recycling; paper and cardboard require recycling, incineration, or landfill.

Cosmetics and Social Sensibility

Cosmetics have economical, biological, and age implications. Economically, cosmetics are part of pop culture, offering a relatively inexpensive means of integrating people of different ages with fashion and traditions, on the one hand. On the other hand, cosmetics can become a symbol of wealth, prosperity, and elitism through the monied symbolization of specific brands that offer products with extremely rare ingredients and high prices. Remarkably, the men's and children's cosmetics markets have been increasing as consumer needs increase. As such, the use of cosmetics is not necessarily anchored to women alone.

Cosmetics and Culture Diversity

Cosmetics connect and divide people. In the process of globalization, leading cosmetics companies stimulated a process of the unification of cosmetics subculture. At the same time, new (especially green) culture-oriented companies have been trying to make a change in society by promoting more innovative and planet-saving cosmetic products. There are also ethnical and religious peculiarities, since cosmetics include elements of social identity that directly interact with diverse cultures.

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See Also: Children; Consumption Patterns; Social Sensibility.

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Crime and Garbage

Crime and garbage refers to the myriad associations of crime and garbage, including crime-related materials, ownership, organized crime, not following procedures, illegal dumping, recycling scams, and environmental crimes. There is also the issue of crime and deviance. While crime is the violation of a written statute, deviance is a violation of social norms. In such cases of violation, there is no official penalty; rather, condemnation from a group or individuals may be the result. There is differing social opinion as to the deviance of acts related to garbage. In some communities, the response to negligent disposal of garbage is severe; while in others, the practice may be the norm and thus be more accepted. There is also a large degree of variance based on individuals. Their education about the environment, personality, and range of social associations can be factors in determining whether they view acts related to garbage as deviant.

In popular culture, one of the most common contexts of crime and garbage is the incident in which a material related to a crime—such as a weapon, some form of evidence, or even a body—is found in a trash bin, garbage bag, or dumpster. U.S. crime serial shows and newspaper headlines like "Baby Found in Trash" point to the macabre interest that people often have in crime and garbage.

Garbage, because it represents the way in which most people dispose of their personal possessions, is subject to the question of control: who owns garbage? Freegans (people who seek free food) and dumpster divers are known for their interest in obtaining disposed food items and making their meals from them. Some are concerned that this practice could lead to lawsuits if a freegan gets sick from such a meal. Others are concerned with the disruptions and potential invasions of private property caused by such dumpster diving.

Collecting Information

Trash trawling, *dumpster diving*, and *waste archaeology* are all terms given to the practice of culling garbage for potentially valuable information. This information can be of interest to private detectives, law enforcement officials, and identity thieves. Businesses that wish to understand trade secrets or interpret corporate planning documents may engage in forms of dumpster diving. Individuals are even more commonly targeted for such crimes. Information gleaned from garbage—including personal identification numbers and other personal information—is used to commit various forms of identity theft. This form of crime stems from the convenience of people throwing their garbage out without regard for what is thrown out. In response, in the United States and other nations, there has been a growth in personal shredders as well as businesses that pick up documents and shred them on the spot. There is also the issue of privacy and due process of the law related to garbage.

In 1988, in overturning a California court's decision in *California v. Greenwood*, the U.S. Supreme Court ruled that the Fourth Amendment's protection against unwarranted search and seizure does not extend to trash. Criminal defense attorneys have attempted to argue that police searches of garbage should occur only after obtaining warrants. Some U.S. cities have passed legislation making it illegal to go through garbage. The laws are focused on reducing identity theft resulting from trash pilfering. Canadian officials, responding to cases of their own (including the case against a man who was discovered to have marijuana paraphernalia in his trash), have expressed that laws related to garbage are especially not well defined. In 1995, a British Columbia justice wrote that, "putting material in the garbage signifies that the material is no longer something of value or importance to the person disposing of it . . . when trash is abandoned, there is no longer a reasonable expectation of pri-

vacy in respect to it." This ruling is similar to the U.S. Supreme Court's decision in 1988 that defined garbage as *bona vacantia*, or "ownerless goods." The reasoning behind this view of garbage as no longer belonging to the individual who disposed of it relates to interpretations that the individual exercised free will in disposing of the garbage. Some advocates complain that such laws result in violations of the individual's privacy, regardless of what is contained in the garbage.

Cities have also weighed in on who has access to garbage. In 2008, 28 Redding, California, waste management workers were disciplined for crimes considered theft, including the pilfering of old tools, metal, and other items that had been thrown away. The probe that netted these workers began in response to the mismanagement of waste by the city's former solid waste manager. In response to the scandal, a Redding city official expressed, "When people put their trash out they expect it to be buried." Scavenging has long been a problem at the city's transfer station and, while some believe that people should be able to scavenge through the garbage, city officials state that this is a crime since it robs residents of potential funds generated by recycling the garbage.

Organized Crime

Because of garbage's ubiquity, the control of garbage disposal can be profitable. Throughout the world, the Mafia and organized crime have played a major role in hauling garbage. In some cases, Mafia involvement is in the legal trade of hauling trash. Organized crime groups take control of the waste disposal businesses in a city, set the prices, fix bids, and control the organization of trash hauling such that people have no choice in the matter. In New York City, the garbage industry was controlled by La Cosa Nostra until the city took control of it in the 1990s. In Taiwan, there have been cases of organized crime groups collecting gravel, selling the material to companies, and then filling the holes with waste. In the United Kingdom, there is also a prevalence of organized crime involvement in illegal waste practices. In many societies, businesses handling waste are socially marginalized. In the postbellum United States, waste hauling was left to eastern and southern European immigrants because the work was seen as dirty. The resulting businesses were suspected of unscrupulous behavior in part because of criminal activity and partly because of xenophobic fears.

Illegal Disposal

In 2007, New Orleans imposed a new law that requires that all city trash be disposed of in specific legitimate trash bins that allow for easier collection by robotic-arm trucks. In the aftermath of Hurricane Katrina, the city was beset with massive amounts of dumping, and the new law was aimed at curbing such offenses. Penalties range from a $5,000 fine to six months in jail for each offense. Also, for individuals who refuse to obtain a city-approved bin, the city plans to stop collecting trash at that residence. The law also specifies rules about how garbage may be disposed of in carts, making it illegal for residents to fill carts excessively such that the lids will not close. Residents in cities throughout the United States and the United Kingdom express discontent that overly bureaucratic disposal rules will result in criminal justice agencies targeting individuals when, in fact, such agencies should target more wide-scale forms of garbage crime, such as illegal dumping.

In the United Kingdom, the Environment Agency has cracked down on a range of forms of illegal dumping. Such illegal dumping is referred to as "fly-tipping." Between 2005 and 2006, some 2.5 million cases of illegal dumping were recorded in the United Kingdom, and it is estimated that 63 percent of all fly-tipping is in the form of black bags or garbage bags that are thrown out by consumers, often in alleyways. There are also organized gangs who profit from the fly-tipping business. Offenders are prosecuted at a rate of one out of 100. Fly-tipping may be tied to a technique of neutralization known as "denial of a victim." The assumption that there is not a victim, however, is contradicted by the fact that private property owners have to deal with the cleanup of such garbage and the fact that the environment is a victim. In 2008, the UK's Environment Agency created a National Environmental Crime Team composed of former detectives, intelligence officers, and forensics individuals. According to the agency, the team is charged with investigating organized waste crime. Examples of successful

investigations include a metal recovery company that was attempting to export hazardous waste cable to China, a serial fly-tipper who was collecting household and business garbage for a fee and then disposing of it around the city of Bristol, a car company caught dumping numerous types of garbage at a fly-tipping spot in the city of Bristol, and an individual found accepting illegal dumping on his property. The agency's work has not been without its detractors. In 2007, a Boston, Lincolnshire, man was fined for what the city called "illegal fly-tipping." The city had tracked a bag that the man placed in a public bin.

In the United States, though less organized than in the UK, there have been numerous attempts to crack down on illegal dumping. In Midland, Texas, officials have attempted to educate the public about the crime of illegal dumping. Many Texans are familiar with dumping trash on other people's properties and dumping used oil or old car batteries. For some, this is culturally accepted. City officials have responded by illustrating the effects of the damage that such crimes pose to the environment and emphasizing penalties that include fines up to $50,000 and five years in prison for each day of the offense. In explaining the severity of the punishments, officials explained that one quart of motor oil can contaminate 250,000 gallons of water, that illegal litter creates germs and contains sharp objects that can harm people, and that disposed car batteries can leach lead into the environment. A major form of illegal dumping is known as "cocktailing." This involves the mixing of hazardous waste with nonhazardous waste, with the hopes of the material passing as nonhazardous waste.

A man rummages through a dumpster at the back of an office building in Central London. Personal information such as bank account numbers and other identification extracted from garbage is often used to commit various forms of identity theft.

In 2010, 31 individuals were charged with recycling fraud in the state of California. The alleged perpetrators trucked millions of cans and bottles into the state, taking advantage of state redemption money. In some cases, cans were filled with sand so that they would weigh more. In the United Kingdom, similar crimes of recycling have taken place. Police and officials from the Environment Agency have discovered the illegal exporting of computers and other e-waste. The materials are often shipped to China, countries in Africa, and India where small children are exposed to hazardous materials in the process of recovering precious metals like gold, copper, and steel. Law requires that such materials be recycled only in the United Kingdom. Recycling illustrates one example of the attempt to harness the productive potential of garbage (in terms of the money generated) for legal means.

Pay as You Go

In the United Kingdom, one response to fly-tipping has been to pilot a new pay-as-you-go system in which individuals' garbage bins are fitted with computer chips. The bins are then weighed, with the amount of each household's garbage tracked. Households with less excess waste could receive reward vouchers. Some residents, however, are concerned that this attempt to better deal with refuse could result in crime also. Some worry that computer systems could be hacked to determine if resi-

dents are not home and then burglaries could be committed. Others express that the system may result in an invasion of privacy, and some worry that households that might be eventually charged for excessive amounts of waste could resort to illegal dumping or fly-tipping in order to avoid taxes. Policies and plans like these, while originating in the efforts to address crimes like illegal dumping, may also affect the growing environmental concerns that result from waste and overconsumption. The overall issue of garbage's impact on the environment is the subject of green and environmental criminology. These specializations of criminology include a number of arenas in which environmental harm has resulted from human action. Air pollution, deforestation, water pollution, despeciation, and the dumping of various forms of hazardous waste are some of the emergent concerns. These many environmental issues may be connected to the issue of risk society, identified by Ulrich Beck.

Environmental law aims at risk reduction, deals with social issues that are inevitable and pervasive, and is aspirational—meaning that it attempts to radically improve environmental quality. While some environmental laws may not directly apply to garbage, most do. The many harms caused by illegal dumping and other forms of waste disposal include immediate and future injuries, emotional distress, disruption of economic and social activities, remediation costs, property damage, and ecological damage.

Two emerging issues with crime and garbage include sentencing and mens rea. In the first area, there are concerns that sentences handed down against environmental criminals are especially light. In the second, criminologists have questioned whether a "guilty mind" is present in cases in which the scope of garbage crimes may not be known beforehand. Since the 1970s, there have been a number of international efforts to ban the dumping of hazardous materials sea, into the air, and less-developed nations. The last of these identifies a growing concern with environmental racism, which may include the dumping of hazardous garbage onto the lands of peoples considered less important than those doing the dumping. Crimes have also occurred in response to the many environmental groups that have attempted to draw attention to these issues. In 1985, the Greenpeace ship *Rainbow Warrior* was sunk by explosives of French commandoes. The associations of crime and garbage will, no doubt, continue to capture the imagination of criminologists, politicians, environmentalists and laypeople alike.

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See Also: Dumpster Diving; Environmental Justice; Fly-Tipping; Freeganism.

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Culture, Values, and Garbage

All societies are connected to garbage. Early human societies, while much smaller in population and less impactful in terms of resource use and waste, produced garbage. Mobile groups of early humans produced single-use midden sites, but as human inhabitation became more sedentary in nature, the physical relationship of humans and waste changed.

Population increase, the development of complex systems of production, social differentiation, and changing lifestyle patterns all contributed to differing amounts, distribution, and human relationships to garbage. All humans have relationships with garbage, therefore it is important to focus on how values impact these relationships. Values refer to abstract cultural understandings of what is considered right and desirable in society. All cultures maintain values, yet cultures express values in different ways and, thus, cultures display different relationships to garbage.

Trash Talk Project

In 2009, the Massachusetts Institute of Technology Trash Talk project was developed in order to better understand the lifecycle of garbage. The project uses small location tags that frequently update the position of a given item of trash and sends this information to researchers. Through this system, researchers have tracked over 3,000 pieces of individual garbage in New York, Seattle, and London. In many Western societies, including the United States, a value association of "out of sight, out of mind" governs many people's relationships to trash.

The goals of Trash Talk include the reworking of refuse infrastructures and behavioral change in consumers. What is most prescient about the project is how it illustrates the complex ways in which culture, values, and garbage are intertwined. While a person viewing the project data might become more aware of the problems with the attitude that once an item leaves one's possession it is no longer of consequence, actually motivating that person—and millions of others—to act on the data and to change practices is a much more complex matter.

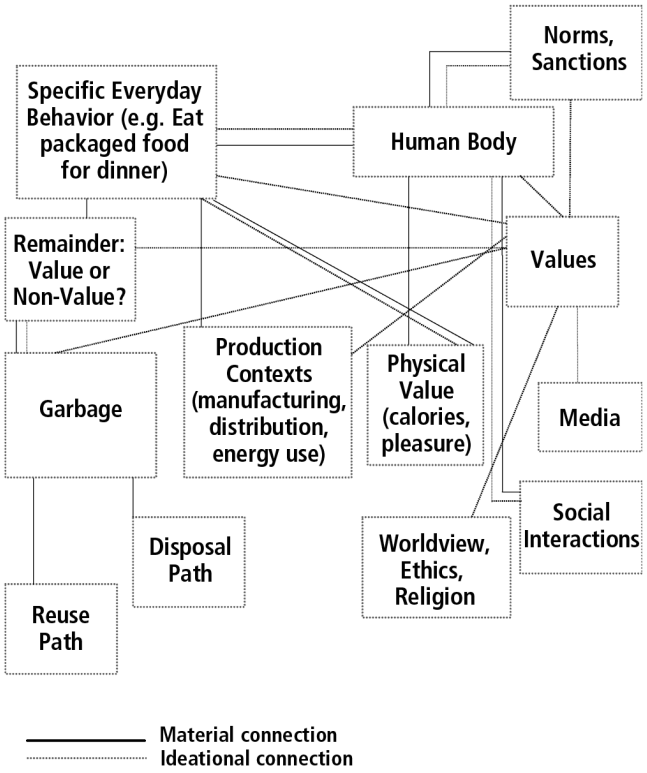
Human Connections to Garbage

The Trash Talk project emphasizes the complex, yet overlooked, relationships that garbage and people share. In terms of their relationship to garbage, all people interact with it on two levels. One is a material connection, indicative of the physical and sensory contacts that people have with garbage. In some households, this connection begins with an individual removing an item from packaging, disposing of that item in the kitchen receptacle, placing that item and others into a larger bin, taking that bin to the curbside, and then the material connection ends. Others, including workers in sanitation plants and recycling centers, then continue a material connection with the garbage, but the material connection of the consumer and the garbage ends with the bin on the curbside.

The second connection that people maintain with garbage is an ideational one. Unlike the material one, which is manifested in things that can be touched, moved, and sensed, the ideational connection operates on the level of cognition. The differentiation of an item of value from an item of trash, for example, has nothing to do with the material principles of the object. Instead, humans determine whether the object is of value or whether it is considered trash. The decision of whether an individual decides to dispose of a broken radio or to consider it an heirloom to be kept is highly subjective and rooted in the value systems of a culture.

Values and Behaviors

As the thought picture indicates, any everyday human behavior is connected to a myriad of material and ideational contexts. These contexts impact the specific ways in which individuals think about garbage. For example, a person needs to eat. This individual might choose to consume a packaged product for dinner, an item with production contexts that impact the environment and produce waste but also supplies the body with value in terms of calories and pleasure. The media, worldview, specific values, and their associated norms and sanctions all impact the behavior in question. After the item is eaten, the individual has to decide what to do with the remainder, such as the leftover package. The package might be reused, repurposed, or recycled but, most likely, will be disposed



As this thought picture indicates, any everyday human behavior is connected to many material and ideational contexts. Note: while the diagram indicates meaningful connections, it does not posit the amplitude or direction of the effect of one thing on another.

of in the trash. Values are particularly significant in this chain of connections. Values help determine whether an individual will choose a certain product in the first place, how it will be used, and how any remainder will be reused or disposed of. The functional relationship of these material and ideational connections is especially relevant. If, for example, the media emphasizes the happiness that can accompany the purchase of high-environmental-cost products and if a particular religion shared by the consumer does not emphasize the value of natural theology, it becomes more likely that because of the preponderance of like values, the consumer will maintain current relationships with garbage.

Investigators, such as those in the documentary *No Impact Man*, have discovered that it is difficult, if not impossible, to simply alter material lifestyle patterns. One could decide to pursue a path of less material waste, but this decision is not left to the individual alone. Society, through its value structure, in large part determines how individuals interact with the material environment. In the case of garbage, values are impactful in three ways.

First, values condition people to think about the material world in specific ways. For a member of a Native American culture, the relationship to the material world might be conceived of in terms of mutual respect and stewardship, while for a North American consumer, the same relationship might be thought of through the economics of production. Such values impact how individuals go about a particular behavior and how people will react to certain behaviors that might result in greater waste than others. Second, values impact people's perceptions of "remainder." In cultures in which people do not think about how garbage will impact the environment, disposing of an item appears to be of no cost. In cultures in which people perceive a close connection between themselves and the natural world, reuse of an item might be done in lieu of disposal. Finally, values—even when seemingly ingrained in cultures—may impact people in indirect, as opposed to direct, ways. Sociologists speak of ideal culture as including those values that people purport to uphold, as compared with real culture, which refers to the values that people actually express. In the case of garbage, some people purport to be environmentally aware, yet they dispose of items that have large environmental impacts. William Rathje and Cullen Murphy indicate that a common facet of people's connections to their garbage is the disconnect that exists between the mental (people's perceptions about waste) and the material (what they actually waste). In this sense, people could, conceivably, consider themselves to be environmentally friendly, yet dispose of items, such as newspapers, that could be detrimental.

Sociologists have also pointed to the presence of value contradictions—situations in which competing values coexist in a society. For example, people might believe in both the ideas that abundance is good and frugality is good. A person might be inclined to save old items and, at the same time, purchase new ones. Perhaps this individual ends up having less of an impact at the end of throwing out garbage, but the impact at the production end of the products being purchased is significant. In

some cases, apparent contradictions between values may be the result of structural requirements of the culture. In the United States, when CDs were sold in stores, a common practice was to sell them in large plastic cases. The cases were needed because storekeepers desired to address loss prevention—a larger CD case means that the item will be more difficult for shoplifters to steal. While this packaging was wasteful, it did prevent the material losses that storekeepers experience from shoplifters. In cases such as these, nations or local communities may have to decide how to balance the costs and benefits of various forms of consumption and associated waste and environmental costs.

Social Norms

As compared to values, norms, while dependent on a culture's value structure, are more specific codes that dictate social behavior. Some norms, including mores, are addressed more stringently by a society, while others, including folkways, are met with few, if any, sanctions for violation. The specific ways in which norms are played out in society determine how strongly people will be impacted by values. Sociologist Robin Williams indicated that norms represent those things that people should follow in society, but they often do not due to distribution (social knowledge about the norms), enforcement (how norms are punished or not), transmission (how people learn norms), and conformity (the extent to which deviance occurs in society or not). A reaction, such as a scowl following a person's disposing of garbage alongside a highway, may have little impact on the violator, depending on distribution, enforcement, transmission, and conformity present in the culture.

Norms reflect the specific ways in which values are acted upon in a local context. In terms of garbage, norms will vary highly if a person is living in a large metropolitan area that tolerates forms of excessive consumption—such as driving cars, permitting open dumping, or not recycling—as compared to a person living in a small town that has established consumption codes of conduct for both businesses and individuals. Were one to move between these fictional communities, one would discover that throwing out a plastic cup could be a folkway in the one place and a more in the other.

Table 1 American Values and Garbage

Value	Garbage Impact
Achievement and Success	If success is defined in terms of material items, it could result in use and disposal of more material products.
Efficiency and Practicality	Desire for up-to-date technology could create more waste in production and disposal.
Material Comfort	The desire for material comfort may involve wasteful forms of living.
Freedom	The belief in absolute freedom may result in individuals not following governmental recommendations on the environment and waste.
External Conformity	Individuals may imitate others, including celebrities, who display wasteful behaviors.
Individual Personality	By focusing only on the self, an individual might be inclined to think less about the impacts of consumption.
Live for Today	People's behavior patterns with respect to material culture will result in more waste and less conservation.
Obsolescence	Instead of fixing a broken item or living with an old but still useful one, people are inclined to buy new replacement items.

As well, one would begin to see specific associations between norms and, in terms of the connections discussed in the thought picture on the previous page, it would be possible to see that certain norms correlate with others, such as "One should be kind to passersby" and "One shouldn't litter."

When cultures express norms, they are reflecting on the specific values that are cherished in their cultures. As the world pushes toward more integrated and global forms of connection, it becomes clear that certain value systems are at odds with others. This is particularly clear when the relationships of culture, values, and garbage are addressed in a cross-cultural manner.

A number of the values presented in Table 1 are based on Robin Williams's study of U.S. values. Williams identified a series of core U.S. values, many of which can be tied to consumption patterns and resultant environmental impacts and garbage effects. In a global context, a number of these values are taking root in cultures that have adopted new values or are in the process of shedding old

Table 2 Non-Western Values and Garbage

Value	Garbage Impact
Community Spirit	Because people feel connected to a community, they may be less likely to produce excessive garbage, especially of the form that could impinge on other's rights or well-being.
Bricolage	People may feel inclined to make do with what is available, to act as jacks of all trades, and to remake rather than buy anew.
Environmentalism	People may live in a manner that expresses deeper respect for the environment and thus may deliberately alter wasteful practices.
Sustainability	People focus on the idea that they should preserve the environment for future generations.
Responsibility	As opposed to feeling free to do anything possible, people live with the idea of sharing responsibility with others.
Nonmaterialism	While people in the Western world sometimes view money as the end of all things, other people focus on things beyond material ones that could bring happiness and value to living.

ones. Table 2 illustrates some of the indigenous values that are being replaced by U.S. values.

Bricolage

Values are abstractions and approximations of cultures, and therefore it is possible to find non-Western values in the West and vice versa. The comparison of Western and non-Western values shows that there are radical differences in terms of how people relate to their garbage. The *zabbaleen* of Cairo, Egypt, practice a form of recycling that has roots in the ways in which they relate to garbage and consumption.

Instead of seeing items that in the Western world would be detritus, the zabbaleen look at the item as a resource—as something that can be reshaped in a new, useful form. They express what anthropologist Claude Levi-Strauss notes: the *bricoleur* works not from the principle of making things only if natural resources are available but makes things according to those things at hand, making do with what is available. The spirit of bricolage is not simply a utilitarian one. While the practice is expressed in cultures including those in Papua New Guinea, Mexico, Morocco, Senegal, Trinidad, and Kenya and can be considered practical, it is much more than that. It is an expression that, like the natural cycles of the Earth, attempts to make something new from something old.

As a practice and value, bricolage is dependent on the other values that correlate with it. In a society that remakes, people are less inclined to think of consumption as a process of buying an item from a store, disposing of its packaging, eventually throwing the item out, and buying a new one. Instead, people are likely to look at the entirety of how they are living.

One example of this approach to living on a larger scale is present in the small nation of Bhutan. In the 1970s, King Jigme Singye Wangchuck established a system known as gross national happiness (GNH). The Buddhist-based GNH focuses on four pillars: sustainable development, preservation of cultural values, environmentalism, and governance. Bhutan has an economy that establishes both material and ideational connections between people, resources, and garbage, but what is unique with GNH is how it revalues and reevaluates these connections.

While tourism and logging could be immensely profitable, the nation has agreed to limit the former and outlaw the latter because sustainability is a value considered to be of higher worth than materialism. Cultures like those of Bhutan express a model that, while favorable in terms of its lessened impact on the planet, is perhaps not practical for cultures based on large-scale systems of production and consumption.

Garbage Informs Culture

Martin O'Brien indicates that garbage is not the ephemera of society—rather, it is at the heart of a given society's productive activity. How a culture decides to act on its material objects—such as in whether to reuse or dispose of an item—speaks to the nature of the culture. All cultures are integrated, and thus the ways in which a culture deals with its garbage is connected to issues independent of garbage. Susan Strasser expresses that the difference between how the developed world and the under-

developed world relates to garbage is that the developed world throws out garbage simply due to the fact that people do not want something any longer. It is a choice and a form of power. Thus, quite independent of values, the myriad relationships of cultures and garbage in the world are tied to forms of economic and cultural power. If members of a culture are living in poverty, they have little choice but to remake or reuse discarded items. If other people are living lives of affluence, they will likely not even consider reusing something. As globalization continues and as cultures increasingly connect (or collide) with one another, the issue of the power of value systems will necessarily come to the forefront. The world is a marketplace of products, not of values and, as such, people will not likely find themselves in the position of choosing between the values of gross national happiness and those of global capitalism.

Values and their associated connections with garbage are not immutable. Like any form of culture, the relationships that people share with their trash changes over time. A case in point is the early U.S. colonies. Susan Strasser points out that forms of bricolage were present and prevalent in this historical period. The remaking of animal byproducts into soaps and candles, quilting, reworking clothes, metal recycling, and the fact that early manufacturers encouraged reuse of their products (such as tobacco tins as lunch boxes) paint a picture of U.S. culture and consumption quite different from that in the 21st century.

In 21st-century U.S. society, freecycling, freeganism, and dumpster diving represent a social expression that harkens back to the spirit of remaking in the U.S. colonies. What is curious about the ideology of freeganism is that many of its practitioners, while clearly enjoying the utilitarian benefits of the practice, express that what they are doing is revaluing garbage. They are establishing a practice that is both useful and, in terms of values, something different than the mainstream. In studying examples like those of freeganism and dumpster diving, researchers have discovered that by reducing garbage and by changing lifestyles, new values could be expressed. Consuming and throwing away is socially significant, and perhaps what is most significant is the realization that not only could garbage be meaningfully reduced in such reenvisioning but also that new social forms could take hold in the aftermath.

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See Also: *Garbage Dreams*; Garbage in Modern Thought; Sociology of Waste.

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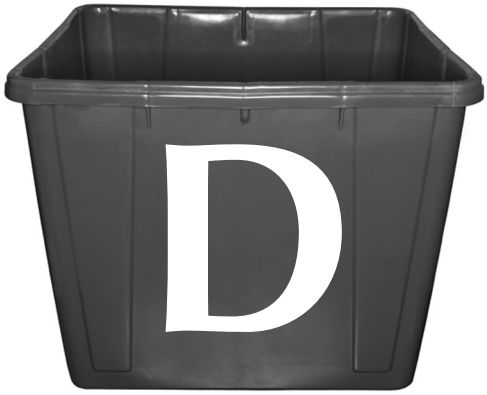

Dairy Products

A popular advertising campaign in U.S. print media asks people if they "got milk?" The ads depict popular celebrities with an exaggerated white "moustache" that one may have above their upper lip after a big gulp of milk. Regardless of the grammatical faux pas, this campaign poses a very interesting question about human food consumption. To some adults, the answer to this question is "yes." Roughly one-quarter of the nearly 7 billion people across the globe regularly consume milk and other dairy products, which refers to any food produced from mammalian milk. While typically coming from cattle, dairy products can also be produced from the milk of several other animals, including goats, water buffalo, sheep, camels, donkeys, reindeer, yaks, and horses. Raw milk from these animals can be processed into a variety of high-energy-yielding food products. The human species, which drinks and eat dairy into adulthood, is an exception to the rule, as other mammals do not consume milk beyond infancy. A look at dairy products not only provides insight into human food consumption patterns but also illuminates the reasons why some humans can digest dairy as adults while others cannot.

Nutrition

Mammals have highly specialized sweat glands, called mammary glands, which produce milk. Evolutionary researchers suggest that the production of this opaque white liquid evolved as a means to keep eggs moist and point to the egg-laying monotremes as evidence for this claim. Milk provides a highly effective means of delivering nutrients to mammalian infants, who cannot yet digest many types of foods that older members of the species consume. Milk also supplies infants with antibodies that boost the immune system. The composition and components of mammalian milk vary from one species to another, but all contain large amounts of protein, calcium, saturated fat, and vitamin C.

Digestion and Lactase

In order to consume dairy products, mammals must produce lactase. This enzyme breaks down the milk sugar lactose and enables digestion. Lactase is essential for infants of all mammalian species, as they receive key nutrients from their mother's milk. In humans, breast milk contains the proper balance of water, protein, fat, and sugar necessary for growth and development. Additionally, a 2007 U.S. Agency for Healthcare Research and Quality–compiled report for the World Health Organization showed

that breastfeeding provides the infant greater immune health, lower chance to develop allergies, higher intelligence later in life, less chance to develop diabetes, decreased risk of obesity, and reduced risk of sudden infant death syndrome. While milk consumption is necessary for mammal infant growth and development, adult mammals, with the exception of humans, do not consume milk. Humans are unusual mammals because they not only consume milk as adults but they also consume the milk of other animal species.

Adult Consumption

For much of human history, the ability to digest dairy products was unnecessary beyond the age of weaning. As food foragers, ancient humans consumed vegetation and animal protein and procured food by gathering, hunting, scavenging, fishing, and beachcombing. With the rise of agriculture during the Neolithic revolution, which occurred independently in as many as seven or eight separate regions beginning around 10,000 B.C.E., human food consumption patterns forever changed. Groups that adopted agriculture replaced nomadic, food-foraging methods with sedentary, food-producing methods. Some of these groups also brought animals permanently into their settlements. Beginning in the Middle East and then spreading out both east and west from there, this domestication of animals is what led to adult human dairy consumption.

Initially, it appears that animals were domesticated only as an easily accessible source of meat. Archaeological evidence shows that humans began to use milk for food about 7,000 years ago during what is known as the Secondary Products Revolution. In terms of economy, consuming milk is much more efficient than killing an animal for meat. Like all other mammals, ancient humans were not

Cow's milk is produced on an industrial scale in the United States and is the most widely consumed dairy product. As of 2010, there were 62,500 U.S. dairy farms, predominantly in California, Wisconsin, Idaho, New York, and Pennsylvania. U.S. per-capita milk consumption was 22 gallons a year in 2008, compared to the high of 45 gallons a year in 1945; competition from soft drinks caused the decline. Meanwhile, Between 1970 and 2008, annual per-capita cheese consumption tripled from 11 pounds per person to nearly 33 pounds per person.

biologically equipped to consume milk beyond infancy because the ability to produce the lactase essentially switches off after weaning, resulting in drastically reduced levels of the enzyme and the condition known as lactose intolerance. Humans with this condition cannot metabolize lactose in their stomach, so dairy products remain intact as they pass into the colon. Here, dairy begins to ferment and produces gas, resulting in symptoms such as loose stools, bloating, flatulence, nausea, and stomach cramps. Gastroenterologists estimate that roughly 75 percent of the world's population is lactose intolerant.

Though researchers debate the origins of adult lactase production, some suggest that a single mutation event that occurred in the Middle East during the Secondary Products Revolution is responsible. This trait then radiated outward among both pastoral and agrarian groups. One commonly finds adult lactase in populations from northern and central Europe, the Middle East, northern India, and among several groups indigenous to Africa. Conversely, one is much less likely to find adult lactase among groups native to east Asia, Australia, and the Americas. The key evolutionary factor seems to be whether these ancestral populations used large domesticated animals. Though animal domestication occurred both in the Old World and New World (but not in Australia), one only finds large domesticated animals in the Old World. The one notable exception is the llama, which was domesticated in Peru around 4000 B.C.E. However, this camelid species was geographically restricted by the Andes Mountains and thus was not widespread. Natural selection acted on Old World populations that used large domesticated animals because possessors of the adult lactase trait were able to consume dairy in times of food scarcity. This increased their reproductive fitness and led to greater concentrations of the trait in future generations.

Modern Production

In the 21st century, cow's milk is the most widely consumed dairy product in the United States and is produced on an industrial scale. Before reaching the consumer, milk and other dairy products must first undergo processing in dairy facilities. Raw milk destined to be whole milk is first clarified to remove impurities. Instead of being clarified, skim or partly skimmed milk is separated, which eliminates butterfat and also removes impurities. Next, both whole and skim milk are heated for a short time in order to kill any harmful microorganisms in a process called pasteurization. Pasteurized milk is then stored cold to prevent spoilage. After sitting for a day, whole milk has a natural tendency to separate into a higher-fat cream layer and a skim milk layer. To prevent this separation, dairies use homogenization, which is a process that breaks up fat globules by pumping milk through narrow tubes at high pressure.

Several grades and types of milk can be produced from raw milk. Some milk products, such as cultured buttermilk, or kefir, use fermentation. Other products, like powdered milk or condensed milk, convert milk into a more concentrated form with a much longer shelf life. Dried milk can also be made into infant formula. Another common application for milk is a variety of thick creams that include sour cream, the slightly fermented crème fraîche, and clotted cream. Milk can also be used to produce a wide range of other dairy products, which include butter, ghee, cheese, curds, whey, casein, yogurt, and ice cream. Regardless of the grade, type, or product, dairy products are widely consumed by specific segments of the global population. Those who can eat and drink dairy have natural selection to thank for this ability.

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See Also: Baby Products; Beverages; Farms; Food Consumption; India.

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Dating of Garbage Deposition

Garbage leaves a fossil record, the accumulation and degradation of which can de dated to bring insights into patterns of consumption and waste. The origins and methods behind the dating of garbage have an interesting history. Cultural behaviors relative to the formation of trash deposits can be analyzed with relative and absolute dating methods.

Significance

Why date garbage? The answer lies deep in the history of scientific thought and the study of the past. In late-18th-century Western Europe, scientists were looking for ways to understand the origins of geological deposits, challenging the assumed recent origin of the planet. While their efforts ultimately led to the recognition of the Earth's antiquity, they also cleared the way for an empirical study of the past. As field research intensified in the 19th century, the discovery of ancient stone tools alongside the remains of extinct animals showed the utility of stratified deposits to date ancient artifacts. More importantly, it became apparent that the bulk of past cultural remains is composed of refuse—objects and other remains that have been produced or modified by humans but which have lost their usefulness, becoming garbage.

Methods

The discard of trash and its accumulation are different than geological depositions. Consequently, garbologists (archaeologists who specialize in the study of rubbish and refuse deposits) have developed methods to order, sequence, and date trash deposits, from fresh rubbish to ancient archaeological contexts. Broadly, garbologists rely on two categories of dating strategies.

First, patterns of accumulation and superimposition of buried deposits can serve to create relative sequences of events. These patterns can bring insights into the conditions and the time elapsed throughout periods of trash deposition. The number of distinct strata as a proxy to the number of discard events, coupled with the thickness and compaction of the deposits, can all point toward frequency, intensity, and length of the use of middens (heaps of rubbish that represent the accumulation of daily refuse). Meanwhile, comparisons of changes through time can shed light on historical events and broader social changes. More broadly, stratified middens can be organized into broad periods by looking at the characteristics of broken artifacts and their change over time.

Second, the analysis of the physical and chemical properties of garbage deposits can provide chronometric and absolute dates. Chronometric measurements from stratified deposits give archaeologists the opportunity to place sequences of deposition in an absolute time frame. The most commonly used chronometric techniques for dating ancient garbage are radiocarbon and, more recently, accelerator mass spectometry (AMS). Radiocarbon methods measure the decay of a radioactive isotope (C-14) to evaluate the time elapsed since the death of a living organism. These techniques can be advantageously applied to many types of rubbish, including animal bones, charcoal, plant remains, shells, and paper. Precautions are needed when interpreting radiocarbon results, including archaeological associations to contamination, accuracy, and precision. Nevertheless, coupled with relative sequencing, chronometric dating is a powerful tool to date middens and their formation.

Challenges

The challenges of interpreting the chronology of garbage deposition are manifold. At the most basic level, a distinction has to be made between primary and secondary refuse. Primary discard typically happens at the place where trash is produced, whereas secondary depositions imply a certain delay in discard, such as the storage or transportation of trash away from the original activity area. The context of a hearth located in the vicinity of a habitation area where there is evidence for food processing and consumption provides a viable example. In this case, the discovery and radiocarbon dating of burned organic trash can provide a range of absolute dates for activities associated with that same household. Here, it can be assumed that the dating of a garbage deposition is somehow representative of the time when that trash was produced and discarded. In opposition, in the context of secondary trash deposits such as construction and landfills, gar-

bage may have been accumulated and stored for an unknown amount of time before it was discarded. In this particular instance, absolute chronometric measurements provide a range of dates associated with the production of waste, rather than its discard. Moreover, secondary deposits might possibly contain remains from various places and primary activity areas, leaving the chronological interpretation of mixed trash uncertain.

Study and Cultural Interpretation

Middens are the materialization of complex actions and meanings reflected in heavy garbage deposits. The study of garbage deposition thus requires a consideration of cultural variables, including curative and recycling practices, the impact of trash on immediate human life conditions, cultural habits, symbolic meanings, and the ritual use of waste. Trash represents the sum of discrete events situated at unique space-time intersections, and—although it is subject to similar and uniform postdepositional processes—its formation is as culturally laden as any other human behavior.

Archaeologists and other trash specialists must differentiate and characterize the types of garbage deposition to be dated and their respective implications. Modern garbologists might be interested in assessing garbage deposition on a daily or weekly basis, while prehistorians might focus on seasonal patterns of hunting and fishing. The Garbage Project of the University of Arizona, for example, keeps track of individual trash pickup events with detailed time and day data. In contrast, the study of prehistoric state societies often deals with mixed deposits and multiple discard events. Here, the objective might be to evaluate amounts of trash produced and discarded over specific periods of time as proxies for past demographics and patterns of consumption through time.

Processes of decomposition and preservation are also key to date garbages, as the rates of material decay vary whether refuse is deposited in open air dumps, housepits, or landfills. Modern garbologists monitor the production of biogas such as methane to evaluate the rate of biodegradation in different landfill contexts. In contrast, research at ancient cave sites might focus on stone tool debitage and fossilized bones.

The dating of garbage deposition must be considered from a situational perspective in relation to specific preservation conditions, types, and life cycles of refuse, as well as corresponding research questions. The complexity of garbage deposition points toward the importance of developing adequate schemes to date, sequence, and understand discard events.

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See Also: Archaeological Techniques, Modern Day; Archaeology of Garbage; Archaeology of Modern Landfills; Garbology.

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Definition of Waste

The term *waste*, as a noun used colloquially, means some form of devastation such as wasteland; on a smaller scale, it is synonymous with rubbish, garbage, and trash. Waste also has specific meanings, defined for a particular purpose. In economics, waste implies the unproductive use of resources. For example: labor used to move work-in-progress around a factory is defined as waste because the cost incurred in doing so adds no value to the finished product. To protect the environment, governments in many developed countries define waste to include, in effect, every conceivable substance in any conceivable form. Comprehensive definitions enable regulators such as the Environmental Protection Agency to control as tightly as possible the disposal of anything that might potentially injure the environment. Such definitions, however, may not be conducive to achieving optimum results.

Implications for Industry

Historically, substances discarded as waste have been dumped, typically in dedicated landfills, waterways,

or the ocean, even though those substances might have been useful. When regulators progressively restrict land available for (legal) dumping and prohibit discharge to waterways or the atmosphere, pressure to use waste increases. Industry is particularly sensitive to such pressure as the range of options to dispose of waste narrows and the costs increase. However, industry faces a dilemma: it generates many types of waste that are not readily recycled in the way that various resources such as glass, paper, and plastic are routinely recovered from municipal and commercial waste. The dilemma is that in abiding by the immutable definitions of waste prescribed to protect the environment, the regulator acts to inhibit rather than facilitate the use of waste. A substance discarded by its generator (such as the manufacturer that created it) is defined as waste by the authorities even though it may be regarded by others as usable. This implies the transition of a substance from one state to the other, notwithstanding the fact that it remains physically unchanged. The dilemma may be resolved by a definition of waste that accommodates such a transition and incorporates a notion of where it is deemed to occur.

To this end, industrial waste is defined as any substance not required by a generator and is therefore to be discarded from the site at which the substance is located. Transiting the site boundary represents the point at which the waste may become usable. This definition includes any form of matter that is accidentally or otherwise discharged to the environment.

Want and Custody

The notion of want as expressed by "not required" is the defining criterion for what constitutes waste. A substance remains waste for as long as it remains unwanted for a purpose (other than preparation for dumping). If, after a substance has left the generator's site, it is wanted by a user, then it may be accorded a different status. Some part of the original waste may become waste again, if that part ceases to be wanted by one or more subsequent users.

The issue of custody is relevant to this definition of waste, although its legal meaning may be construed differently from one jurisdiction to another. In the context of industrial waste, the general meaning of custody implies physical possession of the waste or a responsibility for its care and its fate. The encumbered entity (a person or a corporation) is the custodian who, in the first instance, would be the generator of the waste. In some jurisdictions, custody—responsibility for its fate—resides with the generator until the waste in question is "unrecognizably transformed," even though it may have been in the possession of others before that point.

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See Also: Culture, Values, and Garbage; Garbage in Modern Thought; Politics of Waste.

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Delaware

The second-smallest U.S. state by area, Delaware occupies the northeast part of the Delmarva Peninsula. While the population is not large (the 2010 census estimated 897,934 residents, 45th in the United States), Delaware has the 6th-highest population density, with over 60 percent of the population residing in New Castle County, the northernmost of the state's three counties. Although statewide development has recently increased, New Castle County is more industrialized, while the two southern counties—Kent and Sussex—have historically been more agricultural. The state has the second-highest number of civilian scientists and engineers by percentage of workforce, mostly because of the prominence of the Du Pont family (owners of DuPont, the world's second-largest chemical company) in Delaware's economic and industrial history. Delaware's economy is generally larger than the national average; its main industrial outputs are chemical products, cars, processed food, and paper, rubber, and plastic products. Agricul-

ture is based on poultry, nursery stock, soybeans, dairy produce, and corn.

Before European colonization, Delaware was home to the Lenni Lenape (the Delaware), Susquehanna, and other Native American tribes. The Dutch were the first to establish trading posts in the early 17th century; however, in 1664, England asserted its claim on the area and expelled the Dutch. Settlement at this point was predominantly rural and situated along waterways, which were the main transportation routes. In the mid-18th century, more towns appeared and large numbers of immigrants arrived, bringing industry and commerce with them. Over-farming saw many farmers move west, and after the Revolution, industry manufacturing grew steadily.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Delaware had an estimated 988,433-tons of municipal solid waste (MSW) generation, placing it 46th in a survey of the 50 states and the capital district. Based on the 2006 population of 852,747, an estimated 1.16 tons of MSW were generated per person per year (ranking 31st). Delaware landfilled 885,283 tons in the state's three landfills (only Connecticut and Rhode Island report having fewer landfills, at two each). Delaware exported 12,617 tons of MSW (third-lowest export in the country), and 650 tons were imported (the lowest reported import in the country). In 2006, Delaware had 5 million cubic yards of landfill remaining and was increasing its capacity; it was ranked joint 32nd out of 44 respondent states for the number of landfills. Only whole tires were reported as being banned from Delaware landfills, with a ban on yard trimmings introduced at Cherry Island Landfill in 2008. Landfill tipping fees across Delaware were an average $58.90 per ton, where the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively. Delaware has no waste-to-energy (WTE) facility, but 103,150 tons of MSW were recycled, placing Delaware 44th in the ranking of recycled MSW tonnage.

Archaeology

As a coastal state, the Delaware archaeological record has numerous shell midden sites, mounds of discarded shell created by the processing of gathered shellfish and incidental food debris from the foods eaten alongside them. These sites are important as they are markers of small Woodland I period base camps, which are otherwise difficult to identify. The Wolfe Neck Site provided the finds that enabled the type description of Wolfe Neck Complex ceramics. Similarly, settlement sites of the Delmarva Adena Complex are little known. The Wilgus Site is a micro-band base camp containing material from the Delmarva Adena Complex and the later Carey Complex. While the living area of the site was on a low knoll that was raised and exposed to plowing and weathering, the nearby middens (both earth and shell middens) had survived relatively intact. As the Wilgus Site rubbish had been thrown down a slope to take it away from the living area, it had subsequently been buried by soil being washed down the slope by rainwater (slope wash or hill wash). The middens were large, around eight meters in diameter, and such a large mass of organics resists biodegradation, particularly shell middens. The calcium carbonate leaching from the clam and oyster shells created an alkaline burial environment, which buffered the acidity of the soil and thus preserved other organics in the deposit bone—antlers, fish scales, and charred seeds. Growth-ring patterns in the oyster shell hinges indicates they were gathered in late winter–early spring.

The Wilgus middens identified food sources such as freshwater fish (indicating the Indian River had not yet become brackish), deer, snake, turtle, and birds. The deer bones were mainly from the skull and legs. Trunk meat was probably consumed at the kill site, or fed to dogs, as it is difficult to carry. The presence of skulls was perplexing as they are of low meat value, although the tongue and brain are desirable foods among hunter-gatherers. Brains can also be used in tanning and processing hinds. The pattern of tooth eruption in the deer skulls indicated winter kills. The wide range of turtle species present was typical of a hibernating turtle population, a late-fall and winter food source. Amaranthus and Chenopodium seeds were found in both earth and shell middens. In the earth middens, they were associated with large pots thought to be related to processing seed plant foods, available late-summer and fall in these species. The seeds in the shell middens

were associated with the winter faunal material and were probably stored for winter consumption. When all of the seasonality evidence is considered, it seems Wilgus was occupied from late summer into the following spring, with shellfish comprising a large part of the winter diet.

In Delawarean archaeology, there has been reconsideration of what were thought to be Native American rubbish pit features in which human remains had been deposited. These had been interpreted as refuse pits based on their shape, the presence of potsherds, flakes, fire-cracked rock, and absence of perceived grave goods. However, the use of ethnohistory and insights of Nanticoke tribe representatives have shown that Native American burial in a trash pit is extremely unlikely and that deposited items that were usually seen as trash can have ritual and symbolic meaning. Careful study of many of the recovered artifacts had attributes that differed from those of superficially similar items from nongrave settings. These findings meshed with data from ethnohistoric, ethnographic, and linguistic studies to create a consistent cultural context for the ritual and symbolic significance of the artifacts.

Reefs

Like the other mid-Atlantic states, Delaware has an artificial reef program. Since 1995, it has created thriving ecosystems on the otherwise featureless sandy ocean floor. There are 14 reefs in Delaware and along the coast, five of which are in federal waters. The eight reefs in Delaware Bay are primarily made from donated concrete culvert pipe and other concrete products augmented with scuttled tugboats and other material. Ballasted tire units have been used at three ocean sites. In 2000 alone, 24,500 tons of concrete products, 8,000 tons of ballasted tire units, and 86 decommissioned military vehicles were recycled into Delaware's artificial reef program.

The Redbird Reef, 16 nautical miles east of the Indian River Inlet, is the state's most popular reef site, with over 10,000 angler visits every year. Over 1.3 square nautical miles of reef have been created from 890 subway cars, 11 large vessels, 86 military vehicles, and 6,000 tons of ballasted tire units. It was begun in 1996 and is named after the 619 decommissioned New York Metropolitan Transportation Authority subway cars donated to create it. Delaware received the subway cars after several states had rejected them because of environmental-safety concerns. Environmental groups had campaigned against the use of subway cars because of the small amount of asbestos used in their glue and insulation. The groups also considered subway cars unsuitable for use in artificial reefs based on the survey of a single car that had been hit and destroyed by a dragger. These concerns proved unfounded and several states have competed for more of the subway cars. The reef became so popular that overcrowding and traffic became problematic, as did crime when the theft and sabotage of fishing traps and pots escalated. The problems reached such a level that the state applied to federal marine officials to make the area off-limits to large commercial fishermen who were clashing with anglers over space and tangled lines.

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See Also: Definition of Waste; Ocean Disposal; South Carolina.

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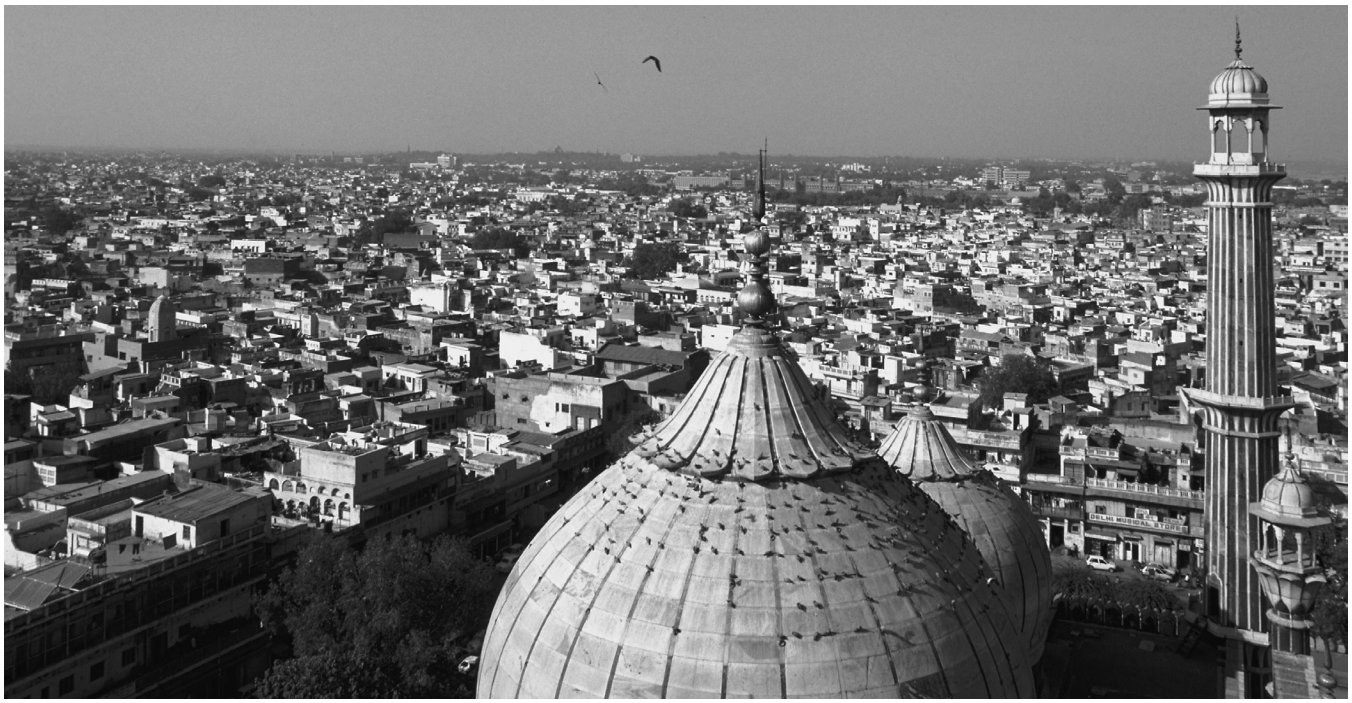
Delhi, India

Delhi is a megacity (population 10 million or more) and the second most populous city in India. Since the 1970s, Delhi has undergone rapid and unplanned growth in terms of urbanization, industrialization, and population increase. This tremendous growth in population and focus to improve the standard



In Delhi, India, the changing lifestyle, increased standard of living, and differences in the types of goods consumed have affected the amount and type of waste generated by citizens, including increases in plastic waste and multimaterial packaging. The 500 grams of waste per person daily is five times the national average. Landfilling is the formal disposal option. There is also less separation of waste, which has supplied the informal recycling industry conducted by ragpickers, scavengers, junk dealers, middlemen, and big merchants.

of living has resulted in land development, growing slums, industry, and automobiles, leading to degradation of the environment. Delhi faces the problem of supplying potable water, basic sanitation, and shelter on one hand, while battling with environmental problems from development activities, like pollution from solid waste, vehicular traffic, industrial emissions, deforestation, and loss of biodiversity, on the other hand. The changing lifestyle (which results in differences in types of goods consumed) and changing standards of living have also affected the amount and type of waste generated in terms of increases in plastic waste, paper packaging, multimaterial packaging items, consumer products, and other related types of waste associated with affluence. The increase in standards of living has also decreased the separation of waste as it happens in rural areas (mainly for economic reasons).

Quality and Quantity of Waste

With a total area of slightly more than 900 square miles (sq mi) and a population of more than 14 million, Delhi generates 7,000 tons of solid waste every day. The generation rate is about 500 grams per person per day, which is almost five times the national average. Moreover, garbage generation is likely to increase to 18,000 tons by 2021.

For solid waste management purposes, Delhi has been divided into three areas. Municipal Corporation of Delhi (MCD) has jurisdiction over 868 sq mi, or 94.22 percent of the total area. New Delhi Municipal Committee (NDMC) has jurisdiction over only approximately 26 sq mi, and Delhi Cantonment looks after another approximately 26 sq mi. MCD is the largest municipal body among the three bodies responsible for waste management in Delhi and has to provide services both to rural areas and a very large urban area. But this does not cover the entire city. There are virtually no arrangements for waste management in squatter settlements, slums, and illegal colonies, which comprise around 50 percent of the urban population in Delhi. As a result, waste is littered in open spaces and drains.

Waste generated from a household depends on the income level and the lifestyle of the people. Delhi households can be divided into a high-income group (HIG), with an income greater than Rs. 8,000 per month; a middle-income group (MIG), with an income between Rs. 8,000 and Rs. 5,000; a low-income group (LIG), with an income less than Rs. 5,000; and slum dwellers.

The quantity of MSW generated per capita varies for the LIG at 0.35 kilogram (kg) per day to 0.48 kg per day for the HIG. Affluent communities generate more recyclable waste than lower-strata dwellings.

Urban solid waste is normally a complex mixture of household, construction, commercial, toxic industrial elements, and hospital wastes. A physical analysis reveals that it consists of about 32 percent compostable matter. The recyclable components include paper (6.6 percent), plastics (1.5 percent), and metals (2.5 percent). Because of economic growth, the composition of waste is expected to change. Plastic is expected to increase to 6 percent, metal to 4 percent, and glass to 3 percent. Paper content is expected to increase to 15 percent, while organic waste will go up from 40 percent to 60 percent. It is projected that other materials (such as ash, sand, and grit) will decrease from 47 percent to 12 percent.

Waste Management

Solid waste management in MCD comes under the jurisdiction of the deputy municipal commissioner (Conservancy and Sanitation Engineering). This person is assisted by two directors: one is responsible for the Trans Yamuna area and the other for the rest of the MCD. These directors are helped by three joint directors, who are supported by subordinate staff. Each zone has a sanitary superintendent (SS) who, with the help of subordinate staff, looks after the collection and transport of solid waste: sweeping of roads, lanes, and by-lanes; removal of garbage from dustbins and community bins; and reports to the appropriate joint director. Administratively, the SS works under the zonal assistant commissioners and additional deputy commissioners.

The director is entrusted with solid waste management, along with sewerage and drainage activities. The engineering staff responsible for allowing the director to devote more time to solving sewage problems, such as choked drains, and in turn solid waste management, does not get the attention it deserves. The operation of the solid waste management is thus left to conservancy staff.

Waste transportation vehicles are maintained in zone workshops. The person in charge of the workshop is responsible for maintaining the vehicles, while the responsibility of loading, transport, and unloading of the vehicles lies with the assistant sanitary inspectors (ASIs), who are often not technically qualified for these operations.

Collection Systems

The system expects each household or commercial premise to deposit its waste at a local waste accumulation area (also called a community bin). These functions are normally carried out by private individuals called *zamadars* who are employed by householders or businessmen for a small monthly fee. MCD employees (called *safaikaramcharies*) are responsible for street sweeping, and the wastes they collect are also placed in the waste accumulation area.

Wastes are collected from these locations by truck, usually on a daily basis, and taken to disposal areas. Safaikaramcharies are involved in loading, transport, and dumping operations. Mechanized curbside collection systems such as those that are standard in Western cities are not used in Delhi. Trials with such systems have failed.

Localized systems, mainly organized by nongovernmental organizations (NGOs), attempt to collect wastes that can be recycled or composted rather than entering the waste deposition, collection, and dumping system. Key problems associated with waste collection systems have been identified as the following:

- Poor civic responsibility (some people dump waste indiscriminately)
- Zamadars are poorly paid, morale is low, and the work is often badly done
- Safaikaramcharies are paid better, but they are poorly organized and equipped
- Health and safety issues for workers are largely ignored

- The number and distribution of waste accumulation areas appears to follow no rational pattern
- The design of built structures at waste accumulation areas is poor, the size and design is often incompatible with the loading and transportation equipment, and inefficient manual loading is usually required
- Maintenance of built structures at waste accumulation points is poor
- The use of steel trolleys (similar to the mechanized bin system used widely for commercial waste in the United Kingdom) has proved unsatisfactory because of equipment costs and lack of maintenance of the complicated machinery
- The timing of waste collection (early in the day) is not ideal since most of the waste generation takes place later in the day

Waste Transport

There is a large fleet of assorted vehicles for transporting wastes from collection points to disposal sites. However, at any given time, a large proportion is out of action because of the age the fleet, overcomplicated types of vehicles, and poor standards of care and maintenance:

- The available fleet is not used efficiently
- The shift system for the drivers and safaikaramcharies is badly organized

Specific problems also include the following:

- Waste handling is often manual, meaning that loading and unloading are time consuming, the round trip time increases, and the labor and vehicle productivity is reduced
- Waste is handled several times because the existing transport and loading vehicles do not match with communal storage bin design
- There is a potential health hazard for workers as all types of wastes, including infectious hospital wastes, are disposed of in the same bins
- Workers are not given protective devices and those who are given any seldom use them
- There is no separate arrangement for transport of infectious wastes from hospitals or nursing homes
- The service level is very low as several bins are not cleared on a day-to-day basis and waste is not transported on Sundays or holidays
- Vehicle capacity is not fully utilized
- There are no standby vehicles for deployment during periodic maintenance or breakdown of vehicles in service

Waste Disposal by Landfilling

Landfilling is the main system for waste disposal in Delhi, and there were three main landfill sites in use as of 2010. Although the composition of waste in Delhi is conducive to composting, this method of disposal is not widely used. There are a few local initiatives organized by NGOs to compost waste in certain localities.

Delhi does have an incinerator, the Timapur incinerator, which was built in 1989. It has not been a success because of the low calorific value and high moisture content of the waste used as the feedstock. It requires the use of additional fuel oil to get the waste to burn, making this a very expensive disposal option. Pelletization to produce refuse derived fuel (RDF) is a possibility. However, this is not considered as a viable option because of the low calorific value and high noncombustible (ash) content of the waste feedstock, the high capital and operating costs of a pelletization plant, and potential atmospheric pollution impacts on combustion.

The informal recycling industry consists of different kinds of people: ragpickers, scavengers, junk dealers (*kabariwalla*), middlemen, and big merchants. There is a set hierarchy among these operators, with scavengers forming the lowest level and big merchants forming the top level of the hierarchy. Ragpickers pick up things from litter, segregate these, and sell them to either junk dealers or middlemen, while junk dealers buy things from households and sell them to the middleman, who sells the same to primary industry. In this system, ragpickers get the least pay, and middlemen make the maximum profit. Junk dealers go around the city on bicycles or with wheelbarrows, buying waste materials such as newspaper, plastic, glass, metallic containers, and

utensils. Another type of dealer collects old textiles, which are usually exchanged for new metallic utensils used for domestic purposes.

The segregation system at the source is very efficient because of the economic incentive. Discarded paper (not crumpled), plastic bags, and other packaging material are collected by the ragpickers from the streets, local garbage collection centers, and landfill sites. According to Sristiti estimates, there were over 75,000 ragpickers in Delhi as of 2010, with their number increasing. It is a profitable business in the early 21st century, where it is often difficult to find a job. Ragpickers are mostly women and children, while junk dealers are generally males. The main reason for the existence of the recycling sector is the economic incentive. The households get extra income (though it is not substantial), but it is a major source of income for the people involved in the recycling business.

Privatization

There have been a few litigations against the local government for mismanagement of waste management in Delhi. This has led to privatization of waste collection and transportation in six zones of Delhi. Some of the terms of this privatization include the following:

- Ownership and Control of Recyclable Wastes (Article 5.15 of the Contract)
- Control and Rights over the Dhalao Space

According to some reports, this has led to loss of jobs for ragpickers and others in the informal waste recycling system.

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See Also: Developing Countries; India; Mumbai, India; Recycling; Street Scavenging and Trash Picking.

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Developing Countries

The term *developing countries* generally refers to nations with low standards of living, although high levels of variability in the societies and economies of developing countries exist. Many such nations, including ones in the Americas, Africa, and Asia, were colonies of the wealthiest nations of the 19th and 20th centuries. Evidence of this history is found in trade and development relationships in the 21st century, as extraction of mineral resources and agriculture endure even as new industrial activities and forms of waste management develop.

A feature of many developing countries is the megacity (a city with a population of 10 million people or more). As many nations won independence from colonial powers between 1945 and 1980, economic development spurred creation of megacities. Whereas there was only one megacity in 1945 (New York City), there were at least 14 such cities in 1995, and 10 of these cities were located in Latin America, Africa, and Asia. It is expected that 22 of the 26 megacities by 2015—also known as the city-region—will be located in developing countries. But this development comes with some consequences, such as environmental degradation, pollution, and growing social inequality.

Developing countries are usually defined by income group, which means their consumption patterns are comparable. Waste management is closely related to resource consumption patterns, urban lifestyle, jobs and income levels, and other socioeconomic and cultural factors. There are marked differences in urban and rural areas, and this is also reflected in the type of waste they generate. There are also differences among countries, but some common elements exist.

There is a significant difference between the waste from industrialized (developed) and developing countries. There are notable variations of waste and managerial problems from country to country and even from city to city. On average, however, low-income countries generate waste of 0.4–0.6

kilograms (kg) per person per day while the waste generation rate in developed countries is 0.7–1.8 kg per person per day. This implies that, generally, the rich produce larger quantities of waste. Waste in developing countries differs from that of developed countries:

- Developing countries have a much larger percentage of organic waste (such as vegetables and fruits) as compared to developed countries. Since the temperatures are usually warmer in developing countries and so is the rainfall (and humidity), there is a higher rate of decomposition and calls for more regular collection of waste.
- Amounts of dust or dirt in street sweepings are greater in developing countries compared to developed nations
- In terms of moisture content, developed countries have two or three times greater moisture in waste
- Waste density in developing countries is also two or three times greater than in developed nations
- Wastes generated in developed countries have much higher calorific value

Waste Management

Since most cities in developing countries are growing at a fast rate, most of the municipal governments are stretched beyond their capacities to deal with the change in waste quality and quantity. The vast majority of countries are struggling with ensuring sufficient collection services and implementing some sort of control as disposal sites are simultaneously facing increasing waste amounts due to the trend of urbanization. It is interesting to note that the problems faced by the cities of low economies in the 21st century and those of 19th-century North America and Europe are comparable. In both cases, the pace of population growth outstripped the capacity to manage urban services.

Just like common characteristics, there are some common problems with solid waste management across developing nations. The issues related to solid waste management can be grouped into a few factors: inability of the local municipal authorities to collect waste; lack of data, data collection, or monitoring; lack of financial resources; lack of capacity and required skills; improper disposal facilities; either lack of legislation or outdated legislation; improper organization structure of the authority responsible for waste management; and improper attitudes of people. The behavior of people is important to reduce or manage waste properly. In addition to income, there are other factors that influence waste management, including the sociocultural factor.

In Asia, for example, organic waste is seen as a resource and has been used for animal feed, fertilization of land—and even, in some, cases cooking—while in Africa waste is seen as dirty and people are often averse to coming in close contact with it. Another factor influencing waste management is religion. Literature and research has shown that in some religions, such as Hinduism, waste is seen as a resource and traditionally handled by certain castes. In some religions, such as Islam, people are averse to handling waste. Based on these factors, some of the common threads for waste management among developing countries are the following:

1. Lack of collection of waste (a large percentage of waste goes uncollected). It has been reported that in some cities, uncollected waste is as high as 70 percent.
2. There is a lack of proper collection bins either in household collection (in most cases, plastic grocery bags are just left outside the houses, attracting stray animals, rodents, flies, and mosquitoes) or even for collection at neighborhood levels (even when these bins or collection points are present, they are not properly maintained and cleaned). In India, for example, in most major cities, municipal solid waste accumulates in communal bins until waste collectors pick it up. Since there is no reliable pickup time from these communities, there are piles of garbage around these bins, attracting rodents and animals. Most of the uncollected waste then gets dumped on streets (usually side streets) or in neighboring areas, leading to environmental and health issues.
3. Transfer stations are available in only a few metropolitan cities where hauling distance

to disposal sites is too long. Waste is usually transported from collection points to transfer stations or to disposal sites through different ways (depending on how big the city is). Waste is carried on head by staff; on handcarts; on bicycles; in some cases animals such as donkeys, horses, or ox-carts are used to transport waste; and in larger urban areas waste is transported via trucks. Most waste handling is done manually, exposing waste workers to serious health hazards, especially in countries where wastes are usually not segregated, forcing workers to handle medical and hazardous wastes.

4. Transport trucks used for collection and transfer trucks are (in most cases) too mechanized for developing countries. In some cases, the collection and transfer trucks do not function to maximum capacity. According to United Nations Environment Programme (UNEP) estimates, in some cities in west Africa, up to 70 percent of collection and transfer vehicles may be out of service at any given time.
5. At times, the machinery used for waste management is not fit for developing countries either. However, changes in consumption patterns affect the quality of waste, requiring different technologies. For example, when the development level is low, there is not much packaging or post-consumer waste, and the waste going to the landfill does not need a compactor. However, as consumption and consumerism increase with increases in income, packaging and other waste that needs compaction increases, justifying the need for a compactor.
6. There are no controlled disposal systems (landfills are not engineered with lining and there is no collection system for leachate), and most of the disposal sites are uncontrolled, open dumps. Leachate can—and does—contaminate groundwater and run off into water systems if disposal sites are based near water systems. Traditionally, waste disposal consisted of hauling waste beyond the city boundaries and dumping it there. Open dumps often become breeding grounds for mosquitoes, thus contributing to the spread of diseases. In some countries, waste is burned or dumped in water systems, leading to air or water pollution.
7. There are inadequate guidelines and lack of legislation for proper siting, design, and operation of landfill sites. This causes problems when landfills are not in appropriate places. Another problem is the proper enforcement of legislation.
8. Most of the dumpsites have scavengers who recycle waste, but this can be hazardous since the waste is mixed with hospital waste, human waste, and hazardous industrial waste, which can lead to serious injuries and illnesses. For example, the Smoky Mountain dump, in Manila, the Philippines, had as many as 10,000 families living in shacks on or adjacent to the dump site. In addition to the health problems, these concentrations of people further complicate transport and unloading procedures and present numerous safety and logistical concerns. There have been cases of landslides and fires leading to many casualties, since it cannot be controlled easily. UNEP estimates also state that about 100,000 people currently scavenge wastes at dumpsites in the Latin American region alone. Even in Phnom Penh, Cambodia, garbage collection trucks are rarely seen on the streets, but female waste pickers are a common sight. Because of the availability of cheap labor, there is a high potential of mechanical recycling in developing countries compared to developed countries.
9. There exist operational inefficiencies of services.
10. There is inadequate management and separation of hazardous and healthcare waste. All waste collected should be separated so that it does not contain any medical, industrial, or construction waste before transferring it to community bins (the primary waste collection point). All biodegradable waste collected from slaughterhouses and markets should be collected and handled separately and in an appropriate manner. Absolutely no waste should be burned under normal circumstances.

Normally, no stray animals should be permitted to move freely around waste storage facilities by walling and gating the storage area.

11. While municipal authorities can choose their own method of collection, storage, and final disposal, it is recommended that collection of waste be carried out on a regular basis and must include the collection of waste from squatter colonies and slums. Normally, squatter colonies and slum areas are excluded from municipal services, but they are located within the city boundaries and leaving them unclean creates health hazards.
12. One of the challenges in solid waste management is when authorities under the influence of developed countries want to use technology, even when it is not applicable or suitable for local conditions. For example, calorific value of solid waste in developing countries is low, and when all the recyclables are sorted, there is hardly anything left to recover energy from in the waste cycle. Still, some municipalities want to own an incinerator or an energy recovery plant.
13. Composting is another option that is used mainly in rural areas in developing countries but can be used in urban areas as well, based on the high amount of organic matter present in the waste in these countries. On average, the organic content is as high as 50 percent. In cases such as Bandung (Indonesia) and Colombo (Sri Lanka), the residential waste stream has been found to have about 78 percent and 81 percent organic waste, respectively.
14. Lack of capacity and financial reasons are generally cited as major causes for lack of waste management in these countries.
15. Lack of data collection affects waste management. Information on local conditions and waste composition helps in selecting the frequency of collection and disposal technology. However, most developing countries lack this data and depend on consultants to come up with data and recommendations for disposal technologies, which can then be biased.
16. In order to prevent a lot of waste going to landfill sites, the highest priority is to achieve reduction in the amount of waste generated irrespective of economic growth and to raise public and political interest in sustainable waste management. This may be accomplished by educating and changing people's attitudes toward waste and increased participation in minimization of the waste generated by them. This minimization can occur through recycling as well as reuse and composting, even though informal recycling communities are very active in some areas—and hence almost all material that can be recycled for profit is siphoned off. Future progress is also required in improving the markets for recyclables. This is further illustrated through an example from Delhi, India, in which this activity is carried out through a chain of self-employed individuals or groups of dealers for whom this work is a source of income. The informal recycling industry consists of ragpickers, scavengers, junk dealers, middlemen, and big merchants.

Legislative Examples

The United Nations Conference on the Human Environment in 1972 prompted India to amend its constitution in 1975 to include provisions for improvements to the environment by amending its constitution. This was done so that sustainable development occurs, which is a balance and harmony between the economic, social, and environmental needs of the country.

Besides the center, every state has its own Department of Environment and Pollution Control Board for planning, promoting, and coordinating the entire country's environmental programs. The Ministry of Environment and Forests (MOEF) has identified the Central Pollution Control Board (CPCB) as the chief monitoring agency. In 2004, the MOEF enacted a National Environment Policy (NEP) for all agencies and civic bodies responsible for environmental management.

This forced the government's commitment to environmental protection and to review all regulatory reforms and legislations of the central, state,

and local governments and to infuse a sense of commonality into the various environmental sectors, such as pollution control, waste management, and water resource management. The key objectives of the environmental agenda of India include the integration of environment concerns into development and economic policies, and the application of the principles of good governance—transparency, accountability, efficiency, and participation—to their system of environmental management.

No policy is going to meet all principles and dimensions of Integrated Solid Waste Management (ISWM), but the Indian policy meets the majority of the requirements. Besides, the policy makers seem cognizant of the importance of addressing the political situation in that they clearly lay out roles and responsibilities for different levels of authority. Some aspects of reality in India are left out, for example, there is no mention of huge populations of waste pickers prominent in every major city throughout the country.

Various different pieces of legislation regarding solid wasted management (SWM) and environmental protection were passed between 1939 and 1999 in the Philippines. For example, the 1939 Anti-dumping Law prohibited dumping of refuse, waste matter, or other substances into bodies of water. The 1999 Republic Act—the Clean Air Act was the first piece of legislation to outlaw incineration, including that of medical waste. The 2000 Ecological Solid Waste Management Act (ESWMA) was a comprehensive piece of legislation that was enacted after the tragedy at the Payatas landfill in the Philippines. The act was written in order to replace the piecemeal legislation that previously covered SWM in the country. Besides India, the Philippines is another country that decided to enact strong legislation to deal with SWM in an integrated fashion. The Philippine government has repeatedly stressed its commitment to good governance and a healthy environment through its emphasis on the decentralization of power for environmental management to local authorities. This ESWMA is almost perfect on paper—decision makers have put a lot of thought into its drafting. The main issue is that it is very hard to tell what aspects of the act have been implemented and what aspects have remained on paper.

Private Sector

Even before the 1980s, there were some private-sector companies involved in waste collection. However, the national governments and development agencies actively began to promote the private sector as a provider of municipal services during the 1980s. However, the private sector had hardly any experience in the provision of solid waste services. As such, they tended to copy government services and made the same mistakes, especially if burdened with using the same old equipment that was being used by the public sector. Local governments in developing countries have access to interest-free grants or transfers, which may not be the case for the private sector, resulting in higher costs, even though productivity might be better.

Most of the activities undertaken by the public sector could be done by the private sector as well. However, only those activities that are performed by government employees most inefficiently should be privatized—activities like solid waste collection. Maintenance of vehicles could be another area of interest for privatization because of labor restrictions on hours of work and associated high costs relating to overtime work in the public sector. The aim of privatization should be to reduce governmental control, ownership, and activity within a service like solid waste collection and disposal.

A significant number of African cities have been implementing pre-collection systems since the 1990s. In private subscription, residents are concerned about the removal of the waste but do not pay much attention to its disposal, meaning a strong regulatory and enforcement framework is required. In that case, a clause could be added that the contract could be terminated if the waste is disposed of illegally.

It is relatively easy to improve solid waste collection and disposal systems by getting the private sector involved. Private-sector participation is not considered successful if it just means improvement in service. On the contrary, such a service should be financially sustainable and cost effective. Before privatizing, a developing country should ensure that the private sector is well established. Otherwise, it is strongly recommended that the public sector should retain services to at least one-third of the service area. After continuous five years of successful opera-

tion by the private sector, the control area could be reduced to 20 percent for another five years.

Another area of concern of developing countries when privatizing is to minimize the termination of employees. One of the ways of handling such a situation is to freeze further hiring and not to replace the retiring employees. Thus, natural attrition creates significant flexibility in transition toward privatization. Standards need to be created for the whole waste industry that include new and emerging technologies and also the management of specific waste types, such as agricultural waste.

Conclusion

There should be a move toward integrated solid waste management and improving the legislations (and their enforcements) in regard to waste collection, transportation, and disposal. There is also a need for education, public information, and public participation.

If human society has to endure but for thousands and thousands of years, people need to learn a way of life that can be sustained. Human society must learn to control population and develop more efficient green technologies that produce as little harmful waste as possible (or no waste at all as the new theme of zero waste or cradle-to-cradle concepts are evolving). People must learn to rely on resources that are renewable.

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See Also: Delhi, India; Recycling; Slums; Street Scavenging and Trash Picking; Sustainable Development; Zero Waste.

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Dhaka, Bangladesh

The south Asian country of Bangladesh and its capital Dhaka (a megacity of over 12 million people), show similar consumption characteristics and face comparable challenges to other developing countries in the region.

Consumption Patterns

The population of Bangladesh spends more than half of its income on food and beverages (54 percent), while only 12 percent is spent on housing and rent. Clothes and footwear, as well as fuel and electricity, both take about 6 percent of income. There has been a trend showing that the amount spent on housing is increasing sharply, both in urban and rural areas, while less money is spent on consumption goods.

With higher income, people also change their consumption patterns. With more money, the population consumes more expensive food, such as fish, chicken, and mutton, while their demand for wheat, potatoes, and eggs decreases. More consumption also means more waste. The use of packaging made out of plastic, such as plastic bags and water bottles, has become very popular among consumers, drastically increasing the amount of solid waste.

Waste Management

The capital of Dhaka is not capable of coping with all the garbage caused by its inhabitants. Solid waste management runs smoothly in rich and middle-class neighborhoods, as they have enough political influence to guarantee regular governmental service. Poor slum areas can hardly rely on organized waste management. The government fails to provide most of its citizens with this public good. The agency in charge, Dhaka City Corporations (DCC), covers about 224 square miles, but not all parts are serviced equally. Since the city is not able to provide all its inhabitants with reliable service, some neighborhoods have established their own form of solid waste management, which is based on mutual trust and reciprocity among neighbors. Usually, the garbage collection system in Dhaka involves regular pickups by municipal workers and the deposit of waste in large, centrally located dumpsters. Individual households

A fruit seller in Dhaka, Bangladesh. The population of Bangladesh spends more than half of its income on food and beverages. They are also spending their higher incomes on more expensive food as well as food with plastic packaging, increasing solid waste.

dump their garbage in small dumpsters in the side streets of their neighborhoods. The municipal workers are responsible for collecting the garbage from these alleys within the neighborhoods and bringing it to the main dumpsters. This service has proven very unreliable, and DCC employees often do not come to collect the trash for weeks. Some neighborhoods have managed to find an alternative to the public system. They hired private contractors to regularly collect the garbage from the neighborhood, and they are paid by voluntary contributions from community members.

Since waste management must be organized collectively, neighborhoods established their own trash disposal committees. While this voluntary solid waste management works very well in some neighborhoods, other areas are not capable of organizing themselves. The ability of self-organization depends on the homogeneity of the community (same ethnic or religious background) and its social capital. Reciprocity is the key to functioning voluntary solid waste management, as it excludes free riders.

The government uses these success stories in order to encourage other neighborhoods to copy this self-help scheme. The authorities further discuss public–private partnerships as another possible solution for coping with waste.

Water and Sewage

Providing safe drinking water to the population has been another big challenge. The rural population gets its water from tube wells. About 11 million of these wells exist in the country, but almost half of them are contaminated. Bangladesh faces a mass arsenic contamination of its water, and the water cannot be used for drinking or cooking. In the city, many slum inhabitants do not have running water at all. Water supply is also frequently cut.

As in many large cities in developing countries, sewage is a major problem. A functioning sewage system needs governmental planning, so the inhabitants of poor areas cannot cope with the problem without the authorities' help. Most of the inhabitants of slums do not have private toilets in their households and have to use public ones, which they share with their neighbors. Open defecation poses large hygienic problems and is a severe health threat. Women in particular have problems using public toilets. They dislike walking across the neighborhood alone in order to use dirty community toilets. Sexual harassment is not unheard of, especially at night. Therefore, many women try to avoid using these toilets as long as possible by not drinking enough. Infections, constipation, and nephritic stones are frequent effects. In some cases, parents do not sent their daughters to schools because they do not have separate toilets for girls.

In many Muslim countries, such as Bangladesh, dealing with feces is taboo, so the problem has long been ignored. In 2010, a promising project was tested in the slum of Maimansingh. The inhabitants were encouraged to use special biodegradable plastic bags as toilets. They can use these bags at their homes and clean themselves with water in their backyards. The inside of these bags is covered with urea, which kills harmful germs. After use, these bags are collected separately from the ordinary household trash and disposed of on an empty field. It is also possible to bury the bags in the backyard garden. After six months, the feces become fertilizer. The Bangladesh Agricultural University is experimenting with this type of fertilizer and is successfully using it for growing lemon trees. In densely populated regions such as Bangladesh, agricultural areas are often close to urban settlements and slums, so both can profit from the symbiotic effects. As of 2010, the

project showed positive results and the inhabitants of Maimansingh accepted the biodegradable plastic bag as an alternative toilet. Regardless, this can only be a temporary solution. Even when produced on a large scale, each bag costs about $0.03, which is unaffordable for most inhabitants. The Sustainable Sanitation Alliance is working on an improved, cheaper version of the plastic bags.

Ship Breaking

While recycling consumption goods can help to ameliorate waste problems in the city, large-scale ship breaking has become an important national industry. At the end of their sailing lives, vessels are bought by steel companies and then dismantled. In Bangladesh, the scrapping of ships is the main source of steel. Since the government does not have sufficient financial means to buy steel on the world market, most of the eight million tons of building materials used in the country each year comes from recycled ships. Many industries profit from ship breaking, as almost all parts of the vessel can be reused or resold. Steel mills remanufacture the scrapping of ships. A large number of businesses specialize in reselling the technical equipment, paint, lubricants, and furniture removed from the ships.

The government supports the profitable ship breaking industry, as it generates a large amount of tax revenues through import taxes and yard taxes. The industry mainly concentrates in the poor and underdeveloped coastal zone of Chittagong. About 20,000 people in northwestern Bangladesh are directly employed in the industry. Almost all are unskilled laborers who must work for low wages under precarious conditions without any labor standards. They do not have written contracts and therefore cannot enforce their rights. Still, economic benefits for the region are great, as those people would otherwise be unemployed.

Despite the economic advantages, ship breaking has many negative side effects. Hazardous waste contaminates the environment, while poisonous fumes and chemicals threaten workers' health. The vessels are cut up and dismantled by hand on the open beach. Usually, they are only cleaned superficially and still contain large amounts of dangerous material. Oil tanks always carry many liters of residual oil in addition to the oil used for engines or as lubricant. It mixes with the seawater and pollutes most of the coastal area from Fauzdarhat to Kumira and Chittagong. Older ships contain asbestos, which was formerly used as a heat insulator. The workers have no protection against it. On the ship breaking beaches, flocks of asbestos fiber fly around in the air, and workers constantly inhale them. Exposure to asbestos causes a wide range of pulmonary diseases and is lethal in the long run. During scrapping, high concentrations of highly toxic persistent organic pollutants (POPs) are released into the environment. They remain intact over long periods of time and accumulate in the fatty tissue of organisms. POPs have become geographically widely distributed, causing problems even in Bangladesh's hinterland. For humans, these toxic substances cause serious health problems by increasing the probability of cancers and by disrupting the hormonal system.

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See Also: Culture, Values, and Garbage; Developing Countries; India; Sewage.

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Diet and Nutrition Surveys

Numerous diet and nutrition surveys worldwide attempt to assist preventive health programs through analyzing people's diets and nutrition. Four main

types can be distinguished: national nutrition monitoring, national nutrition and health, international nutrition and health, and individual with online analysis of the results. The methodology includes all or some of the following basic steps: selecting samples sizes, interviews, food diaries, measurement and medical examination, and monitoring. There are government agencies, nonprofit organizations, and social firms (e.g., Casals & Associates) that provide the surveys.

In the United States, the basic surveys are part of the National Nutrition Monitoring and Related Research Program (NNMRRP), which was strengthened with the passage of the National Nutrition Monitoring and Related Research Act of 1990. The National Health and Nutrition Examination Survey (NHANES) is a program of studies designed to assess the health and nutritional status of adults and children in the United States. In the United Kingdom, there is the National Diet and Nutrition Survey (NDNS), a rolling program that provides a continuous cross-sectional survey of the food consumption, nutrient intakes, and nutritional status of people aged 18 months and older living in private households in the United Kingdom. Demographic and Health Surveys (DHS) are nationally representative household surveys that collect data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition. There are two main types of DHS surveys: Standard DHS Surveys (large samples, typically conducted every five years) and Interim DHS Surveys (smaller samples, focused on key performance monitoring indicators).

A series of specific surveys have been executed by nonprofit organizations. For instance, every two years the American Dietetic Association (ADA) surveys a large sample of American adults to identify changes in people's attitudes, knowledge, beliefs and behaviors related to nutrition, dietary habits, and eating.

International collaborative projects may include two or more countries as researchers and participants, such as China Health and Nutrition Survey, International Nutrition Survey at the Intensive Care Units (ICU), Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA), The European Prospective Investigation Into Cancer and Nutrition (EPIC), and Vitamin D Status Reports by the International Osteoporosis Foundation (IOF).

There are also individual surveys that provide online results for participants. The diet and nutrition survey results are comprised of data about food consumption, the interrelation between nutrition and health, nutrition therapy, and other goals.

Among the data of NHANES is the percent of kilocalories (kcal) from protein and the mean daily caloric intake (in kcals). More than 50 percent of the participants in the recent ADA surveys report they carefully select foods to achieve a healthful diet.

EPIC research had reinforced the hypothesis that a diet high in fiber reduces colorectal cancer risk. It also strongly supported the hypothesis that consumption of red and processed meat increases colorectal cancer risk while intake of fish decreases risk, and that being overweight and having low physical activity increases breast cancer risk after menopause.

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See Also: Alcohol Consumption Surveys; Candy; Dairy Products; Food Consumption; Grocery Stores; Meat; Slow Food; Supermarkets.

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Disposable Diapers

As a universally identifiable consumer product, the disposable diaper emerged in the United States with the introduction of the Pampers brand by Procter & Gamble in 1961. Infant disposable diapers are now a mainstay of U.S. childrearing. A Mass Market Retailers and Information Resources, Inc., report states that U.S. sales of infant disposable diapers reached nearly $1.9 billion in 2009. Other estimates suggest that as of 2010, 96 percent of U.S. parents prefer disposable diapers. Globally, Euromonitor reveals that infant disposable diapers are a $20 billion industry. Aging populations worldwide have also resulted in an increase of adult disposable diaper sales. What is most interesting about the history of disposable diapers is what the industry's target markets reveal about patterns of consumption amid shifting global demographics and cultural norms in developed and developing countries. Also of special interest is what a waste product as ubiquitous as disposable diapers means for the natural environment, and what—if any—alternatives exist.

Developed Nations

In developed nations, the disposable diaper market has reached a point of saturation, so major disposable diaper manufacturers must increase profits by innovating brands with new technology and styles. For example, the company Kimberly-Clark updated its Huggies brand diaper to make them look like blue jeans; the brand's slogan is "it's the coolest you'll look pooping your pants." However, with the rise of the Internet and social media technology, especially blogs and Facebook, innovations are sometimes met with resistance from consumers empowered by social media networking features. In 2010, Procter & Gamble faced a social media storm of criticism in the United States from "mommy bloggers" when the company's new Pampers Dry Max diapers were reportedly giving babies chemical burns. A swift response by Procter & Gamble to consumer concerns was required to defend the purported safety of the product.

Developing Nations

Developing nations have thus far been more indifferent than resistant to disposable diapers. But with global birthrates and consumer purchasing power expected to increase markedly in the 21st century, markets for disposable diapers in developing nations are beginning to burgeon. China and India in particular are major targets of large diaper manufacturers. As of 2010, it was estimated that only about 6 percent of China's population used disposable diapers. To increase usage in that country, Procter & Gamble began its "Golden Sleep" campaign in 2007, which promised Chinese consumers that their babies would sleep better while wearing Pampers.

As a result, Pampers is now the top-selling diaper brand in China, and the company expects to add one billion new customers over the next five years. In India, disposable diaper usage is estimated to be only around 2 percent. Following the success of its Chinese campaign, Procter & Gamble has already begun implementing it in India. With birthrates in India projected to be double those of China in the early 21st century, India may soon become the world's largest disposable diaper market.

Environmental Effects

This huge increase in disposable diaper consumption has some worried about the effect it will have on the natural environment. Data from the U.S. Environmental Protection Agency (EPA) reveal that 3.7 million tons of disposable diapers were introduced to the U.S. municipal waste stream in 2007, or about 2.2 percent of total discards. Constructed of plastic, wood pulp, polyester, and special superabsorbent synthetic polymers, estimates suggest that the average disposable diaper will biodegrade in about 500 years.

Even biodegradable varieties are not much better, because they do not receive sufficient airflow in landfills to break down properly. Disease is another

concern. Since most parents do not empty waste from diapers before throwing them away, most go to the dump filled with excrement, which is potentially introduced into groundwater or spreads disease to sanitation workers. Others have expressed worry about the toxicity of the chemical dioxin used in the bleaching of disposable diapers and the introduction of this chemical into the environment, and the skin of infants.

Cloth Diapers

As a response to these environmental concerns, some Western consumers now prefer reusable cloth diapers. However, some studies suggest that the benefit to the environment may be minimal, because of the added need of washing the diapers as well as the production of cotton to make them. One definite benefit for the average consumer, however, is that of cost: reusable diapers will cost $200–$600 for the time a child is wearing them, versus $2,000 or more for disposables.

The ultimate in diaper chic, however, is no diaper at all. Elimination communication, a process whereby parents learn to predict their child's bodily functions, is on the rise among some Western consumers. Ironically, cloth diapers and elimination communication are methods that have long been popular among parents in developing countries with ripening disposable diaper markets.

Conclusion

In the midst of fears of environmental degradation, disposable diaper manufacturers are ultimately high-tech innovators. For instance, consider that in the mid-1990s, the size of disposable diapers shrank by one-third and continue to shrink in the early 21st century while becoming more effective. Efforts are underway to make disposable diapers compostable and recyclable.

It is also worth considering the benefits disposable diapers give to women living in poverty globally. In the United States, because of the need for constant washing, reusable diapers are outside the realm of possibility for women without easy access to a washer and dryer. In developing nations, disposable diapers may save women living in poverty time and energy and allow them to pursue other opportunities.

In the end, it seems safe to predict that, whether in landfills or nurseries, disposable diapers will be around for a long time.

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See Also: Baby Products; Biodegradable; Developing Countries; Human Waste; Landfills, Modern.

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Disposable Plates and Plastic Implements

The use of disposable plates and plastic implements is having a harmful effect upon the environment. The increase in their use can be largely attributed to three social factors: cultural changes in the perception of meals and family time, the capitalist economic system, and an increased pace of human tasks. Early human food implements were made of more durable materials. Knives were made of various materials, including rock and obsidian. Vessels for food storage, cooking, and serving were made of clay and pottery as early as 2000 B.C.E. Forks in the Chinese Qijia culture were made of bone (ca. 2000 B.C.E.). These materials made the implement durable enough for repeated use by many generations.

In modern society, different materials have been used to construct utensils and other cookware. In the 21st century, many human food implements are made of ceramics, glass, or melamine (plates and bowls) and stainless steel (cutlery). These inexpensive, durable, and reusable materials have become less desirable as people seek alternatives to accelerate food preparation, consumption, and cleanup.

Dining Culture

Food preparation and dining is a universal practice of family and friendship, but this activity is changing. Almost one-quarter of Americans eat fast food every day, according to a 2005 CBS poll. In some cases, gathering to share meals is the exception in family life. Group meals can be difficult for 21st-century families because of an increase in dual-earner households, single-parent families, and a greater push for children to participate in extracurricular activities away from the home. Approximately 24 percent of families eat together three or fewer nights per week.

A desire for convenience supports a greater reliance upon disposable plates and utensils. Plastics, first developed in the mid-1800s, have resulted in products that are durable, lightweight, fairly cheap to produce, and easy to discard. These implements are an example of planned obsolescence, which is a profit-making strategy used by companies that involves producing goods to be used once and then discarded by the consumer. In the United States, an estimated 60 billion paper cups and plates, 70 billion Styrofoam plates and cups, 190 billion plastic containers and bottles, and 40 billion plastic utensils are used annually, and many of these disposable items are not used again. Culture may also contribute to the use of disposable utensils. For example, in Japan, people refuse to reuse chopsticks served in restaurants, contributing to an increased reliance on disposable wooden chopsticks. One company reportedly produces 8 million pairs of chopsticks per day, a consumption rate that is unsustainable and contributes to deforestation.

A swan uses plastic garbage to build her nest. Sunlight breaks plastic down into small pieces rather than into its basic elements, allowing it to easily enter waterways and float into seas and oceans. In a landfill, plastics can take 1,000 years to degrade.

Environmental Effects

The popularity of disposable utensils and plates is counterbalanced by their negative environmental impacts. Plastics and polystyrene can leach toxic chemicals and do not biodegrade. Plastics can break down into smaller pieces when exposed to sunlight, but when buried in landfills, they can take 1,000 years to degrade. Photodegraded plastic and lightweight polystyrene can easily enter waterways and float out to sea. In the oceans, the Great Pacific and North Atlantic Garbage Patches are areas concentrated with plastic particulates and other debris in the upper water column. Organisms that ingest plastics and polystyrene, whether in the oceans or on land, risk death by choking or disease from consumption of toxic chemicals.

In an effort to divert disposable items from the waste stream, consumers, industry, and nonprofit and government organizations are seeking ways to reduce and recycle plastics and polystyrene. For example, members of the Kokua Hawaii Foundation aim to educate the public on the environmental and health benefits of a plastic-free lifestyle. Many municipalities collect recyclable waste from businesses and residential communities. Recycled plastics conserve the amount of oil used to produce new plastics (approximately 8 percent of the world's oil supply). Additionally, some Japanese companies are finding other uses for recycled chopsticks by remaking them into particleboard, paper, and tissue.

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See Also: Fast Food Packaging; Food Waste Behavior; Pollution, Land; Recycling.

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District of Columbia

Neither a state nor a territory, the District of Columbia holds a unique role as the United States of America's capital city and one of the more elaborately planned cities in the nation. President George Washington commissioned French planner Pierre Charles L'Enfant to design a capital city in 1791. Article One, Section Eight of the U.S. Constitution grants Congress ultimate authority over Washington, D.C., and while the city has elected a municipal government since 1973, Congress retains the right to intervene in municipal affairs.

Waste Statistics

With an estimated population of 599,657, the District of Columbia disposed of 899,608.96 tons of municipal solid waste (MSW) and 169,831.67 tons of construction and demolition debris for a total of 1,069,440.63 tons in 2009. However, since D.C. has a ban on private landfill sites in the district, its MSW is collected by truck, taken to transfer stations and then hauled to Virginia, accounting for 7 percent of Virginia's annual MSW disposal. The residential recycling program run by the Department of Public Works (DPW) diverts 33,414 tons of material, or 24 percent of MSW to recycling from the 103,000 residential dwellings from which it collects, matching the national recycling rate. However, residents of the district produce 1.78 tons per capita of refuse, well over the national average.

Population and Labor

The district grew substantially after World War II, and between 1940 and 1970, the African American population became a majority, growing from 30 to 70 percent of the total population. The 1,700-member waste management workforce employed by the city was largely African American by 1970. Two years after the Memphis Public Works Department went on strike in 1968, the district's sanitation workers struck for the right to a comprehensive contract, which was won after a five-day strike.

Recycling and Composting

The district mandates that 45 percent of the total waste stream be diverted to recycling under the D.C. Solid Waste Management and Multi-Material Recycling Act of 1988. To aid in achieving such ambitious goals, the DPW adopted single stream (commingled) recycling and issued larger recycling bins for residential and commercial properties starting in 2005. The core government buildings for the District of Columbia already surpass the mandate by 10 percent, while the overall city rate for recycling is estimated to be only 34 percent. One incentive used by the DPW to increase compliance is the issuance of citations. The 3,114 commercial inspections conducted in 2009 resulted in 1,409 violations.

The district's DPW has expanded collection sites and materials in an attempt to stimulate greater participation in the recycling program. Residents dropped off 173 tons of electronic waste, 1,155 tons of scrap metal, and 93 tons of shredded paper at district transfer stations in 2009. On-site composting is strongly encouraged in the district for residences and commercial buildings, but no large-scale composting facilities are yet available. During 2009, the DPW composted 4,577 tons of leaves as part of the seasonal leaf collection program.

Environmental and financial incentives are driving the recycling and waste diversion program in the district. Hauling and processing fees for MSW cost D.C. $60 per ton, where a ton of recycled

materials comes in at $25 per ton. In an effort to better understand the types and quantities of materials being recycled after the introduction of single stream collection, the DPW conducted a study across the city analyzing data from all of the city's eight wards. The result showed that D.C. residents were much more likely to recycle newspapers and green and brown glass than the rest of the nation, but much less likely to divert steel cans, corrugated cardboard, or clear glass.

All federal buildings and foreign missions are responsible for their own MSW and recycling. No data is available for the embassies and consulates housed in the district. As with the U.S. government though, any potentially sensitive material leaving as waste must be incinerated.

The District of Columbia has set ambitious goals of reaching a 45-percent recycling rate. Perhaps this goal is too ambitious, as a recent study conducted by the DPW concluded that only 36.2 percent of the refuse produced by D.C. residents could be recycled. If composting becomes a viable option for commercial and residential sites, then a 45 percent diversion rate can be attained. The district will remain dependent upon Virginia for meeting its landfill needs for the foreseeable future.

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See Also: Definition of Waste; History of Consumption and Waste, U.S., 1950–Present; Recycling; Virginia; Waste Disposal Authority.

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Downcycling

Downcycling is the reprocessing of material into a new product of reduced quality or value. The reduction in value of the new material results in the use of the material for an alternative, but potentially similar, purpose. Downcycling occurs when recycling most types of materials because of technical limitations of the recycling process, composition of the products recycled, and the state of remanufactured product collection processes and commodities markets. Downcycling is not a method for indefinitely maintaining the use of a material through recycling, but rather serves to delay inevitable, eventual disposal. The concept of downcycling, although not invented by William McDonough and Michael Braungart, was popularized in their 2002 book *Cradle to Cradle: Remaking the Way We Make Things*.

Motivations for Recycling

The act and process of recycling holds great importance in the early development of the modern environmental movement. Recycling served as both a catalyst for organizing and a symbol of change from what was considered the environmental status quo of degradation. Citizen concern resulted in the institution of municipal waste recycling programs in Western nations beginning in the 1970s, and recycling continues to serve as an outlet for the expression of environmental values today.

The symbolic position of recycling has played an important role in increasing consumer demand for collection and reprocessing of waste material and the availability to purchase products produced with recycled content. Recycling of materials, however, is not limited to products encountered by consumers in the municipal waste stream. Recycling waste from the industrial production process along with building and infrastructure construction and demolition, though less visible to consumers, is also an important and long-standing component of the global recycling market.

Recycling provides both environmental and economic benefits. Reprocessing of material generally utilizes fewer resources and creates less pollution than initial processing of virgin materials. Recycling also reduces the need for the extraction, mining, or harvesting of virgin material.

Limitations of Recycling

Because of technical limitations of the recycling process and to the composition of products, almost all materials lose value from changes in material structure when recycled. Most plastics, when broken down, result in a lower-quality polymer. This material cannot be recycled back into the original form (for example, a bottle) but instead can only be used to produce more durable products, such as carpet or clothing. These new products cannot be recycled again. Another example of the limitation of materials and the recycling process is that of paper fibers. Each time paper is recycled, paper fibers decrease in length, resulting in the production of a lower-quality product. Eventually, the fibers become too short to be reprocessed into any form of paper. Whereas the product for recycling may have been first produced as white office paper, after subsequent recycling, the fibers are only adequate for the production of paperboard or paper towels, a lower-quality product with a lower material value.

Limitations of Recycling Collection and Markets

The process through which recyclable material is collected and the state of the market in which this material is sold also impacts product downcycling. In commingled collection of materials, several types or grades of materials are collected together in one stream or container. Commingled collection is popular because it requires a fewer number of separate recycling bins. For example, in commingled glass bottle collection, all colors of glass bottles (brown, green, and clear) are collected in the same container. Recycling bottles back into their original form requires the separation of each color because the mixing of colors in the recycling process causes clouding of glass in the final product. In order to recycle commingled glass bottles into their original form, processing companies must separate each color. This separation requires additional labor and other associated costs. It therefore may be more efficient and cost effective for a recycler to reprocess the commingled glass into a lower-grade and lower-value product, such as fill material for construction projects.

Recycling markets also affect how material is recycled or downcycled. As consumers increasingly request municipal collection of material, more and more "recycled content" is available for use. Recycling markets, however, are not always available or easily accessible for the remanufacture of products from collected material that may be recycled into a new form of lesser value.

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See Also: Economics of Waste Collection and Disposal, International; Economics of Waste Collection and Disposal, U.S.; Recycling.

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Dump Digging

Dump digging refers to the practice of excavating old garbage sites. From beachcombing with metal detectors to digging through 18th-century outhouse contents, whatever the location, dump diggers share a common pursuit—unearthing items that people threw away in the past. Dump diggers also refer to themselves as "historical diggers" to highlight the differences between their work and professional archaeology, particularly garbology. Unlike archaeological garbologists, dump diggers normally search for intact items of historical interest, particularly household artifacts like glass and ceramics, leaving shards or scraps behind. Other dump diggers search for military relics, buttons, stoneware, and coins. Motivations for dump digging range

from recreation to improving private collections and commercial sale.

Dump diggers are usually hobbyists, though some supplement their incomes by selling excavated materials at antique fairs and on the Internet. Dump diggers measure the value of the artifacts they find based on the objects' "collectiblity." To measure collectibility, diggers visit antiquarian shows and public gatherings, circulating photographs and stories about what they find. For example, glass bottles from the mid-1800s are exciting dig finds and popular collectors' items because diggers know that during this period, the United States saw a boom in the production of commercial medicines and home remedies, many of which were sold in glass bottles. During the same era, glassblowing and bottle manufacture evolved rapidly. Dump diggers value medicine bottles not only for the unique advertisements and labels they bear but also because 19th-century glassblowers constructed them using a range of ingredients and blowing techniques.

Techniques

To locate potential dig sites, dump diggers use spring steel probes and metal detectors as well as historical maps and photographs maintained in local libraries and historical societies. Unlike archaeologists, dump diggers generally do not obtain special permits. Most dump digging occurs on private property or on sites marked for development or demolition. Earth-moving machinery often reveals potential new dump sites. According to most veteran diggers, gaining permission from landowners or construction supervisors is as important in the digging process as digging test pits and consulting archives.

While most dump diggers search through abandoned town dumps they locate with archival maps and city plans, disused latrine wells are some of the most publicized dump-digging sites. As archaeologists and diggers know, privies doubled as household trash receptacles in the era before widespread household plumbing and curbside garbage removal. Digging organizations like the Manhattan Well-Diggers, who excavate wells on construction sites, have popularized privy digging, particularly in urban areas, which contain a surprising number of old latrine pits. Diggers look for undisturbed "night soil," or the privy's human waste layer, where they hope to find glass or ceramic bottles, pots, pitchers, plates, and bowls. After the advent of household plumbing, many privies were "dipped." Their human waste contents were removed and used as fertilizer. This process did not necessarily strip the wells of all their contents, and dump diggers continue to excavate these pits in search of artifact-filled night soil.

Controversy

Dump digging is controversial, and digging artifacts out of privy wells elicits particularly active debate between professional archaeologists and dump diggers. Archaeologists have clashed with diggers over how best to conserve and document the contents of dump sites. In particular, archaeologists critique amateur diggers' focus on the bottom of the wells. Archaeologists stress that in order to understand a site, they must excavate and document all of its contents in a meticulous and thorough fashion. Archaeologists of 19th- and early-20th-century U.S. cities point out that a great deal of meaningful evidence, including clues about social and cultural context, lies in pieces along the sides of privy wells. They claim that dump digging hinders their understanding of historical consumption patterns because diggers, in their haste to extract the most intact pieces, disturb or destroy the shards and organic material that are crucial to providing details about social life around dump sites. For this reason, some professional archaeologists have derided dump digging as "looting." Others have recommended that cities place stricter limits on digging at construction and demolition sites. They have also warned journalists and historical societies against overpublicizing or glamorizing the practice.

Looting is hard to define, but it is conventionally thought of as excavation without permission. There are many examples of dump diggers who criminally trespass to excavate sites, but most dump diggers obtain permission from property owners or developers. In the United States, private property laws protect digging on private sites. While digging on private property with the permission of the owner is not illegal, archaeologists still categorize the practice as unethical because artifacts are unscientifically removed from their

context. They claim that little about the past can be understood from examining only diggers' high-profile, high-value collectibles.

Dump diggers see themselves as historical preservationists. Dump-digging handbooks, organizational documents, and Websites make a clear distinction between dump digging and haphazard "treasure hunting." They contend that communities of collectors are just as capable of preserving artifacts as professional archaeologists. Dump diggers see themselves as reclaiming, preserving, and even rescuing historical materials that would otherwise be lost to the hands of development and demolition. Diggers often justify their work as stewardship, and many feel that the trade in collectibles helps raise their value and profile, eventually moving them toward a place in a museum.

Furthermore, they point out, most sites they visit will be permanently altered or destroyed before archaeologists have a chance to excavate them, as small towns and rural areas become overrun by new housing and industry, or as urban historic districts are cleared for skyscrapers. If the context of these archaeological sites will be destroyed, they argue, dump diggers can help preserve something of the historical record.

For many individuals and families, dump digging is a valued recreational pastime. Dump diggers usually begin with little or no formal training, but in some areas, museums and public archaeologists are attempting to engage them more directly in the hope that academic and recreational diggers can aid one another in evaluating the material cultures of the past.

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See also: Archaeology of Garbage; Archaeology of Modern Landfills; Dumpster Diving; Garbology; Landfills, Modern; Residential Urban Refuse; Street Scavenging and Trash Picking; Trash to Cash.

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Dumpster Diving

The large metal trash containers called "dumpsters" in the United States were developed in the 1930s to allow mechanical lifting and upending into a dump truck. Typically, they contain the refuse of several households or one or more businesses. In urban areas, they are usually placed outside apartment complexes, dormitories, or businesses. Temporary dumpsters are set up near construction and demolition sites. In rural areas, a series of dumpsters might be placed outside towns where individuals without garbage service dump their refuse. The volume of refuse that dumpsters contain makes them attractive spots for people looking to intercept the waste stream. These people participate in what is known as "dumpster diving," "skip dipping," or "skipping" in Australia and the United Kingdom.

Purposes

People dumpster dive for different purposes. For some, dumpster diving is an adventurous treasure hunt for choice items that they can use or give away. Certain artists collect items from dumpsters in order to create new and interesting art from old and discarded items. Other people regularly and systematically go through dumpsters, methodically collecting recyclable materials. Probably the most common form of dumpster diving in the United States as of 2010 was the collection of cans. Many low-income people collect and sell cans from dumpsters in order to purchase items that are not covered by a Supplemental Nutrition Assistance Program (SNAP). Some poor people, often mentally-disturbed or homeless, forage in dumpsters for food, while other people derive a decent living from recuperating items from dumpsters to sell. Others glean from dumpsters to provide charitable contributions, or simply to hoard. Freegans resist society's hyperconsumerism

by withdrawing as much as possible from money exchange and living off capitalism's waste. They protest societal norms that define consumption as good and waste as filthy.

Food

The aversion to using the waste of others is particularly strong when considering food, and the enormity of edible food discarded in dumpsters is mind-boggling. The same people who might brag to a friend about finding a particular treasure in a dumpster will often blanch at the suggestion of eating food from the same dumpster. However, for some people, dumpsters provide their primary source of nutrition. Food not Bombs is a "dis-organization" that retrieves food from the waste stream in order to prepare free meals for people. Stores discard food that is past its expiration date, and restaurants and caterers discard food that has been served. Most people do not adhere to such strict regulations in their own kitchens, so at one level people know that this food will generally not make them sick. Dumpster divers often have stories of feasts prepared from free food. They complain of a preponderance of breads and pastries, which have a shorter shelf life than canned foods and seem to be regularly overproduced.

Stories of feasts from dumpsters are paralleled by the long lists that nonfood dumpster divers produce when talking about the activity. The tone is one of disbelief, often tinged with self-righteousness, when recording items like flat screen TVs and boxed sets of china. The very new and very old hold special places in the inventory. Rural dumpster sites are sometimes called "the general store," indexing the abundance of usable items there.

Dumpster diving is often seen as a legitimate form of recycling: U.S. Navy volunteers on the Naval Air Station in Whidbey Island, Washington, participate in the base's annual Dumpster Dive in 2005. The teams compete to recycle as many treasures as possible.

Ideal Times

Timing is important to dumpster divers. Urban dumpster diving is often done in the evening after businesses close and people put out their trash. Some dumpster divers get to know the trash disposal rhythms of particular businesses and particular neighborhoods and adjust their schedules accordingly. Collecting cans after large public events, such as concerts and football games, is particularly rewarding. The calendar is also important. *Hippy Christmas* is a term that has been applied to specific days during the year when residents are allowed to dispose of large items, but more commonly to the end of university terms when students move out of apartments and residence halls, leaving piles of usable objects behind. A 2010 trash inventory at an Oregon State University residence hall midterm found that only one-third of the contents of a residence hall dumpster was trash. Everything else was usable or recyclable.

Restrictions and Hazards

Some businesses discourage dumpster diving by locking their dumpsters or putting them behind tall fences. This brings up the question of when an item ceases to be private property. Does ownership transfer from the individual or business to the waste management company the instant an item is

thrown in the dumpster, or is there a period of non-ownership from the time it is disposed to the time it is picked up? Some cities have passed ordinances making dumpster diving illegal.

Dumpster diving may be hazardous as well as illegal. Some businesses pour noxious materials over edible food to discourage dumpster divers. Other hazardous materials are disposed of in dumpsters with no thought as to who might be handling the contents later. A recent concern in rural areas has been the disposal of waste from methamphetamine labs including drain cleaners, white gas, and large bags of matches from which they scrape the red phosphorous. The fire hazard and poisonous gases that noxious chemicals can produce has caused some waste management companies to remove remote dumpsters.

Lists of "best practices" exist on the Internet for those wanting to try dumpster diving. These include the type of clothing that should be worn and useful equipment to take along. They tell dumpster divers not to climb fences or trespass and not to take confidential records. Dumpster-diver etiquette instructs people not to leave a mess and to take only what one can use, leaving the rest for subsequent divers. However, most dumpster divers learn the practice through oral transmission.

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See Also: Consumerism; Food Waste Behavior; Freeganism; Garbage Art; Overconsumption; Trash to Cash.

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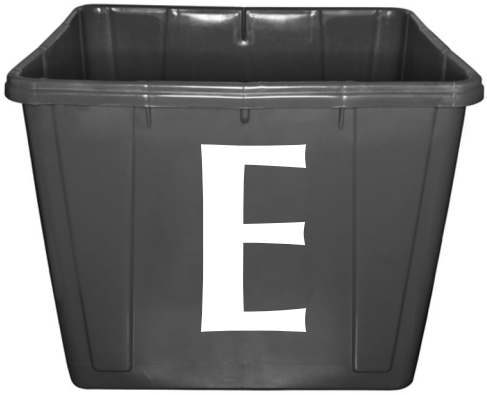

Earth Day

April 22 is the day when more than 180 nations celebrate Earth Day. Earth Day is the world's most widely observed secular holiday. It is supported by the international Earth Day Network and characterized by activities focused on environmental issues.

History

Earth Day was founded by Gaylord Nelson on April 22, 1970, turning April 22 into a national day of observance of environmental problems. According to the founding father himself, a U.S. senator at the time of establishment, the idea for Earth Day started with the realization that the state of the natural environment was not an issue in the politics of the United States.

This was the case despite the growing concern of U.S. citizens in the 1960s, which was stimulated in part by the 1962 publication *Silent Spring*, an influential book by U.S. marine biologist Rachel Carson (1907–64) about the use of chemical pesticides and their influence on health and the environment. The book raised awareness of the dangers of chemicals, led to the formation of environmental protection movements in many European countries, and put environmental issues on the U.S. political agenda.

Nelson managed to persuade U.S. President John F. Kennedy to give visibility to this issue by going on a five-day, 11-state conservation tour in September 1963. The tour became the germ of the idea that ultimately flowered into Earth Day. In 1970, a grassroots protest was organized by Denis Hayes, who was a professor of engineering at Stanford, the director of a national laboratory (SERI), and president of the Bullitt Foundation—an environmental foundation in Seattle. He was an environmental activist and proponent of alternative energy. This demonstration of popular protest tapped into the environmental concerns of the general public and infused the student anti–Vietnam War energy into the environmental cause. The demonstration of approximately 20 million people, many of whom were students from over 2,000 colleges and universities and about 10,000 primary and secondary schools, as well as other citizens, established a forum to express their concern with the environment.

Effects and Programs

Earth Day has been gaining in international popularity since the last decade of the 20th century.

The Earth Day Network (EDN) was founded on the premise that all people have a moral right to a healthy, sustainable environment. The Earth Day Network's mission is to broaden and diversify the environmental movement worldwide and to mobilize it as the most effective vehicle for promoting a healthy, sustainable environment. The EDN provides a combination of education, public policy, and activism campaigns and has, as of May 2010, more than 20,000 partners and organizations in 190 countries. The EDN coordinates more than 1 billion people who participate in the Earth Day activities, making it the largest secular civic event in the world. EDN's programs and activities are guided by goals including promoting civic engagement, broadening the meaning of "environment," mobilizing communities, implementing groundbreaking environmental education programs, and inspiring college students to become environmental leaders.

EDN's Environmental Education Program is one of the most successful in the United States, providing tools to educators and students for integrating environmental issues into core curriculum across disciplines and grade levels, in and out of the classroom. This program is also becoming increasingly known in Europe. In her book *The Morning After Earth Day*, Mary Graham described the sociopolitical effects of Earth Day on the international community in general and U.S. society in particular. The great increase in political efforts to address environmental problems following the establishment of Earth Day was unprecedented in the history of the U.S. (and, partially, European) environmental movement. Earth Day has also raised questions about settled habits, having to do with existing technology, dependency on energy and transportation, and the role that different political and social stakeholders play in environmental degradation. Despite its international success, Earth Day is less known in developing countries.

Earth Day activities range from greening schools in post-Katrina New Orleans to improving water and sanitation services in a refugee community in Ghana. Earth Day activities are widely publicized through social network sites such as Facebook, MySpace, Twitter, and LinkedIn. There were a number of children's books and online activity Websites containing Earth Day in the title published in the last five years.

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See Also: Environmentalism; European Union; United States.

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East Asia (Excluding China)

East Asia, because of its ancient and fascinating civilizations and economic rise, is an important part of the world. It holds a large part of the world's population, plays an ever-increasing role in the global economy, and is thus pivotal for global sustainability—or its failure.

Definition and Location

Geographically, east Asia is the eastern part of the Eurasian landmass. Politics and culture interfere, however, with this simple geographical definition. For example, Siberia is included in this geographic definition, but it has a distinct culture and history. When thinking geographically, it also makes sense to aggregate the diverse countries, regions, and cultures of the area, allowing one to compare the relative impact and importance of different world regions. This is occurring, in particular, in the context of organizations such as the Asia-Pacific Eco-

nomic Cooperation (APEC) and the Association of South-East Asian Nations, together with China, Japan, and the Republic of Korea (ASEAN Plus Three). Even an east Asian community ultimately meant to be similar to the European Union has also been proposed.

These organizations are moving east Asia and its neighbors toward regional integration (or at least cooperation). Trade and security concerns are at the forefront of these talks. Here, however, "Asia-Pacific" and even "east Asia" are commonly meant to include southeast Asia and potentially even Australia.

The term *east Asia* is used in various ways, and it hides considerable diversity within any of those definitions. Even regarding ecosystems, east Asia's ecosystem ranges from boreal forests to subtropical jungles, as well as from coastal urban conglomerates to remote, inland deserts. Parts of Russia, Mongolia, but most importantly China, the Koreas, and Japan all belong to this area. Most commonly, historical and cultural ties that connect these latter three countries are given the greatest importance in defining east Asia.

Taking China's influence as a common thread, east Asia is the region that has been influenced by Chinese thought, language, and literature. China's historical sphere of influence would allow the area to be expanded even further, however. Singapore, for example, is often included in the cultural sphere of east Asia because of its strong ties with China. By the same count, Vietnam could be included, but it is usually seen as part of southeast Asia. Then again, east Asia is sometimes used to refer to China.

Through those historical-cultural links between China, Korea, and Japan, some elements of culture—and also of consumption—are similar across this otherwise diverse area. Thus, not only in terms of geography (as an abstract region to compare with others), but also in terms of culture, it is possible to consider an east Asia that is internally linked and different from other cultural areas. In fact, the very distinctness of east Asian cultures, coupled with their economic successes, led to some resurgence of interest in possible causal connections between the values that are particularly pronounced in a culture (such as education and work ethic in east Asia's Confucian tradition) and the economic success of countries belonging to that culture.

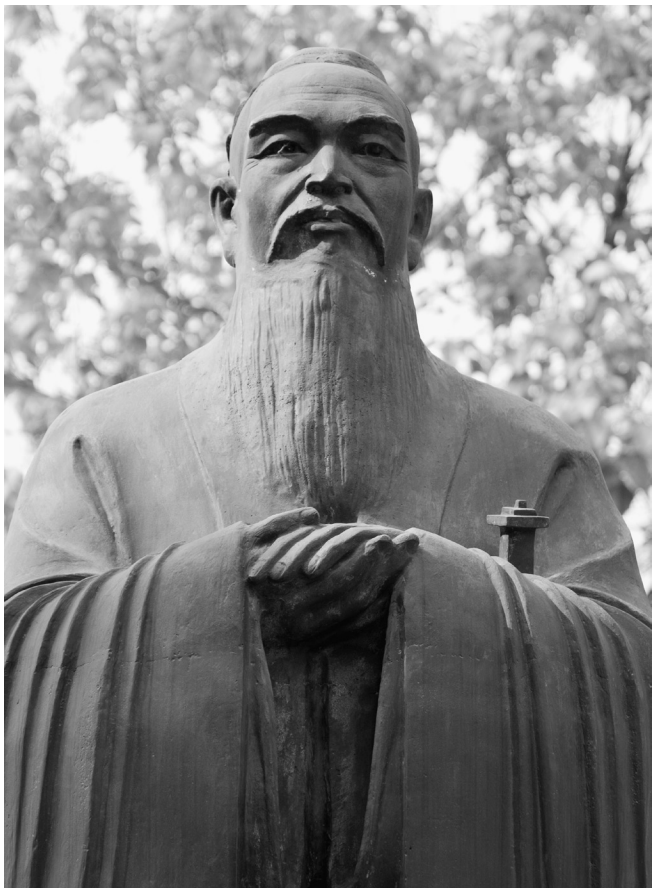
Historical Consumption

Consumption in east Asia is mainly discussed in the context of its economic growth since the second half of the 20th century. Much of the talk is about the (assumed) shift of global power and influence toward this region in an "Asian Century." Historically, however, east Asia long used to be a center of world population, urbanization, and economic activity. As the original home of some of the world's first widely traded luxury goods (such as silk, porcelain, and tea) as well as ancient civilizations with great economic activity, east Asia played a large role in the world economy long before it ever became global.

The region accounted for some 30 percent of global gross domestic product (GDP) between 1500 and 1850 (according to the data compiled by Angus Maddison), when the rise of the Industrial Revolution in Europe and then the United States shifted world economic activity toward the West (colonialism caused further decline in Asia). Even in these early times, there was widespread trade. This occurred along the Silk Road connecting east and south Asia with Europe, the Tea-Horse Route connecting southwestern China and Tibet with continental southeast Asia (what is now Burma/Myanmar, Vietnam, Laos, and Thailand), and far-ranging marine trade. The role of consumption is most apparent in descriptions of trade, not least those by Marco Polo, as well as in the archaeological remains of high-ranking persons, who were buried with a wide range of goods, both quotidian and luxury. Thus, a certain status of consumption and trade in valued products have a long history, although even Confucianism (let alone Daoism and Buddhism) would tend to hold scholars in high esteem and traders in rather low esteem. Moreover, the history of east Asia is also one of shifts between east Asian empires' openness to trade (and cultural exchanges) and closing off from the outside world.

Modern Consumption Patterns

In the 21st century, east Asia is spanning similar chasms: between tradition and modernity, between rampant consumerism and high savings rates, and



The teachings of Confucius introduced traditions that stress the need for humility and moderation in daily life in east Asia. Still, the region has long been a center of world population, urbanization, and economic activity, where luxury goods were first widely traded.

between a fast pace of development in recent history and a future that may be very different. Encompassing the world's most populous country (China) and two of the world's largest economies (China and Japan), east Asia has great importance. It holds 1.5 to 2 billion people and, according to World Bank data, the Asia-Pacific has a share of the world economy that amounts to 7 percent (based on GDP) or even 13 percent (by GDP based on purchasing power parity). Thus, it has a high impact regarding consumption and waste.

Even in 2009, when global primary energy consumption declined by 1.1 percent, energy consumption in the Asia-Pacific increased (according to the BP Statistical Review of Energy). The three largest economies in Asia (China, Japan, and South Korea) consumed 14.78 million barrels of oil per day, 17.6 percent of the total world consumption of 83.62 million barrels per day. U.S. consumption, however, is still higher, at 18.69 million barrels per day, or 22.4 percent of the world total daily consumption; these are absolute numbers and percentages and do not consider the respective population numbers.

Similar contributions to CO_2 emissions are found: eastern Asia produced 7,165 million metric tons of CO_2 emissions in 2007 (a 24 percent share of the world's 29,595 million tons). A particular problem in east Asia is the wide availability of coal, the use of which is greatly contributing to regional carbon emissions as well as atmospheric pollution. Per capita, however, emissions are only slightly above the world average of 4.4 tons, at 5.1 metric tons, and half of the recent growth in emissions results from production of goods for export.

Considering consumption of resources and colonization of nature, east Asia's challenges are apparent. Taking the entire Asia-Pacific together, the region holds 60 percent of the world's population. Even considering only China, Mongolia, the Koreas, and Japan, east Asia is home to 22 percent of the world's population. With 133 inhabitants per square kilometer (sq km), this region is populated three times more densely than the world average (45 persons per sq km). Availability of freshwater in the Asia-Pacific is only 36 percent of global availability, availability of biologically productive area per capita is less than 60 percent of the global average, and availability of arable land per capita is less than 80 percent of global average.

Thus, even while many of the economies are still developing, the ecological footprints of east Asian (and Asian-Pacific) populations exceed their locally available resources. Also, using the work of the Global Footprint Network, it can be shown that the Asia-Pacific region's ecological footprint, in terms of pollution and the capacity of regional ecosystems to absorb it, in particular as it is exacerbated by the high population numbers, is already the most negative in the world. Both the need for resources and the production of waste are set to increase still further into the 21st century. Economic growth in the area (high in the majority of its economies) is driven by improving living standards and by exports (so that consumption of resources in east Asia is not

only for the local population, but also for consumers in other parts of the world).

Waste

East Asia's role in the global problem of waste is peculiar. On the one hand, development and urbanization work together to increase the production of waste. East Asia is a main source of pollution not only in terms of CO_2 emissions but also in terms of atmospheric pollution—one of the most visible and spreading forms of waste. Solid waste production has also been on the rise, and recycling systems for consumers are hardly existent in most east Asian countries (with the exception of Japan and Korea). Therefore, a big challenge is the increasing amounts (and mixing) of organics and plastics, which are mostly deposited in landfills. As one can observe in many rural parts of developing east Asia, attitudes toward waste are anything but environmentally conscious.

Waste, from organics that should be composted to electronics that need special treatment, is simply thrown out. Residential waste, which tends to receive the greatest attention, is still less of a problem than industrial waste. However, industrial pollution of air, soil, and water in China, in particular, is increasingly troubling. According to attempts at calculating a green GDP for China, most if not all of the country's economic growth over the last decades is cancelled out by the increasing cost incurred through pollution. On the other hand, there is a major recycling industry, especially for plastics and metals, utilizing waste as primary material and employing people from local trash collectors up to specialized recycling companies.

It is not only in the production of waste that an attitude shaped by agricultural, local traditions comes to the fore. In the 21st century, consumption behavior in east Asia follows a seeming union of opposites (as was encountered through its history), between materialism and a disdain for it. East Asia has not only shown rising consumption of raw materials because of export-led economic growth in general, but also because of growth in private consumption. One particularly noticeable sector, maybe unexpectedly, is that of luxury goods. Buying for quality—and more importantly for the status that can be shown by it—is a widespread behavior. Japanese consumers used to show this behavior very strongly at the height of their economy but have since become very thrifty and reluctant spenders. The Chinese, on the other hand, have increasingly turned into voracious consumers. Among those who can (or want to) afford it, luxury products are very popular. The reason is less of a Western materialism than a Confucian conspicuous consumption in which possession of luxury goods denotes that one has succeeded, elicits the respect and deference desired from others, shows that one can care for one's dependents, and shows that one is a productive member of the relevant social groups. The wider wish to participate in the pleasures of developed lifestyles is also a reason underlying the wide availability of cheap goods, both for the Chinese consumer eager to purchase and the Japanese consumer wishing to act thriftily.

In the role of thrift, one encounters the other side of consumption in east Asia. The region is also well known for its notoriously low private consumption and the widespread focus on savings. Savings rates in households are typically very high; thrift and frugality are highly prized. It is not just traditional culture that accounts for the savings, however. Research suggests that high household savings in China result from the necessity to save up for a son's wedding; in order for a bachelor to be seen as eligible, he must be able to afford a house. Moreover, social safety systems are insecure (or barely extant) across east Asia, so that the aging population also hold savings as insurance for their own old age. Filial piety and care for elderly parents is a main tenet of the Confucian tradition, but one that has become rather weakened by declining family size, whether resulting from socioeconomic factors or (in the case of China) government policy.

Future

The future development of east Asia's impact is hard to gauge. On the one hand, continuing development is needed and likely. With economic growth and improving lifestyles, there is a trend toward increasing consumption. Waste produced is also increasing and changing, for example, toward a higher percentage of plastics. On the other hand, aging alone implies that growth will slow as there are fewer

people in the workforce—in particular, providing the pool of cheaper labor that much of east Asia's recent, rapid growth was based on. Additionally, younger people may try to limit their consumption as they need to make a living both for themselves and their children, save up for their own retirement, and support their elders (whether directly or in the form of tax money paid into pension systems). At the same time, even if elderly people hold a large share of east Asia's private wealth, they are wont to spend this money because it serves them as insurance in case of health problems or should the need for assistance arise. Predictions are further complicated by the possibility of ecosystem collapse or negative impacts of climate change, which would significantly impact east Asia. Pollution of air, water, and soils was already having a negative impact on population and ecosystem health by 2010). However, in the area of economic-industrial development, there is an increasing drive (not least for their economic potential) toward alternative energy technologies and green production methods. Concern over security and health has a further influence in promoting more sustainable lifestyles.

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See Also: Beijing, China; China; Culture, Values, and Garbage; Japan; Seóul, South Korea.

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Economics of Consumption, International

The forms and meanings of the term *consumption* in human society have varied between time and place. For much of human history, consumption has meant "using things up" produced within households. This is still the case in many parts of the world, and even in advanced societies, such consumption survives on the margins and is especially associated with women's labor. But as societies have developed, the economic meaning of consumption has come to be associated with the consumption of an increasing range of goods and services produced for exchange as commodities. In macroeconomics, consumption is the part of national output that is not saved. Consumption shares vary considerably between countries, as does the balance of private and public consumption. Private consumption is that of the individual. Public consumption arises where the state deter-

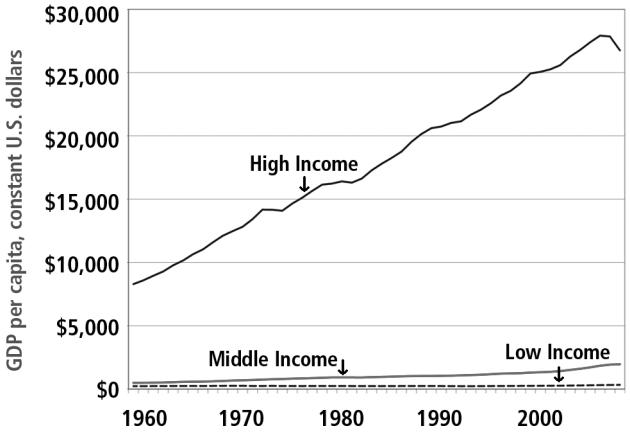

Figure 1 Growth in per capita GDP by country income group
Source: World Bank Development Indicators

mines the collective supply of public goods, such as education, health, and defense.

National Consumption and Income

In 1900, public and private consumption was estimated at a total of $1.5 billion worth of goods and services. By 1975, the figure was $12 trillion; in 2010, the total amount consumed worldwide is $31 trillion (at constant prices). The usual focus of the analysis of global consumption patterns is the nation-state, although some claim that there is a transnational ruling class defined both by its control of production and its consumption pattern. The world's population is over 6.5 billion spread over 194 officially recognized countries with different average income levels, which determine the overall patterns of consumption. The World Bank categorizes these countries as low income, middle income, and high income. Figure 1 shows that the gulf between high-, middle-, and low-income countries has grown substantially since the mid-20th century. gross domestic product (GDP) per capita in Switzerland was 191 times higher than that in Malawi in 1960; in 2010, it was 229 times higher.

Seventeen percent of the world's population lives in high income countries, yet they account for 80 percent of the world's consumption. The United States, with just 4.5 percent of the world's population, accounts for 32 percent of its total consumption. Despite their huge populations and booming economies, China and India only account for 4 and 2 percent of world consumption, respectively. In other words, these two countries, with 37 percent of the global population, consume only 6 percent of global output. For those in less-developed countries, consumption is strongly linked to the fulfillment of basic human needs.

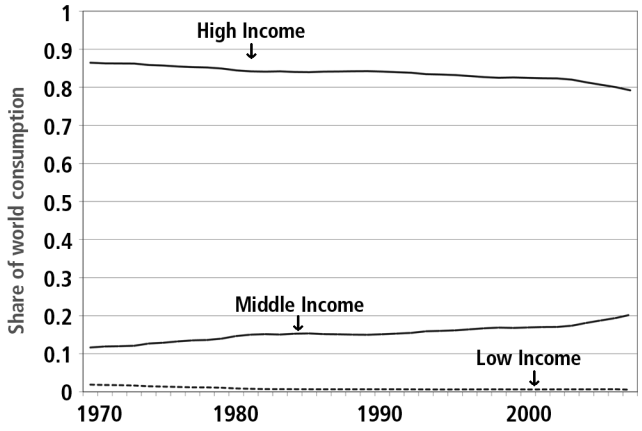

Figure 2 Share of global consumption by country income group
Source: World Bank Development Indicators

Consumption is also a function of inequality—an aspect that has been increasing since the mid-20th century—within countries. The way in which the number of billionaires and millionaires has risen on all continents is one visible aspect of this. Although the exact figures are disputed, there are over 1 billion people in the world living in extreme poverty (surviving on less than $1.25 per day) and an additional 1 billion people living on less than $2 per day. Such individuals have limited access or hope of access to sophisticated mass consumption goods like mobile phones, computers, or even a regular electricity supply. The volatile prices of basic commodities compound the problem of fulfilling consumption needs for those in extreme poverty. Increasing global demand for food, with supply hampered by uneven distribution and environmental disasters, has driven up global food prices, leading to fears of a global food crisis. Food riots in low-income countries reflect a moral economy of consumption that goes beyond market forces.

Pattern of Consumption and Economic Development

Human needs are different to human wants. For thousands of years, humans have lived lives structured around the fulfillment of basic needs: food, clothing, and shelter. The most basic human needs are independent of patterns of economic development. As long as average income per person allows individuals to satisfy only their basic necessities, no other types of consumption can develop.

Historically, the production of food has been the dominant use of labor, land, and capital. Efficiency growth in agriculture, with the development of new tools, labor-saving machinery, and plant and animal breeding, has led to a dramatic increase in yields and a relative fall in the inputs required.

Efficiency growth created the spare resources to drive the process of urbanization and industrialization. As average income per person increased, the pattern of consumption broadened, but the gains are

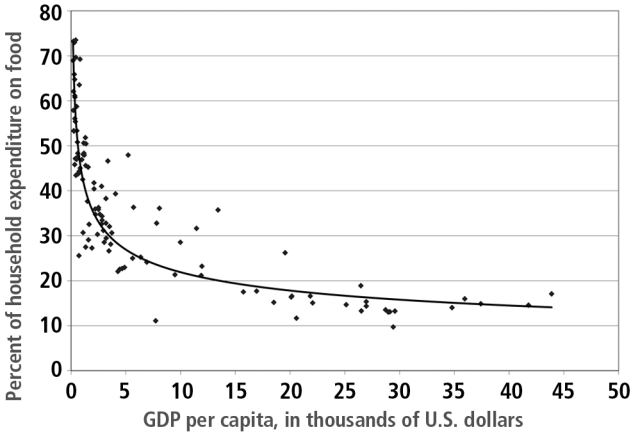

Figure 3 Engel Curve of relationship of household food expenditure to average national per capita GDP in 1996
Sources: GDP—IMF, Food Budget—U.S. Department of Agriculture

unequally distributed, which contributes to increased social differentiation. As society transformed from hunter-gatherers to settled agriculture, it allowed some individuals to become paid for functions other than food production. Warriors, priests, and administrators became full-time professions. It has only been in the last few centuries that (in the West) the mass population felt more of the benefits of this change. In many other parts of the world, consumption remains low for the mass of the population, despite the world becoming 50 percent urbanized by the turn of the 21st century. With increasing average income per person, households have an increased portion of their budget available to consume non-necessities and buy goods previously seen as only available to the rich. This pattern was first quantified by German economist and statistician Ernst Engel into an Engel Curve, which shows the negative correlation between average income per person and the share of household budget spent on food. Over time, as countries developed, the balance of consumption shifted toward manufactured goods and then began to give way to the consumption of service industry goods, including leisure goods, as the length of the working week declined in richer countries.

Theories of Consumption and Global Consumption Patterns

There are several theories regarding how this changing pattern of international consumption can be explained. Neoclassical economic consumption analysis is based on three assumptions. The first assumption, called "asocial individualism," states that individual preferences are not affected by either social and economic institutions or the behavior of others. The second, called "insatiability," states that it is human nature to want more of everything. The third, called "commodity orientation," posits that consumers make rational choices based on full perfect knowledge of the market and all possible alternatives.

Thorstein Veblen, on the other hand, in his 1989 work *Theory of the Leisure Class*, argued that consumption can be driven by a desire for intangibles, such as status. This was not only to be found in primitive tribal behavior but also in consumer behavior in both advanced and developing societies. Consumption goods yield both status and use value to consumers. Consumption patterns "trickle down" as status-good consumption of the wealthy is mimicked by the lower ranks of the wealth distribution. New luxury products are developed to replace the goods that become objects of mass consumption. Veblen saw individuals as intentional status maximizers who live in a social environment of shared values and who consume so as to raise their social status, rather than for any intrinsic product benefit.

With the development of a more integrated world economy and a globalized media and culture, Veblen's ideas can help to explain the ways in which aspirational-status consumption patterns develop across widely different levels of national development. They can also contribute to an explanation of the patterns of overconsumption identified in more-advanced economies.

In poorer countries, consumption by the rich can take place at the expense of investment. Ragnar Nurske argued that if consumers in developing countries attempt to emulate the consumption patterns of those in the developed world, then a lower household savings rate will result and expenditure will leak out, hindering the process of development. At any income, an increased level of consumption can only result in a lower level of saving. The luxury jeweler Cartier, for example, now has "boutiques" in over 125 countries, including very low-income countries, such as Angola, Myanmar, and Yemen.

Globalization and Consumption

For those who can afford it, one is never far away from the opportunity to eat a burger and fries, drive a luxury German car, or watch the latest Hollywood movie. According to Theodore Levitt, "the products and methods of the industrialized world play a single tune for all the world, and all the world eagerly dances to it. Ancient differences in national tastes or modes of doing business disappear." But is a global consumption pattern desirable?

George Ritzer coined the phrase "McDonaldization" to describe the situation where the principles of fast food restaurants are coming to dominate other aspects of society. In McWorld, the term *efficiency* means using the most cost-effective method to achieve a given end. Processes are streamlined in a rationalized setting. Calculability is the organizational emphasis on a calculable advantage. Quantifiable returns are more important than quality. "Bigger" is seen as "better," when in reality it merely provides an illusion of quality. Food portion sizes increase; yesterday's "large" size is today's "regular." The World Health Organization estimates that there are over 1 billion overweight people globally. The problem is not restricted to industrial societies; the fastest growth often occurs in developing countries adopting more advanced patterns of consumption—including the spread of high-calorie processed foods.

A third dimension of McWorld is predictability. A Big Mac is a Big Mac whether it is eaten in Manila or Montreal. Television shows like *The Simpsons* are increasingly seen throughout the world. Control is the fourth dimension of McWorld, the substitution of nonhuman technology for human technology, as result of which both consumers and workers are subject to greater levels of supervision.

These arguments have given rise to critiques of emerging global consumption patterns. One approach has been nationalist. Consumption culture is closely related to national identity, which some argue needs protection from potential homogenization as globalized goods and services sweep the world. The French government, for example, spends billions of euros and employs thousands of people each year to protect and promote French culture. Spain, South Korea, and Brazil all place domestic content requirements on their cinemas.

Writers and political activists like Naomi Klein have challenged branding and logos and the ways in which they are used to hide chains of globally exploitative relationships. At the bottom of global supply chains, those who produce Nike trainers or Apple computers cannot afford to buy the goods they make and may not even understand the uses to which their work is put.

More theoretical critiques of global consumption have been made from several quarters. J. K. Galbraith argued that consumption is not a product of "consumer sovereignty"; rather, it is producers who create consumer desires through market control and advertising. Global firms such as Vodafone and Marlboro turn to sales and marketing in order to create demand for more. The United Nations has suggested that aggressive global advertising, estimated at $450 billion in 2009, is creating a global consumption space. Producer control shifts the balance of support toward private consumption at the expense of collective consumption goods, despite the weak link between privatized consumption and well being.

However, in the late 20th century, neoliberal economic regimes developed in many countries with policies centered ostensibly on the idea of consumer independence and sovereignty. Consumption was often based less on income and savings as the encouragement of growing consumer debt eventually contributed to financial instability in some parts of the world.

The Frankfurt school developed a related critique of global consumption patterns. This group had a pessimistic view of culture and the global culture industries. Drawing from Karl Marx's concept of worker alienation in capitalism, they argued that leisure consumption becomes an afterlife structured by the dehumanized workplace. The centrality of profit leads to a cultural scene that is formulaic, soothing, and banal but maximizes audience share. Global media conglomerates such as Disney, Time Warner, and News Corporation control film, television, news gathering, music, and the publishing industry. Rather than have a revolutionary edge, art becomes increasingly passive, impoverishing existence outside the workplace and allowing individuals to return to the mindlessness of work.

These arguments have, however, been contested. Supporters of globalization argue that although common patterns of consumption may diminish differences between societies, they can create more diversity within, giving individuals a wider choice from which to consume. Cultural homogenization and increased heterogeneity are not mutually exclusive. Culture has always been a process of creative destruction.

Even if one accepts the power of global producers to try to determine any emerging consumption patterns, it does not follow that they will be successful. Whether the consumer or producer is "sovereign" has been discussed as the "agent" versus "dupe" question. Dupes are believed to have ceded their agency to producers. Others argue that individual agency is central to the operation of the market and consumer society. Consumers may have lost the power to reject consumption as a way of life, but firms increasingly use and construct consumer agency as a way to develop products. Those firms who best use consumer agency will profit from it. The failure of Coca-Cola to create a "New Coke" is an example of a global firm falling foul of its market.

Agency can also exist in terms of critique and opposition. With culture always creating a passive citizenry, there is no possibility of a mass revolt. But consumer resistance is always present in the market, although it can be contained, as when anticonsumerism is itself a marketed lifestyle and the anti-globalization movement and its key players become brands in their own right.

Are Global Products Really Global?

It is important to leave open the question of how far a homogenous global consumption pattern is squeezing out local firms. McDonald's is the organization most identified with a global product, but on closer inspection, even they adapt their product to sell in local markets. In India, they do not sell beef; they use halal or kosher meat in certain restaurants, have different policies on the sale of alcohol, and have different interior designs of premises. Films, books, and music all rely on local understanding and knowledge, hence, the existence of national industries despite the threat of Hollywood. The Netherlands, a country of 10 million Dutch speakers, produces most of the books on its best seller list. Organizations are far from overriding local consumption patterns, having to adapt and create products to fill these patterns, which have been described as a process of "glocalization." Moreover, for those living in poverty, access to branded global goods is limited. Although these products may be offered in the global market, they are not in reach of many consumers.

Global Consumption and Economic Sustainability

Some economists have defined the end point of development as the creation of an age of high mass consumption. Whether or not economic development is leading to equally high levels of consumption around the world remains controversial given the huge inequalities that exist between countries. Were such an age of equalized global high mass consumption possible, it could not be at the level of the most advanced countries given the finite limits on the planet's resources. This raises the question of how future allocation of consumption will be made. The political and economic challenge is to allow all humans in all countries to have good consumption levels without threatening the sustainability of the planet.

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See Also: Consumerism; Consumption Patterns; Developing Countries; Economics of Consumption, U.S.; Externalities; Household Consumption Patterns; Sustainable Development.

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Economics of Consumption, U.S.

U.S. consumption has provided markets for the world, enhancing and sustaining economic opportunities for many worldwide. Technological advances have created new methods of communication and access to information that have opened up a world of consumption opportunities. U.S. consumers can—if they have the money—have anything. The U.S. consumer can be anything with an identity in continual flux based on and around the possession and ownership of what the consumer buys. On the other hand, many Americans live in abject poverty or are barely surviving above the poverty level. Without access to markets in everything, they cannot be what they want based on what they buy. Competitive consumerist capitalism has led to a host of ills, including a gulf between the haves and have-nots, its existence dependent on continually luring both haves and have-nots into spending themselves into unsustainable levels of debt.

Poverty

Despite the ability of many Americans to access markets in everything with a click of the mouse or the swipe of a card, the U.S. Census Bureau reported the 2008 poverty rate at 13.2 percent of the U.S. population. Many U.S. families live just above the income level considered minimally sufficient to sustain a family with basic housing, food, clothing, and medical needs, and they move in and out of poverty from year to year. Forty percent of the U.S. population has been in poverty since 2000. The ability to meet basic consumption needs in the United States is unevenly distributed, with minorities and urban residents at higher rates of poverty. Both the absolute levels of poverty and the fact that the burden falls on the poor is underreported in media, almost making the problem invisible. In the United States, one can avoid poverty altogether by simply avoiding pockets of poverty and pretending that they do not exist. Media, advertising, and marketing dollars are directed toward the hyperconsuming, sovereign U.S. consumer.

Sovereign U.S. Consumer

The sovereign U.S. consumer is potentially the most sought-after customer on the planet; relied upon for world economic security; pampered and abused by marketers; seduced and plundered by banks and financial institutions; prodded, poked, and analyzed by researchers; and treated simultaneously as brilliant diviner of taste and unwary sucker. The U.S. consumer makes up approximately 18 percent of the spending in the world. Consequently, changes in U.S. consumption are important to the world economy. Nowhere was this more evident than during the worldwide financial crisis of 2008–09. The financial crisis was due in large part to the housing crisis and subsequent credit crisis in the United States. U.S. consumers who had been living on money borrowed from inflated home values had gone on a consumptive binge for nearly seven years, then suddenly recoiled and left the marketplace. Consumers, fearful of the future, stopped buying and started saving, businesses cut production and stopped borrowing, and banks ceased lending. With decreased borrowing, lending, and investment, consumption continued to decline globally.

Marketplace ramifications for employment around the globe are dependent upon the U.S. consumer. The types of jobs dependent on consumption have changed. Information technology and communications advances have eliminated many desk jobs and have made existing workers more productive. This means that unless new jobs are created or population growth reverses direction, the decline in U.S. consumption implies a global glut of goods with no one to buy them and, simultaneously, a surplus of workers. The irony of the economic situation of the early 21st century is that the Keynesian solution to replace missing consumer spending with government spending has met with substantial resistance. In order to keep or replace the U.S. consumer, marketers resorted to the most extreme forms of exploitation, via invasive entreaties into personal privacy, hidden fees, deception, courting and entrapping younger and younger children, and infantilizing all forms of public and private discourse in order to sell more goods.

Fundamental Question of Economics

Economic historian Robert Heilbronner describes economics as how individuals and societies materially provide for themselves, suggesting at a minimum that the fundamental question of economics is how people meet basic consumption needs. How does society produce, allocate, and distribute what it needs for consumption? The answer to the question of what economics is, and specifically what consumption is, has changed over time, as has the meaning of economics. Economics no longer directly addresses meeting society's basic needs by allocating scarce resources but instead studies behavior, individual choice, and well-being. Lost is the idea of society's provisioning and even the idea that there are basic needs. In the land of plenty, even the idea of scarcity has lost its central place in economics.

1776–1880

The history of consumption and study of consumption in the United States can be divided in four periods. From the founding of the country to approximately 1880, consumption met everyday needs and behaved with respect to the economic theory of the day—a static, simplified model where consumers had fixed preferences and were maximizing some measure of utility or happiness subject to the prices of goods and their budget constraint. In mainstream economics, the sole reason for production is consumption. Assumptions underlying the standard economic model of consumption used almost exclusively in undergraduate texts are commonsense.

Consumers are supposed to know their preferences, these preferences are transitive, the consumer is supposed to be rational in the economic meaning of rationality, more is preferred to less, and consumers are supposed to be able to ignore irrelevant alternatives. Consumers are bound by their budget constraint and prices—if they know them. These models served economists well before the late 19th century, but they were crude and based on primitive, unrealistic assumptions. The modelers refused—or could not incorporate—history, social relations, culture, or institutions.

1880–1950

Thorstein Veblen seized on classical economists' oversimplified descriptions of human economic behavior. He then proceeded to verbally eviscerate them. Veblen's work summarizes the second period of U.S. consumption from 1880 to 1950. Veblen, an economic heretic, shocked and embarrassed his profession while amusing the general public with his sometimes cryptic writings about how institutions, laws, history, and social relations impact economic behavior. Veblen coined the phrase *conspicuous consumption* to describe the idea that consumption serves not only as a tool to meet basic needs but instead as a status symbol, and *conspicuous waste*—the idea that one could consume something of no value at all to oneself or society as a show of status. Veblen fingered the vacuous nature of consumer theory: it entirely ignored the vital needs of individuals for social relations and status. His notion of pecuniary emulation described the competitive nature of conspicuous consumption and waste. He opened up a new way of thinking about consumption that provided the fodder for marketers and advertisers to use in providing consumers the symbolic meaning they craved, while simultaneously exploiting these cravings.

1950–1980

The growth of advertising and marketing post–World War II marks the third period of the U.S. consumer. Producers had earlier recognized in the 1920s that they needed to create new products and demand and build some obsolescence into their products, otherwise profits would be short-lived. Marketers recognized that consumers were so fixated on keeping up appearances that they would even forgo necessities to do so. The critical assumption underlying the still-dominant, unchanged, but renamed, neoclassical theory of the consumer—that tastes were immutable and not the domain of economic theory—was challenged vigorously in both practice and the ivory tower. Combined with the assumption that more is better (the gluttony assumption), advertisers could, theoretically, create wants and desires. Consumers could then be victimized and fleeced of their money; in effect, they could be coerced into making transactions that they otherwise would not. The idea of coercion hit at the core tenet of neoclassical economics that mutual gains could be had from voluntary exchange. If the exchange was coerced—and hence not voluntary—

the theory of the consumer and of markets themselves falls apart. The chief critic of advertising and its potentially devastating impacts on especially the poor was John Kenneth Galbraith, the Harvard professor, U.S. ambassador to India, and adviser to U.S. President John F. Kennedy. Galbraith challenged the idea that tastes are exogenous to the system and echoed many institutional economists' critique of capitalism in general that satisfying wants through the competitive capitalist markets neither leads to greater individual nor societal well-being.

While Galbraith did not necessarily call for bans on advertising, like others had in the 1920s, his cautionary tales were prescient. The average 21st-century American is exposed to over 3,000 advertisements daily. From eggs to bathroom doors to helmets to planes flying overhead at the beach to tattoos on college students—media messages are nearly impossible to avoid. Advertising dollars spent in the United States annually grew from $150 billion in 1997 to $280 billion in 2006. In 2001, over $40 billion (of $230 billion) spent on advertising was spent on children. Advertising spending in the United States is comparable to the amount of money spent on education.

Food is abundant and relatively affordable in the United States, which is one of the world's most efficient producers. However, the nation has an obesity problem bordering on an epidemic, blamed on increased consumption, poor nutritional values, and lack of exercise.

1980–Present

The fourth (and current, as of 2011) distinctive period of U.S. consumption began in the 1970s and 1980s with a significant increase in status-motivated consumption. Juliet Schor provides an extensive body of work documenting the inability of consumers to escape the work-and-spend cycle as consumers are locked in an unending gerbil wheel of a battle to keep up with, not the Joneses or their neighbors, but with reference groups they could never hope to emulate—TV heroes like the characters in *Friends* or *Frazier* or other sitcoms. This run on the gerbil wheel results in more spending, frustration, and reduced joys of consuming precisely because the status-conferring qualities of competitive consumption never materialize.

Overconsumption

From an individual standpoint, competitive consumption, consumerism, and commodification may be disappointing in terms of utility maximization. From a public standpoint, concerns about overconsumption are manifold. Scientific consensus has identified increasing consumption levels around the world and especially in the United States as increasing carbon dioxide levels and other greenhouse gases exacerbate climate change and threaten the overall quality of life. Materialism in the United States is envied and mimicked worldwide. Mimicking competitive consumption globally, combined with U.S. unwillingness to act unilaterally to curb consumption and political gamesmanship, may support the sovereign world consumer and individual consumptive utility maximization, but it may also end up tragically magnifying a global crisis.

The United States has an obesity problem bordering on an epidemic. Food production in the United States is a source of pride and revenue. The United States is a net exporter of food and one of the most efficient world producers of a number of

commodities. Food is, for most consumers, abundant and relatively affordable. Cheap, inexpensive food and profit-seeking marketers have combined with several generations who spend hours a day in front of a monitor, small or large, with little exercise. Questions about whether it is the amount or type of food, the lack of exercise, or a combination of the two has created increases in obesity (particularly childhood obesity). Childhood obesity increases health costs later in life and shortens life spans. Resources devoted to obesity-related costs could be used elsewhere.

While advances in measuring consumption preferences for public and nonmarket goods and services like those that the environment and ecosystems provide for all practical purposes, acknowledgement of this type of nonmarket consumption in practice is rare. Public goods, like infrastructure, public safety, or consumer protection, took the backseat to marketing, politics, and society's focus on the individual. Consequently, public consumption lags behind private consumption in the United States, and infrastructure is crumbling. All levels of government are struggling to raise revenue to cover long-term investments such as bridges, roadways, drinking-water systems, and sewage treatment plants.

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See Also: Carbon Dioxide; Consumerism; Food Consumption; History of Consumption and Waste, U.S., Colonial Period; History of Consumption and Waste, U.S., 1800–1850; History of Consumption and Waste, U.S., 1850–1900; History of Consumption and Waste, U.S., 1900–1950; History of Consumption and Waste, U.S., 1950–Present; Marketing, Consumer Behavior, and Garbage; Materialist Values; Sustainable Development.

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Economics of Waste Collection and Disposal, International

Economics and waste have a complicated relationship; as national economies grow, the waste stream from that country also grows. That seems simple, but if two concepts—sustainability and globalization—are added to the picture, the complexity becomes more apparent. Ever since the Brundtland Commission published its 1987 report *Our Common Future*, the notion of sustainability (defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs") has had an impact on how people regard waste. Images of overflowing landfills, accidents with hazardous wastes, and widespread awareness of the potential impacts of climate change have changed attitudes toward the environment. The environment is no longer a free good, in economic terms, but a valued scarcity with an existence that is threatened by the growing waste production of growing economies. Globalization acts with sustainability to exacerbate human awareness of waste, for these two key concepts point to a closely connected world. Local and international economies intersect, and

environmental policy decisions in one country may affect economic conditions in other parts of the world. In this context, waste is even more of a conundrum. A traditional definition of waste is of material that is no longer wanted and has no value for its owner; however, worldwide environmental regulation has enlarged that definition. Waste now can be viewed both as negative (a threat to the environment and the health of the planet) and positive (a resource or commodity that may be fed back into the production or commercial process to benefit local and national economies).

At the same time, most governments and economists in the developed world, with the developing world following close behind, view the production and consumption of goods and services as necessary to foster economic growth. However, increased production rates, along with increased use of natural resources and raw materials, lead to increased waste. Can increased waste, economic growth, and environmental concerns be reconciled?

Perhaps not, but German theorist Martin Jänicke suggests that local and international markets and environmental protection need not be mutually exclusive. To understand how this might be the case, one needs to examine what is meant by the term waste, how regulation and economic policy affect waste collection and disposal, and how businesses are responding to dramatically increasing international waste management opportunities.

Types of Waste and Waste Management Systems

All countries generate waste. But the kind of waste a country generates and how each country decides to manage its waste stream will, to some degree, depend on many intersecting factors. Geography, systems of government and law, manufacturing capabilities, public attitudes, and even climate will affect what waste is produced and the economic costs and benefits of managing its collection and disposal. Waste has a tendency to slip between categories, but five areas can give a basic image of the range of waste types: municipal solid waste (MSW), commercial, industrial, agricultural, and hazardous wastes. Because these categories are not completely separate from one another, the techniques for collection, disposal, or recycling of each type of waste may also cross categories. Various institutions—such as the Organisation for Economic Co-operation and Development (OECD), the World Bank, and the United Nations (UN)—as well as private consulting firms and some nongovernmental organizations—collect statistics on global production and management of different waste streams, but these figures are not easily comparable because collection methods and definitions of waste vary.

Worldwide, the most common form of rubbish disposal is the solid waste landfill, although amounts of waste disposed of in this way vary between and within continents. In Asian countries with large landmasses, such as India and China, almost 90 percent of MSW is disposed of in landfills. Countries in the Middle East have also traditionally relied on landfills, burying most waste in the desert. In many countries, availability of land for landfill is decreasing (because of population growth, urban sprawl, and resistance by communities to noisome dumps) and incineration provides an alternative. Despite the high costs of constructing and maintaining incineration plants—especially where there are strict emission regulations—these are a popular primary or secondary choice for waste disposal in many countries. The practice is most common in northern Europe, where landfill costs are high, and in Japan, where 73–78 percent of MSW is incinerated.

Other countries, such as the Philippines and Malaysia, have no incineration, in part because of the dangers of emissions from biomedical and hazardous wastes. Other waste streams come from commercial, manufacturing, and industrial sources. As with MSW, disposal practices vary from country to country, and each sector presents its own problems in disposal. Biomedical waste, for example, frequently cannot be recycled, and may contaminate other waste if not appropriately separated at the collection source.

Similarly, electronic waste (e-waste) causes significant disposal problems because of the high content of toxic materials. Other sources of waste that are often overlooked—yet have a direct relationship to economic life—are the waste created by natural disasters and the waste streams produced by the tourist and travel industries. Airports, for example, may generate amounts of waste similar to small

cities, while cruise ships have been condemned for their impact on local environments and economies. Climate change experts suggest that the number and intensity of natural disasters will increase worldwide, and these forecasts have been borne out by the amount of destruction and the number of casualties in recent disasters. The impact of these events on waste production occurs both at the time of the event and in the process of recovery, placing great additional strains on local and national waste practices and budgets.

Economic Growth

While waste is generated by every country, no matter how rich or poor, the amount of waste a society generates is closely related to a country's gross domestic product (GDP). In general, the higher the income in a society, the higher its waste generation will be. Within OECD countries, municipal waste increased an astounding 59 percent from 1980 to 2002 and further increases, though at a lower rate, are expected up to 2020. The pressure on developed nations to continue production and consumption as a means of growing their economies has reinforced this pattern of waste generation.

The implications for land use and the environment are enormous. A similarly disturbing pattern holds true in other parts of the world, especially as economies develop. Some scholars suggest that if developing countries aim for a Western consumer lifestyle, the detrimental impact of human activity on the environment will increase tenfold by 2050. The building boom in the United Arab Emirates (UAE) provides one such example. Not only does the construction industry generate waste but also other technologies—such as desalination plants—that support its cities generate both waste and emissions at rates that give the UAE one of the world's highest per capita carbon footprints. Disposal rates are so high that Dubai's single waste treatment plant is often overwhelmed, and a similar plant in nearby Sharjah has a landfill that processes up to 39,000 tons per day, an amount that is three times the amount processed at Puente Hills landfill (east of Los Angeles)—the largest operation in the United States.

This pattern is duplicated in other parts of the world. Recent economic development in Asia has shown that growth is accompanied by increased solid waste generation, with the management of this sector becoming a major social, economic, and environmental issue. Economic growth and urbanization in Malaysia, for example, is correlated with a rapid increase in the generation of MSW. The World Bank identified MSW management as a major environmental concern for Malaysia, where some areas have a similar solid waste generation to many OECD countries. China, the world's fastest-growing economy as of 2010, has been the subject of even greater scrutiny. With its increasing population, urban development, and rising consumption patterns, China experienced an annual increase in urban domestic refuse of 8.2 percent between 1986 and 1991; by 2005, China had surpassed the United States as the world's largest MSW generator. As a World Bank report from that year noted, "No country has ever experienced as large, or as rapid, an increase in waste generation." The same report suggests that China will have to deal with an eightfold increase in its municipal budgets by 2020 as it struggles to deal with the increased waste stream across the country.

It is a particularly pressing problem to understand how to decouple economic growth from increased waste generation. It is not only MSW that is produced as developing countries scramble to reach the level of consumer comfort that most citizens of developed economies take for granted; as economies grow, so do their energy needs. In many places where efficient and clean energy sources are sought to bolster growing economies, countries are turning to nuclear power—most of nuclear plants now being built are in Asia and in central and eastern Europe. While many commentators laud nuclear power as a green energy because of its relatively insignificant emissions, critics point to the difficulties of safely storing nuclear waste as the more relevant point in the debate.

Waste Management and Regulation

With all of these issues—growing waste streams and problems posed by hazardous technologies and materials—how do governments around the world approach disposal practices, and how do these approaches affect business opportunities? Approaches include both regulatory practice and

economic incentives and penalties to control the way goods are produced, consumed, and disposed of. Just as practices of disposal vary widely, regulatory approaches also differ around the world; however, common standards are increasingly being acknowledged worldwide. The work of the European Union (EU), through its executive body, the European Commission (EC), is particularly notable because it has actively pursued regulation of waste management since the 1990s. Aiming for sustainability, competitiveness, and cohesion, the EC promotes four key principles of waste management, all of which have an economic impact. These principles, as paraphrased by Mark Boyle in his 2003 article on waste management in the Republic of Ireland, are proximity (each member state looks after its own waste and should not need to export waste), the waste management hierarchy (prevention and minimization of waste production, then recycling and reuse over disposal), the precautionary principle (erring on the side of safety if there are any questions of hazard), and the polluter pays principle (PPP: the producer bears the costs of collection, treatment, and disposal). Of these key principles, the waste management hierarchy and PPP have been the most significant in both the EU and in influencing the development of policy and economic instruments in waste regulation around the world.

The EU requires its members to develop waste management plans (based on the hierarchy) with specific goals. A series of directives, such as those focusing on packaging and plastics, mining and extraction wastes, and hazardous wastes, have been promulgated since 1989, and member countries are meant to comply with these standards so that the environmental impact of waste will be halved by 2015. Within this broad framework, European countries develop their own strategies to meet EU targets. Germany, for example, introduced its Green Dot program in 1991, a program that directed producers to collect and recycle their own packaging. Countries seeking membership in the EU are also obliged to develop waste management plans as a condition of entry.

Since the beginning of the 21st century, waste management regulation has also had a high profile outside of Europe. Japan introduced its Fundamental Law for Establishing a Sound Material Cycle Society in 2000, with Korea following a similar approach with its Resources Conservation and Recycling Promotion Law in 2003. Waste management regulation, specifically directed at MSW, has also been enacted in other parts of Asia, including India, China, the Philippines (the Ecological Solid Waste Management Act was the first bill signed by incoming President Gloria Macapagal-Arroyo in 2001), and Taiwan. Other countries, including Indonesia, Malaysia, and Thailand, also have programs in place to control hazardous wastes and to reduce and recycle MSW. Australia has also developed a series of waste minimizing and recycling guidelines and targets ("Less Waste: More Resources") heavily influenced by the EU directives.

Regulation aimed at reducing packaging and e-waste has also been enacted across Asia and some parts of Africa. E-waste presents particular problems for developing nations: although it is banned from export from developed to less-developed countries through the Basel Convention, computers, cell phones, and other electronic goods still find their way to countries such as India, Nigeria, and Ghana, either illegally or through loopholes such as donations of goods. While India is attempting to address this issue with active recycling programs and regulation, the problem (often referred to as toxic colonialism) had not been solved as of 2010. Plastic bags and packaging are also often restricted or banned altogether by countries as diverse as Rwanda, Bangladesh, India, and the Republic of Korea, while recycling programs have been actively pursued in the Middle East (the United Arab Emirates and Israel, for example) and increasingly across Asia. Regulation, however, is not always the first step in encouraging waste management; in the UAE, cooperation and education (with a remarkable success rate of 85 percent usage of recycling receptacles, similar to rates in countries such as Canada) have been the foundation of recent programs, with compliance through regulation and economic incentives still to follow.

The climate for regulation and cooperation between government and industry has been slower in Latin America, but policy development indicates that this region is paying close attention to waste management practices. A short and incomplete list of examples includes Brazil, which has national regulation of pesticide packaging, with state laws

on recycling, plastic takebacks, battery and medicine disposal; Mexico, which has similar covenants on pesticides and packaging and classifies expired medicine as hazardous waste; and Peru, which has national legislation that promotes producer responsibility and recycling.

Regulation Compliance: Incentives and Penalties

In all cases of policy development, the costs involved—to consumers, producers, and governments—are carefully scrutinized and actively debated. Regulation is generally accompanied by some form of economic instrument, whether in the form of incentive or penalty, but the underlying question of who will bear the cost can make or break the success of waste management programs. There is no uniform answer to this question: regions and countries decide on the best approach depending on their particular mix of industry, legislation, communal wealth, waste type, and attitudes toward the waste management hierarchy. Japan's sound-material-cycle approach expects both producers and consumers to take an active role in contributing toward the safe disposal of goods, while policy in India suggests that responsibility for disposal and recycling should be shifted away from the end user. These varying approaches underscore the local interpretation of international standards. Despite these variations, economic instruments are needed along with standards and effective monitoring and enforcement.

Incentives and penalties often work together. In recycling programs worldwide, households and businesses are encouraged to increase recycling by having deposit refund programs, while use-based waste generation fees and disposal taxes discourage larger waste streams, and outright penalties encourage compliance with environmental laws. In Japan, for example, the Home Appliances Recycling Law mandates that producers actively recover and recycle products, while consumers actively contribute to recycling costs. Similar programs are being tested in Australia. Japan has a similar approach to its end-of-life vehicle laws, where manufacturers are obliged to accept CFCs, air bags, and automobile shredder residue to recycle, but consumers contribute to the cost of recycling.

In areas where municipal waste management practices are still being introduced, such as some towns in the Philippines, surveys showed that over 80 percent of residents and businesses agreed on the principle of collection fees; 49 percent of households and 67 percent of businesses agreed that costs should be correlated to the volume of waste generated. Increased organization of waste management in developing areas, though, has implications for government budgets, with local and national expenditures increasing. Budget gaps are frequently addressed by strengthening private-sector participation, developing markets for sale of recyclables, and encouraging regional cooperation to develop economies of scale.

In many cases, compliance with regulation is often seen as an economic burden. It costs consumers more to cover disposal or recycling costs; it costs producers more to design and implement preventive or end-of-pipe measures, as well as bear partial or full responsibility for recovery and disposal; and it costs governments greater portions of waste management budgets to properly collect and dispose of waste. In particular, producers in Europe, where regulation has been active, see the cost of compliance as a negative; if legislation is not uniformly observed around the world, competitors are able to produce goods at lower cost without regulatory penalties.

Economic Benefits

However, that negative picture is incomplete. Despite free market rhetoric around the world, regulation and economic instruments may in some cases act as protectionist policies rather than always disadvantaging local producers. In addition, stricter environmental and waste regulation may offer many economic opportunities at local, regional, and international levels. These opportunities exist for providers of goods and services and for workers across the spectrum of informal and formal sectors. Recycling programs are an example of the complexity and the economic potential for waste management. Successful recycling programs (which target both supply and demand) are cheaper than new landfills, provide used materials that may substitute for virgin resources, and create jobs in the informal and formal sectors. As efforts become more organized, recycled goods become market commodi-

ties, rather than waste. This effort, while generally positive, does have its downside: larger quantities are collected, causing oversaturated markets and volatile pricing. For example, the post-consumer commodities market fluctuated wildly in 2008, with prices for old corrugated cardboard and old newsprint falling by 79 percent and 72 percent, respectively. Such fluctuations cause local stockpiling of recyclables and may also lead to temporary, improper disposal of collected goods.

Recycling

Despite these pitfalls, new businesses abound in the greening of waste management around the world. In the formal sector, start-ups are entering markets to promote recycling. In the Middle East, for example, where recycling has been minimal, new joint ventures in the UAE (between municipal governments and local and international private companies) encourage voluntary recycling through collection points at Abu Dhabi's National Oil Company stations. Start-ups in India are also trying to address the safe disposal and reuse of Waste Electrical and Electronic Equipment (WEEE) goods, while China has emerged as a leader in recycling, with the largest plastics recycling plant in the world in 2007. In the informal sector, waste pickers collect and recycle material at the local level. According to a World Bank report, approximately 2.5 million waste pickers worked in China in 2005, earning up to $150 per month (about half the earnings of cab drivers). This kind of informal collection, present in both developing and developed countries, connects local activity to world economic cycles, since goods circulate both in the pre- and post-consumer phases before making their way to disposal sites.

Waste to Energy

Waste management may also contribute to economic opportunities in other ways. Waste-to-energy (WTE) incineration plants are attractive to many municipalities because they simultaneously deal with two pressing issues: the disposal of waste and the need for energy. Although WTE plants need to be larger than typical incinerators to be cost effective and to meet emission regulations, they are utilized in Asia (notably China and Japan), in many parts of Europe (including the United Kingdom, Italy, and Scandinavia), and in North America (Canada and the United States) and are under consideration in other countries, such as Israel.

The proposal for the WTE plant in Jerusalem, undertaken with the assistance of U.S. companies, illustrates another area of economic growth within waste management: the provision of expert advice and services. Many countries, especially those with developing economies, have a dearth of waste management experts and must turn to international firms and government experts for advice, equipment, and services. International firms look for opportunities around the globe. North American firms, for example, may provide expertise to clients in the Middle East and Asia on waste management, while seeking expertise from countries such as Denmark on WTE projects. The EU, as a leader in waste management regulation, is also a key provider of expertise, especially in the developing world. The global market for environmental and facilities services stood at $227.1 billion in 2008, with the leading revenue source in this industry being solid waste management services (nearly 52 percent of the total). With ongoing increases of over 14 percent, industry watchers estimate that global waste services will be worth $260.3 billion by 2013, making it a growth industry for investors.

Small Business

It is not only large firms that benefit from the greening of waste management. In China, an estimated 90 percent of enterprises working in the environmental protection section are small firms. In addition, migrant workers have joined the stream of economic opportunities, traveling within countries (e.g., from the south to the north of India), or between countries (e.g., from India and Pakistan to the UAE), to work in recycling projects.

International Institutions

International institutions, such as the World Bank, also support the economic flows of waste management projects. Funding from the World Bank has gone to projects in locations as diverse as the West Bank, Jordan, Belarus, Vietnam, North Africa, and China. The EC also plays a significant role in the provision of funds and advice, working in conjunction with institutions such as the World

Waste-to-energy (WTE) incineration plants, such as this Teesside WTE power station at Haverton Hill, United Kingdom, address the pressing issues of waste disposal and energy needs. The European Union is a leader in waste management regulation. The European Commission promotes principles of waste management that aim for sustainability, competitiveness, and cohesion; all have an economic impact. Member states look after their own waste, prevent and minimize waste production, err on the side of safety, and use the "polluter pays" rule.

Bank or providing technical expertise to projects in India, China, and elsewhere.

Conclusion

Waste management services is one of the fastest-growing industries in the world, yet its existence presents an economic and environmental conundrum. If the industry continues to grow, it could well mean that one of the primary goals of current waste management practice—to reduce the amount of goods disposed of in landfills and by incineration—has not been met. A thriving industry—a success from an economic standpoint—will mean that the environmental mission identified by government regulation worldwide has failed. Conversely, if environmental targets to encourage less consumption and less waste are met, the waste management industry will cease to be an economic powerhouse. Clearly, this conundrum will continue to pose challenges for governments and businesses worldwide, but perhaps the biggest challenge of all is to the dominant vision of incessant growth as positive, necessary, and inevitable.

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See Also: Consumption Patterns; Developing Countries; Economics of Waste Collection and Disposal, U.S.; European Union; Incinerators; Sustainable Development; Zero Waste.

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Economics of Waste Collection and Disposal, U.S.

The economics of solid waste management in the United States have a wide range of variability by region. Many factors coalesce to generate this unevenness, such as availability of land for the placement of landfills, the political views of residents, the degree of urbanization and industrialization of the region, the type of waste and the amount generated, the prevailing wages, the choices of solid waste managers, and the degree of interaction with their communities. The modern approach to solid waste management in the United States and other advanced countries is labeled integrated solid waste management (ISWM) because it makes use of a variety of procedures to handle the solid waste that is collected. The chief strategies pursued through the ISWM system are landfill disposal, incineration, recycling, and composting.

About one-third of every dollar spent on municipal solid waste (MSW) management goes into the collection of waste. This basically accounts for the capital costs of the equipment (and its maintenance), for the labor costs (which constitute a large fraction of the collection costs), liability, and insurance costs. Unless the final disposal or processing site is within a short distance of the collection area, the waste is typically transported to a strategically located transfer station where it can be redirected to its destination: a landfill, an incinerator, a composting facility, or a recycling center—also known as a materials recovery facility (MRF). In the case of landfills, the waste may be transported hundreds and even over one thousand miles, adding significantly to transportation costs.

Landfills

Modern landfills have to meet strict design and operation criteria imposed by federal and state governments. Title D of the amended (in 1984) federal Resource Conservation and Recovery Act (RCRA) requires that landfills be lined at the bottom and sides by several layers of plastic and clay to prevent rainwater that percolates through the landfill to reach the water table of the site where the landfill is located. This percolated water, known as the leachate, is highly contaminated with organic chemicals and heavy metals. The RCRA also mandates that this leachate be monitored and treated. Furthermore, these modern sanitary landfills slowly decompose organic matter buried deep within them in an anaerobic biological process that generates methane. This methane must also be extracted and either burned on the spot or used to generate electricity through controlled combustion. All these requirements make the construction and operation of a sanitary landfill a relatively expensive undertaking.

For example, a landfill that processes 300,000 tons of waste per year with a life span of 20 years can have a fixed cost of $86.7 million, including post-closure costs. According to the RCRA, the owner of the landfill is liable for methane gas recovery and leachate monitoring and treatment for up to 30 years after the closure of the landfill. These costs vary with location. In the northeast United States, land availability for landfills is scarce. Also, the closer a landfill is to a metropolitan area, the more expensive it is to build and operate. This is reflected in the tipping fees that landfills charge for waste. The average tipping fee for the 100 largest cities in the United States is $47 per ton of waste. However, if one takes New York City as a reference point, the tipping fee for a landfill located 100 miles away from the city is $94 per ton, while that of a landfill 500 miles away is about $38 per ton.

The siting of a new landfill is also a politically arduous process with many communities not willing to allow proximate placement because the landfill

is expected to create air pollution, possibly water contamination, a decline in the quality of life due to increased truck traffic and odors, and a concomitant decrease in property values. Within two miles of a landfill, housing values drop 6.2 percent for every mile that the home is closer to the landfill. This reluctance by citizens to allow the placement of a landfill (or, for that matter, an incinerator) near their community is what is known as the NIMBY (Not in My Backyard) phenomenon. As a result of both NIMBY and the RCRA regulations, the number of landfills has declined steadily, their size has increased substantially, and their locations have become more remote. The current trend is in the regionalization of landfills that accept waste from many towns, villages, and cities. These landfills have become larger, doubling their expected life span from 10 to 20 years. Many of the closed landfills were small waste dumps that did not meet state and federal regulations. Between 1988 and 1997, 500 landfills closed every year, decreasing from 8,000 in 1988 to 2,500 in 1997. By 2009, the total had declined to 1,800 landfills. Despite these reductions, the 10th-largest cities in the United States use a land area larger than the state of Indiana to discard their solid waste. In fact, the importation of solid waste from one state to another became a source of revenue for some states. By 1999, 8 percent of all waste generated was disposed of in another state. Pennsylvania went from burying 3.8 million tons of solid waste in 1993 to 7.9 million tons in 1996. Since it closed its huge Fresh Kills landfill in 2001, New York City sends 12,000 tons of solid waste every day to 26 different landfills and incinerators in New York, New Jersey, Virginia, Pennsylvania, and Ohio.

Incinerators

Incinerators have always been a controversial choice for the disposal of solid waste. They require a substantial capital outlay for their construction, their operating costs are high, and they have no flexibility regarding the throughput of waste—they must always operate at near their maximum capacity for economic reasons. Furthermore, their solid and gas outputs are considered hazardous, which results in their rejection by many communities with a more vigorous NIMBY response than that expressed against landfills.

Incinerators are designed to handle on the low end as much as 300 tons of waste per day, while the largest ones can handle up to 3,000 tons per day. Their corresponding initial costs range from $39 million to $780 million, respectively. Thus a mid-range-capacity incinerator burning about 1,200 tons per day, 365 days a year, for 20 years will need to charge a minimum of $39 per ton just to cover the capital investment. Even before considering operating and maintenance costs, this figure comes close to the tipping fees of many landfills in the United States. A reflection of this economic reality is the fact that the national average tipping fee for incinerators is about twice the national average of the tipping fee of landfills.

Most incinerators, as of 2010, are privately owned and generate and sell electricity to offset the operating costs. Incinerators operate under the principle of economies of scale and thus need to operate at or near maximum capacity in order to cover their expenses and guarantee a profit. This can be achieved only if the municipality agrees to deliver sufficient burnable solid waste to the facility. However, incinerator operators suffered a setback in 1994 when the U.S. Supreme Court issued a decision that made invalid all the "flow control" ordinances that municipalities had enacted in order to supply incinerators with this trash. This, in turn, forced incinerators to increase their tipping fees, which made them even less attractive as a waste disposal alternative.

Incinerators make economic sense either when they have a guaranteed supply of trash or when landfill operations are too expensive due to the scarcity of land, as in the northeast of the United States. The higher population density in this region makes it prohibitively expensive to find suitable sites for new landfills. Incinerators produce a variety of pollutants in their flue gas. Despite strict regulations that compel them to operate sophisticated air pollution control equipment, including the capture of fly ash (very fine and hazardous ash captured in filters), a very small fraction of the initial contaminant generated (such as carcinogenic dioxins) is released into the atmosphere. Furthermore, incinerators do not get rid of 100 percent of their burnable inputs; they produce a significant amount of ash collected at the bottom of the

incineration segment of the unit. Original burnable trash is only reduced in volume by 70–80 percent. The remaining ash contains heavy metals and other toxic substances and was also declared hazardous by a U.S. Supreme Court decision, meaning that it has to be discarded in special landfills reserved for hazardous waste. Incinerators have to send this waste to a landfill, but a hazardous-waste landfill is more expensive than a regular landfill. It costs approximately $260 per ton to landfill ash. Comparing this to about $65 per ton to landfill the original (preburned) waste makes incineration significantly uncompetitive with direct preburn landfilling. In addition, the hazardous chemicals in this ash are more concentrated and more bioavailable, making it a substantially riskier mode of waste disposal.

Taking all these factors into consideration, communities have massively rejected the construction and operation of incinerators in their midst. By 1985, more incinerator capacity was being cancelled than proposed. Nationally, the number of incinerators peaked in 1991 at 170; by 1997, this number was down to 130. In addition, communities all over the United States successfully forced hospitals to close down the incinerators in which they combusted their medical waste.

Recycling

The other two components of modern ISWM systems are recycling and composting. Frequently, composting is treated as a special case of recycling. Organic waste is processed just like any other recyclable waste and the final product is put to use by a third party. However, recycling (of discarded manufactured items) and composting are often addressed separately.

Recycling has been the subject of intense controversy since the mid-1990s, when some economists began to question its costs and benefits and estimated that the costs of most recycling programs exceeded the economic benefits. Recycling was contrasted to landfill disposal and found to be significantly more expensive. Ever since, the debate about acceptable rates of recycling and about what is appropriate to recycle has continued. Many local governments initially resisted the implementation of recycling programs, and the efficiency of these programs is fairly diverse from city to city and between the states. Recycling has three major components: collection and processing from the waste generator by municipalities and businesses, use of the recycled material by manufacturers to produce new products, and the purchase by consumers of products made from recycled materials. The first two components have been subjected to deep scrutiny and to laws and regulations to propitiate an environment in which the recycled material makes it into a product. Recycling involves the cooperation of households in segregating recyclables from the rest of the waste, making them available to the collection entity, which then takes them to a transfer station, much like with trash destined to the landfill. From here, it is transported to the processing center—the MRF. The bulk of what is recycled as of 2010 falls under the categories of white paper, newspaper, mixed paper, cardboard, plastics, metals, glass, batteries, electrics, and electronics.

Recycling: Supply

According to 2006 Environmental Protection Agency (EPA) estimates, 32.5 percent of solid waste was recovered for composting and recycling as a national average, with 24.3 percent being recycling alone. However, there are cities like Portland, Oregon, in which the recycling rate is 50 percent, with a target rate of 60 percent. Nearly 9,000 curbside recycling programs have been operating nationwide since 1997, serving almost half of the population. Recyclables are also collected at drop-off centers. An analysis of the composition of solid waste, according to 2006 EPA estimates, shows a distribution of paper (33.9 percent); yard waste (12.9 percent); food waste (12.4 percent); metals (7.6 percent); wood (5.5 percent); glass (5.3 percent); rubber, leather, and textiles (7.3 percent); and other (3.3 percent). According to these figures, about 89 percent of the solid waste stream is either recyclable or compostable.

There is room for improvement. Such is the view of the EPA's Office of Solid Waste that considers the costs of efficiently run curbside recycling programs to be comparable to those of the collection and disposal of solid waste in landfills ($50–$150 per ton versus $70–$200 per ton, respectively, in

1997 dollars). In many programs, the cost of collection and processing of recyclables exceeds the revenue generated by the sale of recycled materials. Moreover, depending on the location, the cost of collection and landfilling is also lower than that of recycling. However, the more densely populated an area is and the more recyclables a collection vehicle collects per run, the lower the recycling costs because of economies of scale. Besides, in the northeast, where land is scarce and the NIMBY phenomenon is strong, recycling costs for an efficiently run program can have an advantage over landfill disposal.

Solid waste managers have improved the efficiency of recycling programs simply by educating the population about the benefits of recycling, compelling more households to participate in recycling or increasing their recyclables. Other strategies have involved providing containers for recyclables or increasing the size of the available containers. Further efficiencies can come from the redesign of the collection vehicles so that they can collect more recyclables per run or to have multiple-use trucks that can collect recyclables simultaneously with the regular trash destined for landfills. The fine-tuning of collection routes has been attempted with the idea of maximizing the number of collection stops per hour while minimizing the driving time. In addition, as recyclables collection increases, the number of routes assigned to collect landfill-bound trash can be reduced and the number of recyclable collection routes can be increased with the same personnel.

Another way that local governments have found to increase the relative amount of recyclables collected is by charging the households directly per bag of landfill-bound trash put at the curbside. The reasoning is that if the households want to cut their trash disposal expenses by cutting down the number of bags they produce, they will recycle more items. For example, Grand Rapids, Michigan, charges $1.25 per bag. By 1999, 4,000 communities in the United States priced their garbage directly. Nevertheless, this approach has its drawbacks because of relatively high administrative costs incurred by local governments trying to determine how much garbage each household has generated and to deter the illegal dumping of those trying to avoid paying their per-bag fees.

Recycling: Demand

Municipal solid waste, in principle, is collected from households and institutions like schools and government offices. This accounts for 250 million tons of solid waste per year for the whole country. However, commercial and industrial waste that is nonhazardous is also allowed to join the municipal waste stream, approximately doubling this figure. The most significant role that industry plays in solid waste economics is in the purchasing of recycled materials to use as raw material inputs into their products. This is the demand side of the recycling question. Although the situation has progressed since the 1990s, many manufacturers are still reluctant to accept recycled materials into the processing streams, either because they claim it is too expensive to refit the equipment for this purpose, or because they allege that the supply of recycled materials is inconsistent.

In order to compel manufacturers to use recycled materials, a series of laws and regulations have been imposed by local, state, and federal governments. Governments require that products that they purchase have a minimum amount of recycled material in them. Some are considering instituting a program similar to Germany's Green Dot program in which manufacturers are made responsible for the recycling of their packaging. About 30 percent by volume of landfilled waste is made up of packaging materials, and for every dollar spent by a consumer on disposable goods (such as food), approximately 10 percent goes to pay for the packaging. Another way to compel manufacturers to accept more recycled material is through landfill taxation, which can be used to subsidize recycling programs or to tax virgin materials. Business-oriented economists decry most of these measures. But virgin materials benefit from subsidies in the form of federal tax breaks. Income generated by the timber industry is taxed at the capital gains rate and not at the corporate income tax rate. Minerals are depleted from their mining region, and this is used by the mining companies as a deduction from their income in the form of a depreciation; and much of mineral exploration and extraction is carried out on public lands at no extra cost to the companies. In addition, freight rates paid for recycled materials are often higher than those paid for virgin materials.

Composting is another solid waste treatment method that avoids either landfill disposal or incineration. Most types of organic materials can be composted, including yard waste, household food scraps, commercial organic waste, and paper. At the end of the process, the original waste has been reduced by as much as two-thirds. The humus byproduct has an economic value as topsoil, mulch, fertilizer, or landfill cover. In 2010, quality mulch could be sold for $39 per cubic yard. Composting realizes a $14 per ton cost savings over landfilling.

The argument that recycling programs lose money and therefore should be cut back in favor of the cheaper disposal of trash in landfills goes against the grain of the thinking of large segments of the population. It baffles economists that the public is willing to pay even more money for their solid waste disposal if it benefits recycling programs. Surveys indicate that households are willing to pay an extra $3.27–$4.91 per month for access to yard waste collection and $6.44–$9.66 to have access to both yard waste and recyclables collection. Deposit-refund systems (for example, for bottles and containers) are popular, with the state of Michigan having a 100 percent return rate. It is estimated that a 10 percent reduction in solid waste destined for the landfill can be achieved through the institution of a system that collects and refunds $59 per ton of returnable material.

Proponents of recycling argue that the fact that a number of recycling programs do not break even—they lose money because the costs exceed the revenue from the sale of recycled materials—is a red herring because most government programs "lose money." This is particularly true of solid waste disposal in a landfill or through incineration. People have to dispose of their solid waste in some way; when it is done by these two latter means, this is money spent without the expectation of getting any of it back. Meanwhile, there are a variety of benefits when people recycle that cannot immediately be easily allocated a value. Benefits include the recovery and reuse of materials (for example, the trees that can be spared by recycling paper), the reduction in the disposal of waste (and the land that is conserved with the concomitant suppression of pollution generation), and the reduced efforts at collecting waste (and the reduction in greenhouse gas emissions that this entails). Moreover, there is significant disparity between the number of jobs generated by landfill disposal in contrast to that generated by recycling programs. According to some estimates, recycling 10,000 tons of material generates 36 jobs, while landfilling the same amount creates six jobs.

Composting

Composting is another solid waste treatment method that avoids either landfill disposal or incineration. All sorts of organic materials can be composted, including yard waste, household food scraps, commercial organic waste, and paper. Up to 15 percent

of the solid waste stream is food waste, while yard waste constitutes 15 to 20 percent, either by weight or volume of municipal solid waste. Composting is a relatively simple process in which the shredded organic waste is combined with municipal sludge and then aerated properly (through a variety of technologies) for a period of weeks or months. At the end of the process, the original waste has been reduced by as much as two-thirds of the original waste, producing carbon dioxide, water, and humus (decayed organic mater). Humus has a variety of uses, such as topsoil, mulch, fertilizer, or as landfill cover. Initially, the "mulch" was given away for free to farmers and horticulturalists, especially when the quality of the mulch was inconsistent. In 2010, a properly processed mulch could commanded a revenue of $39 per cubic yard. Composting can be performed year-round on the ground in warmer climates like those of the Gulf Coast states, but it can also be carried out indoors with the proper technology and process design. For example, the city of Edmonton, Canada, has indoor composting facilities the size of 14 professional hockey rinks. Composting is economically superior to landfilling, with a net cost savings of $14 per ton.

Conclusion

The data presented describing the economics of solid waste management in the United Sates is hard to gather because of inconsistent, unavailable, or faulty records maintained by local governments. In spite of this, the economic picture shows that solid waste managers have a variety of options through the ISWM approach. Which methods they choose depends on a variety of factors. These factors depend on the population density of the locality and the particular idiosyncrasies of local government bureaucracies. Often, local residents form coalitions to force changes in the solid waste management system, for example, increasing recycling efforts or closing down incinerators. When solid waste is not directly handled by municipal governments, the job is done by private companies with the oversight of the government. By 2010, two companies, Waste Management, Inc., and Republic Services, Inc., handled more than half of the solid waste generated in the United States. These companies reduced costs by using fewer personnel. In general, government collection and disposal of solid waste is more costly than when private companies perform these services. According to some studies, whether collection is by private companies or by municipalities depends on the ideological bent of the local population. In conservative municipalities, waste collection and disposal is carried out by private companies, while in more liberal towns and cities, it is the municipality that takes care of solid waste.

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See Also: Composting; Incinerator Construction Trends; Incinerators; Industrial Waste; Landfills, Modern; NIMBY (Not in My Backyard); Post-Consumer Waste; Recycling; Waste Management, Inc.

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Emissions

The generic term *emissions* is used to portray gases or particles pumped into the air by various sources. Emissions are not necessarily pollutant or harmful for living creatures. The Environmental Protection Agency (EPA) is mainly concerned with emissions that are or could be harmful to people. The EPA calls this set of principal air pollutants "criteria pollutants." The identified criteria pollutants are car-

bon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2).

Carbon Monoxide

Carbon monoxide is an odorless, colorless, and toxic gas. Known sources for carbon monoxide are unvented kerosene and gas space heaters; leaking chimneys and furnaces; back-drafting from furnaces, gas water heaters, wood stoves, and fireplaces; gas stoves; generators and other gasoline-powered equipment; and tobacco smoke. Incomplete oxidation during combustion in gas ranges and unvented gas or kerosene heaters may cause high concentrations of CO in indoor air. Worn or poorly adjusted and maintained combustion devices (such as boilers or furnaces) can be significant sources, as can the flue if it is improperly sized, blocked, disconnected, or leaking. Automobile, truck, or bus exhaust from attached garages, nearby roads, or parking areas can also be a source. The effects of CO exposure can vary greatly from person to person depending on age, overall health, and the concentration and length of exposure.

Lead

Lead's toxicity has been recognized for more than a century; the metal is associated with the impairment of neural development in infants and young children and with cardiovascular disease and premature death in older people. Governments have long tried to reduce exposure by controlling industrial emissions, removing lead from gasoline, and mounting campaigns to remove lead-based paint from homes. In the United States, some of the highest lead levels in blood can be found in children in older cities like Philadelphia, Pennsylvania; Providence, Rhode Island; and Cleveland, Ohio. In 2008, the EPA set new limits for exposure at 0.15 micrograms per cubic meter of air, down from 1.5 micrograms.

Nitrogen Dioxide

Nitrogen dioxide is a highly reactive oxidant and corrosive gas. The primary sources indoors are combustion processes, such as unvented combustion appliances like gas stoves, vented appliances with defective installations, welding, and tobacco smoke. Effective measures to reduce exposures to this gas are venting the NO_2 sources to the outdoors and assuring that combustion appliances are correctly installed, used, and maintained.

Ozone

Ozone is a molecule consisting of three oxygen atoms. Ozone in the lower atmosphere is an air pollutant with harmful effects on sensitive plants and the respiratory systems of animals. The ozone layer in the upper atmosphere is beneficial, preventing potentially damaging ultraviolet light from reaching the Earth's surface. Exposure to ozone has been associated with premature death, asthma, bronchitis, heart attack, and other cardiopulmonary problems. The EPA lowered its ozone standard from 80 parts per billion (ppb) to 75 ppb in 2008. Nevertheless, the World Health Organization recommends 51 ppb.

Particulate Matter

Particulate matter is a mixture of very small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles. According to the EPA, the size of particles is directly linked to their potential for causing health problems. Particles that are 10 micrometers in diameter or smaller can pass through the throat and nose, invading the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. The EPA groups particle pollution into inhalable coarse particles (those found near roadways and dusty industries, larger than 2.5 micrometers and smaller than 10 micrometers in diameter) and fine particles (those found in smoke and haze that are 2.5 micrometers in diameter and smaller). These particles can be directly emitted from sources such as forest fires or they can form when gases emitted from power plants, industries, and automobiles react with other substances in the air.

Sulfur Dioxide

Sulfur dioxide is a highly reactive gas. According to the EPA, the largest sources of SO_2 emissions are from fossil-fuel combustion (especially coal) at power plants (73 percent) and other industrial

facilities (20 percent). Smaller sources of SO_2 emissions include industrial processes such as extracting metal from ore and the burning of high-sulfur-containing fuels by locomotives, large ships, and non-road equipment. Sulfer dioxide is linked with a number of adverse effects on the respiratory system.

Other Pollutants

There are also a large number of compounds that have been determined to be hazardous and are called "air toxics." They are pollutants known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects.

Categories and Measurement

The EPA has grouped emissions into two main categories: point and mobile emissions. Point source emissions come from clearly identifiable and relatively fixed sources like factories and electric power plants. Mobile sources include cars, trucks, lawn mowers, airplanes, and other moving items that put gases or particles into the air. Additional classifications can include biogenic (produced by living organisms or biological processes) and area emissions (spread over a spatial extent, like a county or air district).

Measurement of emissions is a complex process involving the detection of thousands of different substances in a variegated set of environments. In the United States, there is a central repository for measurement data from emissions. The Clearinghouse for Inventories and Emissions Factors (CHIEF) is a centralized resource for emissions data. The emissions data that is stored by CHIEF is normally used to create models, which can help to predict what air quality will be like in the future and what effect new regulations might have on air quality.

Greenhouse Gases

Greenhouse gases (GHGs) are released into the atmosphere by several sources. One of the main areas of interest regarding emissions has to do with global climate change due to anthropogenic sources of GHG emissions. The main GHGs in the Earth's atmosphere are water vapor, CO_2, methane, nitrous oxide, and ozone. Once in the atmosphere, those gases absorb and emit radiation within the thermal infrared range. This process is the cause of the greenhouse effect. Controlling for emissions coming from GHGs is a major environmental challenge for the United Nations. The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing GHG emissions. These amount to an average of 5 percent against 1990 levels over the five-year period 2008–12.

Natural gas is mainly composed of methane, which produces 20 times more radiation than carbon dioxide. Carbon dioxide receives more attention in the media over other greenhouse gases because it is released in much larger amounts. Still, it is inevitable when natural gas is used on a large scale that some of it will leak into the atmosphere. Current estimates by the EPA place global emissions of methane at 3 trillion cubic feet annually, or 3.2 percent of global production. Direct emissions of methane represented 14.3 percent of all global anthropogenic greenhouse gas emissions in 2004. According to the United Nations' Intergovernmental Panel on Climate Change (IPCC), from 1750 (the dawn of the Industrial Revolution) to 2005, the concentration of atmospheric CO_2 has risen from 280 to 379 ppm. Emissions have mounted in the 21st century. In 2009, total global CO_2 emissions had increased 25 percent since 2000 to 31.3 billion tons and almost 40 percent since 1990, the base year of the Kyoto Protocol.

Current trends in GHG emissions have impacted global weather. The amounts and types of emissions change every year in different countries. Those changes are caused by changes in global and regional economies, industrial activity, technology improvements, traffic, and many other factors. Air pollution regulations and emission controls also have an effect.

In 1970, the U.S. Congress passed the Clean Air Act (CAA) Amendments (the CAA was passed in 1963), which set into motion a nationwide effort to improve the country's air quality. Since then, additional laws and regulations have been added, including the 1990 amendments to the Clean Air Act. The global economy is a powerful driver for

emissions. For example, in 2009, for the first time since 1992, there was no growth in global CO_2 emissions from fossil fuel use, cement production, and chemicals production. In 2009, a strong world economic recession led to a dramatic decrease in CO_2 emissions of approximately 7 percent in most industrialized countries. This drop of 800 million tons in emissions compensated for the continued strong increase in CO_2 emissions in China and India of 9 percent and 6 percent, respectively. This would have been the largest drop in more than 40 years because the global recession froze economic activity and slashed energy use around the world.

Since 2000, carbon emissions in China have more than doubled; in India, emissions have increased by more than half. Since the end of 2008, China has been implementing a large economic stimulus package over a two-year period. This package includes investment in transport infrastructure and in rebuilding Sichuan communities devastated by the 2008 earthquake. In 2009, CO_2 emissions jumped by 9 percent to 8.1 billion tons, even though China has doubled its installed wind and solar power capacity for the fifth year in a row. India, where domestic demand makes up three-quarters of the national economy, remained relatively unaffected by the credit crunch. Emissions continued to increase in 2009 by 6 percent to 1.7 billion tons of CO_2. India surpassed Russia as the fifth-largest CO_2 emitter.

A recent global estimate of the share of energy use attributed to urban areas (approximately 66 percent) suggested that the GHG emission share reached 70 percent. A global, geographically disaggregated estimate of GHG emissions from urban areas, however, had yet to be conducted as of 2010. Nonetheless, most of the measurements are performed in industrialized countries. The assessment excludes CO_2 emissions from deforestation and logging, forest and peat fires, postburn decay of remaining above-ground biomass, and decomposition of organic carbon in drained peat soils. The latter mostly affects developing countries. These sources could add as much as a further 20 percent to global CO_2 emissions.

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See Also: Automobiles; Car Washing; Engine Oil; Fuel; Gasoline; Tires.

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Engine Oil

Engine oil is used to both prevent friction between internal metal surfaces of an engine and transfer heat away from the combustion cycle. Rubbing of metal engine parts produces microscopic metallic particles from the tiring and wearing of surfaces. Such particles could circulate in the oil and grind against moving parts, causing wear. To prevent this, oil is typically circulated through a filter to remove damaging particles. An oil pump powered by the engine pumps the oil throughout the engine, including the oil filter, catching the waste gathered by the oil along the cycle. Engine oil also cleans the engine of waste chemicals and buildups by grabbing the hurtful by-products of combustion, such as silicon oxide and acids, in suspension. Many engine oils have detergents and dispersants added to help keep the engine clean and minimize oil sludge buildup.

Modern varieties of engine oil are designed to work for extended periods under tremendous heat and pressure without losing mechanical or chemical characteristics. Engine oil is supposed to reduce oxidation that occurs most frequently at higher temperatures. Corrosion inhibitors are sometimes added to the engine oil. The specific composition of any given corrosion inhibitor depends on many factors, including the material of the system it has to act in, the nature of the substances it is added into, and the operating temperature. Some of the most common inhibitors are nitrites, chromates, and phosphates.

Used Oil and Oil Filters

An average car utilizes up to five quarts of engine oil, which has to be replaced approximately three or four times per year. Most of these changes are performed at service stations, where worn oil and filters are generally collected for different uses. A primary use for used engine oil is to re-refine it into a base stock for lubricating oil. This process is very similar to the refining of crude oil. According to the American Petroleum Institute, lubricating oil does not wear out, it simply becomes dirty as it does its job. Once water and contaminants are removed from used oil, it is returned to a full and useful life as re-refined base oil. The claimed result is that the re-refined oil is of as high a quality as a virgin oil product. Other sources assert that only 2.5 quarts of re-refined lubricating oil can be produced from one gallon of used oil.

A secondary use of the used oil is to burn it for energy production. Some used oil is sent to power plants or cement kilns to be burned as fuel. On a smaller scale, small quantities of used oil are burned in specially designed heaters to provide heating for small businesses.

An average car requires up to five quarts of engine oil to run properly, which should be replaced three or four times a year. Engine oil can be repeatedly refined as a base stock for lubricating oil, in a process similar to crude oil refinement.

Each year, the United States generates 425 million used automotive oil filters containing 160,000 tons of iron units and 18 million gallons of oil, since used oil filters can contain more than 45 percent used motor oil in weight when removed from the vehicle. Recycling all the filters sold annually in the United States would result in the recovery of about 160,000 tons of steel, or enough steel to make 16 new stadiums the size of Atlanta's Turner Stadium. Nonetheless, in the United States, less than 60 percent of used oil and filters are recycled.

Runoff

A significant amount of car owners change engine oil routinely at home. In California alone, one in five households have a do-it-yourself (DIY) oil changer. Those DIY devices can collect used oil for recycling, but some of the oil is not recovered. Cars leaking oil and oil spilled directly into driveways are an important cause of what is called *nonpoint source* (NPS) *pollution* or *polluted runoff*. This phenomenon is created when rain, snowmelt, irrigation water, and other water sources run over the land, picking up pollutants and transporting them into local water bodies. NPS pollution is also called "people pollution" because much of it is the result of activities that people do every day. Because each individual contributes to NPS pollution by performing daily activities, NPS pollution is the biggest threat to ponds, creeks, lakes, streams, rivers, bays, estuaries, and oceans. With each rainfall, pollutants are washed from surface and land areas into storm drains that flow into nearby waterways. Oil dumped on land reduces soil production. In the United States, more than 60 percent of water pollution comes from NPS, such as runoff from agricultural areas draining into rivers, fertilizers from gardens, or failing septic tanks. The oil from a single oil change can ruin the taste of a million gallons of drinking water (1 part per million), the supply of 18,250 people for 24 hours. It also has been demonstrated that concentrations of 50 to 100 parts per million (ppm) of used oil can pollute sewage treatment processes. According to the Environmental Protection Agency

(EPA), one quart of motor oil can pollute 250,000 gallons of water.

Oil and petroleum products are toxic to people, wildlife, and plants. Used motor oil can contain toxic substances such as benzene, lead, zinc, and cadmium. Since oil does not dissolve in water, it lasts a long time. Oil sticks to everything from beach sand to bird feathers. Films of oil on the surface of water prevent the replenishment of dissolved oxygen, impair photosynthetic processes, and block sunlight. The EPA has calculated that used motor oil is the largest single source of oil pollution in lakes, streams, and rivers. For Christine Todd Whitman, former administrator of the EPA, countless small acts, such as changing cars' oil in driveways without cleaning up leaks, can add up to big problems. According to the EPA, Americans spill approximately 180 million gallons of used oil each year into the nation's waters. This is approximately 16 times the amount spilled by the *Exxon Valdez* in Alaska in 1989.

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See Also: Car Washing; Emissions; Fuel; Gasoline; Tires.

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Environmental Defense Fund

Nonprofit organizations have played a crucial role in both forming state and national policy on waste and environmental issues and shaping public behavior. One of the oldest and most influential nonprofit organizations, with more scientists and economists on staff than any other similar organization, is the Environmental Defense Fund (EDF). EDF primarily focuses its resources on four key areas: global warming; land, water, and wildlife; oceans; and health. It is a critical source of information and advocacy, and its efforts have provided four decades of significant results for environmental and human health.

Beginnings

EDF was founded by middle-class New York suburbanites in 1967 as a result of focused attention on environmental issues such as those exposed in Rachel Carson's 1962 book *Silent Spring*. Carson revealed the damaging effects of DDT, a commonly used pesticide, on wildlife and humans. The EDF founders, resolved to halt the use of DDT, initiated a successful lawsuit to ban the dangerous chemical. After their success, they incorporated as EDF and grew from a small, volunteer organization operating out of an attic in the Stony Brook post office to the leading environmental organization in the country, employing around 350 individuals, enjoying a membership of over 700,000, and working on environmental issues worldwide. The majority of EDF's funds come from individual donations and memberships. Foundation grants provide another large portion of funding, while less than 15 percent of operating support and revenue comes from bequests, investment income, and government grants. Charity Navigator, an independent organization that evaluates the financial responsibility of charities, gives EDF its highest rating.

Activities and Successes

EDF's activities are governed by four key principles: a commitment to sound science, the power of partnerships, the power of the market, and a commitment to getting the law right. Nonpartisan and rigorous, EDF's scientific pursuits help guide its efforts and are used by state and national authorities in setting policy. The first major success of the fledgling EDF, the ban on DDT, was based on sound science. Basing its advocacy on careful studies provides EDF a trusted and respected voice. As a result, scientific studies linking chemicals in drinking water to high rates of cancer helped secure 1974 passage of the Safe Drinking Water Act, which, with amendments, is still used in the 21st century to ensure

that Americans have safe water to drink. In 1985, EDF scientists played a crucial role in banning lead from gasoline, resulting in a significant decrease in childhood lead poisoning. EDF builds on past successes in 21st-century initiatives. One project promotes public understanding of the science behind climate change. Another initiative utilizes partnerships with leading universities to investigate the science of ocean mining and the implications of nanotechnology.

Corporate Collaboration

When EDF initiated a waste-reduction partnership with McDonald's in 1990, it was the first environmental group to work with a corporation. Up to that point, corporations were largely regarded as the enemy of environmental organizations, and working with a for-profit company engendered controversy within the environmental movement. Critics wondered if EDF was selling out to corporate interests or appealing to the lowest common denominator. The EDF-McDonald's partnership, however, was successful. It led to the elimination of 150,000 pounds of waste through new product packaging, and other fast food companies adopted the best practices developed by the EDF-McDonald's task force. A 2000 partnership with FedEx to create a more energy-efficient delivery truck enhanced fuel economy and decreased emissions and soot. In 2007, EDF opened an office in Bentonville, Arkansas, home of Walmart's headquarters, to help Walmart develop environmentally friendly policies and to assist the behemoth retailer in setting guidelines for its suppliers. EDF has partnered with local youth groups as well as rural communities to promote sustainable growth. Through partnerships with businesses and other groups, EDF aims to promote best practices within industries and to show the economic value of environmental stewardship.

Other Successes

The focus on improving the bottom line through environmentally friendly practices is also evident in EDF's principle of the power of markets. It is a proponent, along with corporations such as Ford Motor Company, Caterpillar, General Electric, Shell, and others, of a national cap-and-trade program to reduce global warming. As a result of scientific studies showing the far-reaching effects of acid rain, EDF successfully lobbied for a provision in the Clean Air Act of 1990 to include a cap on sulfur dioxide emissions. A 1995 plan allowed landowners compensation for protection of wildlife covered under the Endangered Species Act. EDF hopes to use market-based incentives to reduce deforestation in the Amazon, to reduce wasteful and dangerous fishing practices, and to limit air pollution, congestion, and overdevelopment in U.S. cities.

EDF prefers to enter alliances to negotiate for tough laws to protect the environment. However, when alliances fail to achieve their goals, EDF will initiate or participate in lawsuits to ensure the law is tough, fair, and based on sound science. It has been instrumental in creating guidelines for commercial vehicles, eliminating loopholes that led to significant pollution from diesel engines. EDF played a key role in the U.S. Supreme Court case that gave the Environmental Protection Agency the authority to regulate pollution from global warming.

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See Also: Environmentalism; Greenpeace; Packaging and Product Containers; Safe Drinking Water Act.

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Environmental Justice

Environmental justice refers to both a protest movement that emerged in response to unequal

exposure to waste and a set of principles developed out of that movement. Growing out of a realization of social inequities relating to waste, the environmental justice movement has spurred consciousness throughout the United States and around the world about the racial and economic dimensions of waste production and management.

The term *environmental justice* has roots in the U.S. civil rights movement in both the rhetoric and organizational strategies used. Of particular note is the Memphis Sanitation Workers strike of 1968, which attracted international attention when Dr. Martin Luther King Jr. supported the strike (and was ultimately assassinated while participating in it). In 1982, an African American community in rural Warren County, North Carolina, protested that state's siting of a toxic waste dump. The residents were joined by national civil rights figures, including the Southern Christian Leadership Conference's (SCLC) Joseph Lowery.

While the protest was unable to stop the site's development, it inspired similar protests as well as research into the relationship between waste and race. Five years later, the United Church of Christ's Commission for Racial Justice published a study, "Toxic Wastes and Race in the United States: A National Report on the Racial and Social Economic Characteristics of Communities of Hazardous Waste Sites" that concluded that race was the dominant factor in the siting of waste in the United States.

Scholars and activists across the nation mobilized during this period, with sociologist Robert Bullard (who had worked on these issues in Houston as early as 1979) emerging as a leading advocate and scholar. Bullard advised the Clinton administration as it took office, upon which the Environmental Protection Agency established environmental justice guidelines.

Legislative History

Enacted by the U.S. Congress in 1969 and signed into law by President Richard Nixon on January 1, 1970, the National Environmental Policy Act of 1969 (NEPA) requires all federal agencies and programs to consider the impact of their actions on the environment. Provisions of the act require that federal programs must be administered in an environmentally sound manner. Of particular historical significance is Section 102(2)(c), which established the requirement of a detailed statement of the environmental impact of the proposed action, any adverse effects, and alternatives. This review process results in an Environmental Impact Statement that solicits expert testimony and data that is circulated to affected parties, is reported in the Federal Register, and includes public hearings. The review and corresponding comments are then used to mitigate any actions that are taken. Shortly after this landmark act was instituted, the Environmental Protection Agency (EPA) was established in 1970 to oversee this and other environmental protection legislation.

The earlier Civil Rights Act of 1964 and the provisions of Title VI-Nondiscrimination in Federally Assisted Programs, specifically Section 601, stated that "no person in the United States shall be excluded from participation in or otherwise discriminated against on the ground of race, color, or national origin under any program or activity receiving Federal financial assistance."

In theory, this should have by default included a greater involvement of minority and underrepresented segments of the population when the NEPA process was enacted. However, this was often not the case when stakeholders most impacted by a proposed project were unaware of or unable to attend public hearings because of scheduling and location.

In addition, growing concerns were raised by grassroots organizations, which felt that their communities were being targeted for actions that had potentially negative environmental consequences because they were not politically or economically empowered. They believed that their views were not being fully considered as part of the environmental review process. Concerns were heightened by projects such as the placement of environmentally sensitive waste transfer stations and trash incinerators in mostly impoverished and minority communities. This led to the growth of Not in My Backyard (NIMBY) resistance movements.

As a response to many of these public concerns, in 1992, the EPA created an Office of Environmental Justice. In 1993, the EPA established the National Environmental Justice Advisory Coun-

cil (NEJAC) to gather independent advice and recommendations from a variety of stakeholders, including academia, community groups, industry, nongovernmental organizations and environmental organizations, state and local governments, and tribal governments and indigenous groups.

To involve a wider array of government agencies, President Bill Clinton issued in 1994 Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. The executive order refocused attention on Title VI of the Civil Rights Act of 1964 wherein ". . . each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. . . ."

Goals and Effects

Environmental justice must involve the fair treatment of people regardless of their racial, ethnic, or socioeconomic status. No community or subpopulation should have to carry a disproportionate share of negative environmental outcomes. There must also be meaningful involvement of the potentially affected community. This requires seeking out those groups who will bear the greatest risk of a proposed action by scheduling public meetings during times and in locations that are fully accessible to members of the community and must consider the participants' concerns in the decision-making process.

Environmentalists and grassroots organizations involved in promoting environmental justice as a civil rights issue have developed additional terms specific to actions that have been viewed as creating a negative environmental impact on minority and indigenous populations, including the concepts of environmental racism and environmental colonialism.

The history of environmental protection has been one of balancing risk to human health, the preservation and conservation of natural resources, and economic development. Environmental crime resulting from noncompliance with environmental protection legislation raises public apprehension about the regulatory oversight of these policies. This is of particular concern when specific populations and locations are disproportionately affected.

Although a number of policies are in place to promote environmental justice for government-related projects, they do not necessarily cover actions by private industry. In response to these public fears, both the Emergency Planning and Community Right-to-Know Act of 1986 and the Pollution Prevention Act of 1990 were enacted to protect public health and the environment by improving community access to information about chemical hazards in the air, land, and water and to increase the capacity of emergency response and risk management. These were further clarified in 1995 through President Clinton's Executive Order 12969, Federal Acquisition and Community Right-To-Know Federal Actions.

Furthermore, to enhance public notification of environmental activities that may affect air, water, and land in certain neighborhoods, the EPA has created in support of its environmental justice initiatives EnviroMapper, a Web-based database that maps all facilities that have to report their use of controlled materials to the EPA. This can range from locations that produce and release air pollutants to Superfund sites.

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See Also: NIMBY (Not in My Backyard); Politics of Waste; Race and Garbage; Social Sensibility.

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Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) is a government agency of the United States. Its overall aim is to safeguard the environment and human health in the United States and to cooperate with other countries to protect the global environment. Specifically, the EPA's duties include developing national regulations and standards based on environmental laws passed by the U.S. Congress; monitoring and enforcing regulations via fines, legal sanctions, and other measures; collaborating with government and industry in pollution prevention and energy conservation programs; conducting environmental assessment, research, and education; and providing grants and support to external environmental programs and scientists. In the 21st century, the EPA has focused on priorities such as climate change, air and water quality, safety of chemicals, environmentalism, and building partnerships with state and tribal governments. An up-to-date listing of the EPA's current projects and programs is available on its Website.

History

The EPA was established on December 2, 1970, under the direction of President Richard Nixon. It was formed following a merger of smaller government agencies and departments involved in environmental monitoring and enforcement. The 1960s and 1970s in the United States were characterized by increased public concern for the natural environment. Rachel Carson's 1962 book *Silent Spring*, which discussed the widespread pesticide poisoning of nature, and other literature and media revealed the scale of the country's environmental problems to a largely unaware general public. There was a gradual cultural shift in people's attitudes toward the environment, including a public outcry for direct government action to protect the natural world, which marked the beginning of the modern era of U.S. environmentalism.

Administrators and Structure

The EPA is led by an administrator, appointed by the U.S. president. The first administrator was William Ruckelshaus (1971–73), followed by Russell Train (1973–77), Douglas Costle (1977–81), Anne Gorsuch (1981–83), William Ruckelshaus (1983–85), Lee Thomas (1985–89), William Reilly (1989–93), Carol Browner (1993–2001), Christine Whitman (2001–03), Michael Leavitt (2003–05), Stephen Johnson (2005–d09), and Lisa Jackson (2009–). The administrator heads a senior management team, including a deputy administrator, several assistant administrators, and regional administrators. The EPA has approximately 18,000 employees and several thousand contractors located across the country; most are employed as engineers, environmental protection specialists, scientists, support staff, and legal professionals. The agency's headquarters is located in Washington, D.C., and is made up of several offices, such as the Office of Air and Radiation, the Office of Environmental Information, the Office of Research and Development, the Office of Water, and the Office of Solid Waste and Emergency

Response. In addition, there are 10 regional offices located around the United States; each is responsible for implementing the EPA's programs within several states, except for programs delegated to U.S. states and Native American tribes. In 2010, the EPA's annual budget was about $10.486 billion.

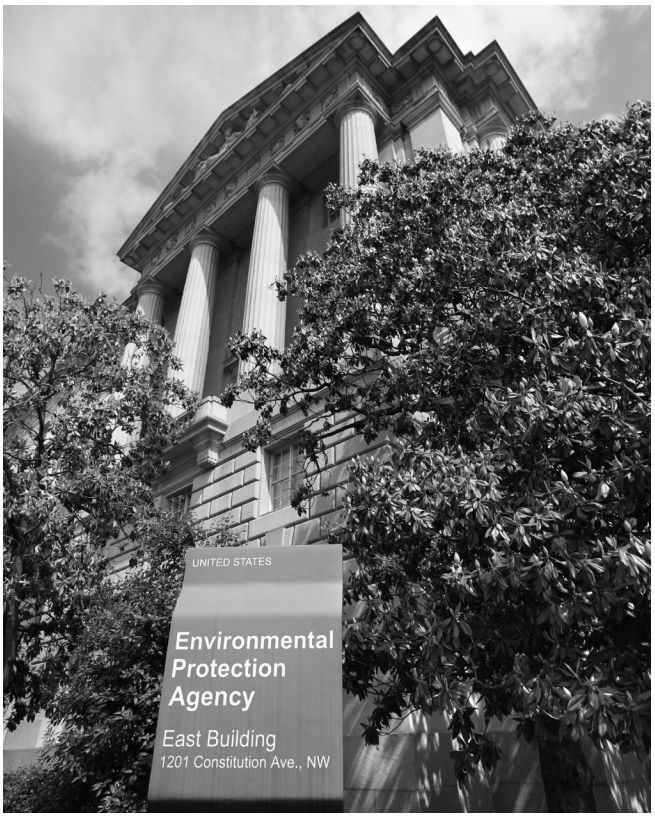
Powers and Responsibilities

As a regulatory agency, the EPA is authorized by the U.S. Congress to create and enforce regulations to implement environmental laws and presidential executive orders. Approximately 130 substantive regulations are issued every year. Regulations written by the EPA help businesses, government, individuals, public authorities, and others to abide by environmental laws as they explain the necessary technical, operational, and legal details for compliance. The laws that are regulated by the EPA cover a range of environmental and public health protection issues; examples include the Clean Air Act, the Clean Water Act, the Energy Policy Act, the Pollution Prevention Act, and the Safe Drinking Water Act.

There are also a number of laws that guide the processes by which the EPA develops regulations. The EPA provides compliance assistance activities such as explaining regulatory requirements and ways to abide by them (such as providing specific compliance information); offering support services and resources, such as counseling, training, fact sheets, and guides; and providing technical assistance. This is accompanied by monitoring and assessment of compliance through inspection and evaluation at facilities and sites, detailed investigations, providing self-evaluation compliance tools for organizations, detailed review of information submitted to the EPA, and incentives for organizations and the public to report violations of environmental laws.

Enforcement

The EPA uses three main enforcement programs to ensure compliance with regulations. Criminal enforcement is used against serious violations and intentional disregard of the law and can result in stringent sanctions such as jail sentences. Civil enforcement uses legal means, but without criminal sanctions. Cleanup enforcement ensures the cleanup of pollution and waste or arranges reimbursement to the EPA for cleanup. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) is often used by the EPA as a cleanup enforcement mechanism. The EPA's enforcement programs work closely with the Department of Justice and local governments to take legal action.



Despite the Environmental Protection Agency's strong reputation, a number of its decisions have been controversial and criticized. Scientists and environmentalists call for more action on health and environmental threats, while industry wants fewer regulations.

Research and Planning

The EPA's Office of Research and Development conducts scientific research about the environment and awards grants and fellowships to scientists not employed by the EPA. It also provides expertise and technical support to address environmental issues. Research topics are wide-ranging and include air, computational toxicology, drinking water, ecology, human health, land, nanotechnology, pesticides and toxics, sustainability, and water quality. The

office's work is coordinated across three national laboratories, four national centers, and various research centers and facilities. The national laboratories are the National Exposure Research Laboratory, National Health and Environmental Effects Research Laboratory, and the National Risk Management Research Laboratory.

Similar to other federal agencies, the EPA is required (under the 1993 Government Performance and Results Act) to performance manage its activities and to communicate information about its performance to the U.S. Congress and the public. Accordingly, the EPA conducts performance activities such as strategic and annual planning, detailed analysis and reporting, sets performance targets, and seeks input from internal/external stakeholders and external reviewers. The EPA writes documents about its performance, such as its Strategic Plan Annual Performance Plan and Budget, Performance and Accountability Report, and program evaluations, all of which are published on its Website.

Controversy

On the one hand, scientists and medical experts argue that not enough is being done to combat many environmental and health threats, whereas on the other hand, business leaders and others often argue for fewer regulations. As a government organization, the EPA follows the political agenda of the majority party, yet Democrats and Republicans disagree on a number of issues concerning environmental stewardship; and there have been reports of political interference in the work of the EPA.

Other criticisms include not enough reliance and power within the EPA among nonscientists, research activities that are not in tune with the agency's regulatory goals, failure to acknowledge some environmental and health risks, and lack of progress toward environmental justice.

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See Also: Clean Air Act; Clean Water Act; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Environmentalism; Public Health Service, U.S.; United States.

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Environmental Tobacco Smoke

Environmental tobacco smoke (ETS) is smoke that has originated from the use of tobacco products and remains in the environment. It is usually a combination of smoke emitted from a burning cigarette or cigar (known as sidestream smoke) and smoke exhaled by the smoker (known as mainstream smoke). In contrast to direct smoking, environmental tobacco smoke is inhaled by people not using the tobacco product, and, therefore, exposure to it is often labeled as involuntary smoking, passive smoking, secondhand smoke, and tobacco smoke pollution. The phrase *thirdhand smoke* is used to describe by-products from tobacco smoke remaining on smoke-exposed materials like clothing, skin, and upholstery.

Composition

Environmental tobacco smoke contains more than 4,000 chemicals, including at least 250 harmful to health and 50 carcinogens. Carcinogens in tobacco smoke include arsenic (a heavy-metal toxin), benzene (a chemical found in gasoline), beryllium (a toxic metal), cadmium (a metal used in batteries), chromium, ethylene oxide, nickel, and vinyl chloride. The chemical composition of smoke is highly variable and dependent on factors such as the tobacco type, chemical additives, wrapping paper, the way the product is smoked (such as smoking rate), contact with indoor surfaces, and environmental conditions. Research shows that environmental tobacco smoke can have a different composition than mainstream smoke, including more toxic substances, and it is not simply diluted smoke. The presence of tobacco smoke in indoor air is determined by testing for smoke constituents; and

exposure of a nonsmoker to smoke can be tested by measuring cotinine (a nicotine by-product in body-fluid levels) in blood, saliva, or urine.

Risks

There is a scientific consensus that environmental tobacco smoke is a risk to human health, although the causal link is not always clear. Exposure to smoke in the environment is associated with the same health problems as direct smoking, particularly, a significant increased risk of cardiovascular diseases, cancers, respiratory problems, and cognitive impairment and dementia.

The Environmental Protection Agency (EPA) classifies environmental tobacco smoke as a known human carcinogen and estimates that each year it is responsible for several thousand lung cancer deaths among nonsmokers. Environmental tobacco smoke can also trigger asthma, allergies, and other respiratory problems; cause breathing and other problems among young children and infants, such as asthma, bronchitis, colds, infant death, ear infections, and pneumonia; and be a risk for pregnant women and babies, such as low birth weight, premature birth, and foetal death.

The health risks of exposure to environmental tobacco smoke are substantially lower than those associated with direct smoking. However, there is no safe exposure level, as studies have shown that even low amounts in the environment can be harmful, although the magnitude of risk remains debated by scientists. The overall risk is higher when nonsmokers spend many hours in an environment where environmental tobacco smoke is widespread, such as in the home or workplace. As a consequence of potential health risks, many state and local governments around the world have implemented smoking bans in indoor public facilities such as airports, bus terminals, cafés, hospitals, nightclubs, residential care facilities, restaurants, and schools. At the national level, some countries have adopted legislation to protect citizens from exposure to environmental tobacco smoke; for example, in March 2004, the Republic of Ireland became the first country in the world to impose an outright smoking ban in all indoor workplaces. Since then, many others have followed suit, including Italy, New Zealand, Norway, and Sweden. In countries without bans, an increasing number of private work and other places have taken voluntary measures to be smokefree. Smoking bans tend to be more effective when complemented by additional initiatives such as health awareness campaigns concerning health risks of smoke and programs to help people quit smoking. Alternatives to smoking bans include ventilation and air cleaning systems to reduce tobacco smoke pollutants and separating smokers from nonsmokers, but a ban is the only way to fully protect against smoke exposure.

Effects of Smoking Bans

Scientific research shows that smoking bans eliminate exposure to tobacco smoke in the indoor environment, thereby dramatically improving air quality, while exposure remains high in venues with no smoke-free regulations. Some studies have reported health benefits following policy implementation, such as a considerable reduction in the incidence of heart attacks and significant improvement in the respiratory health of workers, but more research is needed to substantiate these claims. Smoking bans also contribute to a reduction in tobacco consumption among employees and, therefore, lower the prevalence of tobacco-related diseases and their economic burden and social costs.

In the long term, the potential health improvements could have major economic benefits. Opinion polls reveal that most people are aware of the health risks of environmental tobacco smoke and that smoking bans have considerable public support. Criticisms of smoking bans include difficulty enforcing bans and possible harm to the economy (especially the hospitality and leisure industries), although there is no evidence of an overall negative impact. Some scientists disagree on the risks associated with passive smoking and its causal link to ill health, and they also criticize policy proposals to restrict smoking in communal places. The tobacco industry is also known for criticizing, and funding scientific research that casts doubt on, these issues.

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See Also: Air Filters; Pollution, Air; Ventilation and Air-Conditioning.

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Environmentalism

Environmentalism (as a philosophy) calls into question the impact of human actions on the environment and (as a movement) seeks to alter human-environment interactions to lessen the human footprint on the environment and foster environmental health. As a philosophy, environmentalism is usually associated with human values for conservation, ecosystem protection, restoration, and a deep concern for the natural environment.

As a social movement, environmentalism is associated with local, regional, national, and international political involvement in environmental policy development and reform, green technology development, advocacy for more protected areas, and improved citizen opportunities to shape and influence policies and development activities that affect the environment.

History

Sociologist Riley Dunlap and several others have documented an increase in environmentalism, in the form of increased concern about the environment in North America and a number of other countries. In the United States, long standing concern about conservation of natural resources and local concerns about public health gave way to rising concern about environmental health and quality after World War II. This process intensified in the 1960s, as organizations such as the Environmental Defense Fund grew, the popularity of Aldo Leopold's 1949 book *A Sand County Almanac* extolled the notion of humans having an ethic to protect the land rather than simply produce wealth, and Rachel Carson's 1962 book *Silent Spring* galvanized worries about toxins. Public pressure produced political action, including the advent of Earth Day in 1970 and a myriad of environmental protection policies that (for a time) enjoyed bipartisan support in the United States.

Worldwide, environmental politics spread in industrialized nations, aided in part by concern over nuclear weapons and nuclear power. Those concerns spurred the growth of West Germany's Green Party in the 1970s (a party that continues in the early 21st century as a substantial presence in parliament), and green parties exist, with less influence, in several other nations.

Greater public interest in the environment in the United States was heightened by the widely read book *Silent Spring*, which detailed the destructive role of pesticides and other agricultural applications on bird life; the first Earth Day in 1970; and the energy crisis in the 1970s (due to an oil embargo), where then U.S. President Jimmy Carter urged Americans to consume less energy. The environment began to hold greater sway over public media and interest in North America and elsewhere, and suggested a move away from a dominant social paradigm that viewed humans as exceptional creatures who are able to overcome environmental limits, particularly through technological advancements.

The stewardship ethic under the dominant paradigm is based on utility for humans, where land is primarily useful for harvesting natural resources, and it is reasonable to use land and water for waste disposal. Under the new environmental paradigm, humans are one among many creatures and increasingly learn to recognize their interdependence with the physical world. The new environmental paradigm is associated with environmental protection, population control, and constraints on industrial activity.

Approaches

Since the 1960s, surveys measuring adherence to the new environmental paradigm have found increasing levels of support, as support for the dominant social paradigm lessens. The work of environmentalism is largely undertaken by environmental organizations (typically termed *environmental nongovernmental organizations* or *ENGOs*. The approaches of various ENGOs reflect distinct views on how to best address environmental crises. Such views include the following:

- Degrowth, or scaling down the amount of raw material taken from the Earth and placed back into the Earth via wastes or pollution. There is considerable advocacy involved in this approach, often to stop a development, to build a hazardous waste facility, for example, or to increase the safeguards taken to assure that environmental harm is minimized (such as the one might expect now for offshore exploratory oil rigs, especially after the Big Horizon Gulf oil spill off the coast of Louisiana).
- Ecological modernization, or the increasing role of institutional reform to channel economic growth and industrial development in a direction that minimizes harm to the environment and incorporates environmental science into the design of new infrastructure, technology, and decision-making systems.
- Environmental conservation, or the ways in which wildlife, habitat, natural resources, and ecosystems can be protected at the individual, organizational, and governmental level.
- Environmental economic instruments, or the tools that government, industry, and other organizations can use, such as taxes or traceable pollution permits, to provide both incentives and disincentives for improved environmental behavioral outcomes.
- Public education, or the provision of learning opportunities to enhance public knowledge, attitudes, and behaviors about how natural environments function and how human beings can manage their behavior and ecosystems to live sustainably.

While each approach may adhere to a new environmental paradigm, there are often differences in the level of focus (e.g., individual, private sector, public sector) and in the acceptance or rejection of industrial capitalism (with its assumptions of constant economic growth). The listed approaches simplify the terrain considerably, but provide illustrative representations of the state of environmentalism in the 21st century.

Degrowth

The cornerstone of the degrowth approach to addressing environmental concerns is the notion that more economic growth can never be a solution to the environment, as it is the primary cause of the problem. Taking a critical stance of "sustainable development," adherents to degrowth feel that the aim of making economic growth environmentally sustainable is untenable: economic growth can never coexist with environmental sustainability. The *Limits to Growth* report published by the Club of Rome in 1972, which predicted an ecological collapse as a result of accelerated economic growth, is an influential document for the degrowth movement as was the work of Nicholas Georgescu-Roegen (a Romanian economist), who established the study of the bioeconomy in the 1970s.

Numerous ENGOs adopt a degrowth perspective on at least some of their work. For example, Greenpeace has been active in attempting to halt industrial production in Canada's oil sands (a large oil extraction project in Alberta). The premise for these organizations is that no level of industrial production can justify the damage inflicted to the natural environment and local people, including water pollution, toxic waste, and massive mining projects. A quotation from Greenpeace Canada's Website depicts a degrowth orientation: "Greenpeace is calling on oil companies and the government to stop the tar sands and end the industrialization of a vast area of Indigenous territories, forests and wetlands in northern Alberta." To achieve such ends, ENGOs involved in degrowth often engage players at multiple levels, including government, industry, community organization, and individual. However, unlike those supporting ecological modernization and environmental economics, those working from a degrowth perspective would be critical of working with government and industry, instead choosing to place pressure on them from the outside and trying to gain adherents from the broader public.

Ecological Modernization

Ecological modernization is a sociological theory of environmental reform. Growing out of Western Europe in the 1980s, early ecological modernization theorists sought to make room for advances in addressing environmental problems, rather than focusing solely on negative human-environment interactions. Initially, much attention was placed

on the role of technological innovation in environmental reform. While this remains a feature of ecological modernization in the early 21st century, its prominence is less than in early conceptualizations. Ecological modernization theorists think little of approaches that concern only the public sector, maintaining a favorable attitude toward the marketplace as a driver of positive environmental change. The distinct features of ecological modernization are a view of environmental problems as challenges for social, technical, and economic reform; an emphasis on transformations in these arenas undertaken by the public and private sectors; and a rejection of degrowth perspectives that see economic growth as a threat to environmental sustainability. Rather, ecological modernizations suggest that economic growth and improved environmental reform can go hand in hand, as the innovators in ecological modernizing set new standards for others to follow, and those successful at reducing environmental harm find that it is also more profitable given the reduced costs they face for wastes and energy inefficiency.

In contrast to the focus on degrowth, ecological modernization is focused largely at the national or industrial level, rather than at the individual or community level. For example, the Pembina Institute (a sustainable energy thinktank in Alberta, Canada) approaches environmental action from an ecological modernizationist mindset. The group has a corporate consulting branch that, according to its Website, "provide[s] solutions for select industry leaders in Canada seeking to make their businesses more sustainable and climate-friendly." By supporting technology that is ostensibly beneficial to the environment and involving a range of stakeholders (such as communities, governments, and industry), the Pembina Institute works within the capitalist system to achieve results that improve environmental outcomes. Such results include life cycle assessments, alternative measures of progress, and ecological fiscal reform.

Environmental Conservation

Environmental conservation (or protection) is the form of environmentalism with which most people are familiar. This approach also has the strongest historical precedent. The Fabian Society of the late 19th century supported environmental protection as a means of creating a more civil society; John Muir acted to save tracts of wilderness (and cofounded the Sierra Club) in the western United States at the same time; and Henry David Thoreau expounded on the restorative qualities of pristine environments in the mid-19th century. Most governments have federal bodies that oversee the establishment of national parks and a mandate to protect at least some percentage of the country's land mass.

An example of a conservation ENGO is the Canadian Parks and Wilderness Society (CPAWS), with the primary aim to establish more protected areas in Canada. On its Website, its mission is "to keep at least half of Canada's public land and water wild—forever." To do so, CPAWS works with community groups and lobbies government. Those ENGOs seeking environmental protection are not necessarily for or against increasing industrial development. Conservation groups have varied stances on industrial growth; their goals tend to focus on policies that can further protect landscapes that are rare, hold endangered species, or that are of high social value given their proximity and potential for human recreational use.

Environmental Economic Instruments

Environmental (or ecological) economics focuses on the relationship between the economy and the ecosystems that support it. An environmental economics approach to environmentalism is at the state or industrial level and typically seeks to "fix" the current economic system rather than replace it—as a degrowth environmentalist might wish to do. Thus, efforts in this arena have emphasized the importance of modeling ecosystem functions in order to better understand the natural world as well as improving measures of progress—such as gross domestic product (GDP)—to account for decreases in human and environmental health as a result of economic activity. Additionally, this field of study addresses the valuation of ecosystem services, recognizing that in a system where the worth of a good is determined by its price, the environment will continue to be overlooked by most players in the economy. Finally, ecological economists seek to establish policy that uses fiscal incentives

and disincentives to better the relationship between humans and the environment. For example, some of the economic instruments that are debated among environmentalists, industry, and government as possible solutions to environmental problems include taxes, pollution credits, mitigation banks, and carbon credits.

In addition to the Pembina Institute, other ENGOs that take an environmental economics approach to their work include the World Resources Institute (WRI). For example, in its Markets & Enterprise division, WRI's stated goal "is to harness markets and enterprise to expand economic opportunity and protect the environment." There are overlaps with ecological modernization, and the two approaches are quite similar. But while ecological modernizationists seek to involve stakeholders in the environmental policy arena, ecological economists are more closely focused on the use of economic instruments to achieve change.

Public Education

The final major approach is public education. Focused on the individual or community, the aim of public environmental education is to provide information to the general public on how the environment functions and how to live in an environmentally sustainable manner. Such education need not be in a school but can rely on other media as well (e.g., labeling, television shows, and advertising campaigns). Approaches to environmental education range from outdoor education (where individuals are taken into the wilderness to experience the natural world) to public information campaigns (e.g., on topics such as littering or idling a vehicle). In general, the aim of environmental education is to create a more aware and conscientious citizenry that cares about the environment and thus seeks to increasingly behave in informed and deliberate ways to minimize environmental harm. Environmental educators seek to equip citizens with the skills and information to make wise choices informed by environmental information.

The Evergreen Foundation is an ENGO with a mission, according to its Website, "to support and inspire community action [that] promotes the connection between a sustainable natural environment and healthy communities." As with most environmental educators, its focus is not on industry or government but on teaching individuals and community leaders about how to make cities more liveable by creating more outdoor spaces. The foundation works on community gardens, native plant identification, and local restoration projects. Like environmental conservationists, environmental educators do not necessarily subscribe to a capitalist or anticapitalist doctrine and often leave the motivations for social change from political activism to those they educate.

Conclusion

Environmentalism is constantly changing itself and the world. Despite differences in opinion about how best to address environmental problems, there exists agreement among environmentalists that nonhuman species deserve protection and similar moral rights as humans. Taken together, the various approaches described are affecting change in policy, in public attitudes, and on the landscape.

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See Also: Capitalism; Consumption Patterns; Greenpeace; Sustainable Development; Zero Waste.

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European Union

The European Union (EU) is an economic and political union comprising most of the countries in Europe. With roots in several economic and diplomatic alliances forged in Europe after World War II (including the European Economic Community), the EU was established by the Treaty on European Union (signed in Maastricht on February 7, 1992, and which entered into force on November 1, 1993). In 2011, member states included Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. Candidate states included Croatia, Macedonia, Iceland, and Turkey.

The EU maintains common policies on trade among its member states, including a common currency (the euro, used in most member states, although not in the United Kingdom), as well as the movement of people, goods, and services. While its policies generally promote free movement of goods and services within its borders, the EU has developed policies aimed at controlling the production and distribution of wastes.

The 21st-century EU legal framework on waste is based on Directive 2008/98/EC. This directive includes a preamble of 49 points indicating the general orientation of the EU toward waste policy, management, recovery, and disposal. The directive is structured into seven chapters, which contain a sum of 41 articles. The chapters respectively include subject, scope, and definition; general requirements; waste management; permits and registrations; plans and programs; inspections and records; and final provisions. According to the EU summary, the most significant articles are those concerning waste hierarchy, waste management, permits and registrations, and plans and programs.

Waste Hierarchy

The complex legislation of waste management has been developed not only in relation to the geopolitical transformation of the EU legislative domain, but also with regard to technological progress in the field of environmental sciences. The numerous amendments to the laws reflect the need to cope with these two factors and are expressions of the awareness by the European Commission (EC) of the need to maintain a certain degree of flexibility over time. The 2008 regulation enlarged the scope of the previous one, introducing clearer definitions not only of the types and qualities of waste, but also of the hierarchy of waste treatment procedures. This step underlines the importance of differentiating possible ways of waste management within a general priority for the safeguard of human and animal health and of environmental protection. Thus, according to the 2008 directive, waste hierarchy is, in order of priority: prevention, preparing for reuse, recycling, recovery (such as energy recovery), and disposal. This hierarchy replaces the one formulated in the 2006 directive, which prioritized prevention, followed by recovery and reuse. In particular, the 2008 directive specifies that waste prevention should be the first priority and that reuse and recycling should be preferred to energy recovery from waste.

Waste Management

The section related to waste management refers to the responsibility of waste management, which is in principle that of the original producer or holder. Even in case of transfer of the responsibility for recovery or disposal, this responsibility is not completely discharged from the original producer. Also, the principles of self-sufficiency and proximity are

sanctioned. The former concerns the idea that the community as a whole should reach self-sufficiency in waste management. The latter refers to the cooperation needed by (especially bordering) member states to establish an "integrated and adequate network of waste disposal and recovery installations." Articles 17–22 regulate the control and labeling of hazardous waste and oils.

Permits and Registrations

The section on permits and registrations underlines that any member states carrying out waste treatment shall obtain permits that specify the types and quantities of waste, technicalities, safety measures, method of treatment, monitoring operations, and other provisions when necessary.

Plans and Programs

The section on plans and programs defines the types of management plans that have to be issued periodically by each member state following the objectives and provisions of the directive. One relevant part of these plans concerns waste prevention programs, according to which each member state is expected to establish its own program by December 2013, indicating existing prevention measures as well as planned quantitative and qualitative benchmarks for assessing the progress of prevention measures.

Orientation and Coordination

Concerning the general orientation of the EU legislative framework, attention is paid to harmonizing EU directives with the freedom of each member state to amend or adapt its own legislation. This is done under the aim to "set general environmental objectives for the management of waste within the Community," or "to enable the Community as a whole to countries' self-sufficiency in waste disposal and recovery." Again, a strong emphasis is added to "help the EU move closer to a 'recycling society'" in order to allow each state to become aware of the need to reduce generation of waste and to learn to use waste as a resource. These general orientations somehow juxtapose with pluralistic indications over the freedom of member states "to limit incoming shipments to incinerators classified as recovery," to stress individual states' decisions over the use of waste as an economic resource, and to develop states' individual waste prevention programs. Even the ambitious call for a "European recycling society" is modulated through awareness that member states maintain different approaches to the collection of household waste and to waste composition; therefore it is considered appropriate that general targets "take account of the different collection systems in the Member States." One particular and extremely significant case of pluralism in the recent directive concerns the list of waste. This section specifies that a member state is allowed to consider waste as hazardous even though this does not appear in the annexed list, and an item present in the annex as nonhazardous. This tension between the EU and national freedom of interpretation of the EU legislation has often provided space to nontransparent and even illegal practices, such as the case of waste shipment.

The introduction of the single market in the EU in 1993 stimulated the development of trans-boundary shipments of goods—including waste—requiring more attentive regulations. These followed the expansion of EU boundaries, especially since the mid-1990s. There are four main principles regulating the shipment of waste. First, since waste for disposal is considered a heavy environmental burden, the general EU policy orientation is to promote self-sufficiency in the state members, thus reducing as much as possible the shipment of waste among them. Second, in principle, waste for disposal should be treated in the nearest installations, thus avoiding long shipments. Third, regulations concerning shipments of waste for recovery are less restrictive than those of waste for disposal, allowing a higher degree of mobility of the former within the EU. Fourth, export of hazardous waste within EU boundaries is allowed only if following special procedures. Hazardous waste shipment to non-Organisation for Economic Co-operation and Development (OECD) countries is prohibited, since these countries are not expected to possess proper treatment capacities. Trans-boundary shipments of hazardous waste are regulated by the Basel Convention, according to which the ratifying countries are expected to inform the other members of hazardous waste typologies itemized by national standards, designate and communicate the lists of competent authorities to control and authorize the shipment,

and set the relevant duties and rights in the light of cooperation agreements among countries. The Basel Convention had been ratified by 172 countries as of 2010.

In 2007, EU countries exported a total of about 5.4 million tons of hazardous waste. It is calculated that only 80 percent of this amount is notified through the annual country reports; the remainder is assessed. This number shows a constant increase, whereas the percentage of hazardous waste exported compared to the overall generated waste remains stable (around 12 percent). This seems to prove that the EU is achieving self-sufficiency in handling its waste disposal activities. The main items of the hazardous waste exported are demolition waste, including mainly polluted soil and asbestos; waste from thermal processes; waste from organic chemical processes; and oil wastes of liquid fuels.

Illegal Waste Shipment

In spite of the regulations issued by the Basel Convention, the monitoring process of the European Environment Agency (EEA), and several transnational and national environmental organizations, the number of illegal waste shipments from EU countries is increasing. Official figures on this type of trade are still scarce and their relevance is often overlooked. A large portion of illegal waste exported to non-OECD countries is made by waste from electric and electronic equipment (WEEE), a portion of municipal waste. It is thus not directly classified as hazardous waste, in constant increase in the EU countries. Most of this waste is shipped, legally and illegally, to non-OECD countries such as China, Africa, and the Middle East.

A similar case is that of end-of-life cars, another significant item of illegal waste shipment from EU countries. Cars are shipped as secondhand items, hence avoiding the controls and documentation necessary for waste. The most common destinations are eastern Europe, western Africa, and the Middle East. The great economic incentives generated by the illegal waste trade make this traffic difficult to track, especially in the case of ordinary items such as electronic devices and cars. In the case of the most common types of hazardous waste generated by building and manufacturing, it is expected that illegal practices will continue to increase thanks to the interest of criminal organizations, which in some EU countries have been reported as participating in the waste trade business.

Household Waste Production and Recycling

The quantity of household waste generated by EU countries shows several degrees of variations. In most EU countries, industrial waste is from eight to 10 times larger than household waste, even though the latter has gradually increased. From 1995 to 2008, household waste generated in the EU increased from 474 to 524 kilograms per capita. This increase was not linear but showed a degree of stability in growth from 2006 onward. Generally, Western European countries produce quantities of household waste that exceed eastern European countries by 75–240 percent. In 2008, the four major producers per capita were Denmark, Cyprus, Ireland, and Luxembourg. The five minor producers were Poland, Slovakia, Latvia, Romania, and Lithuania.

Figures about national outcomes of recycling policies are even more telling of the differences among EU countries. The overall tendency is toward an increase in recycling among all countries, although with significant differences. The main body of the "EU recycling society" project is comprised of paper and cardboard, biowaste (kitchen and garden waste), glass, plastic, and metal. Recycling of bulky waste is significant only in a few of the old member states, whereas construction and demolition material is recycled in over 50 percent of the reporting countries as of 2010. Considering the national figures from 2005, the countries that produced less household waste roughly correspond to those that recycled the smallest percentage of the produced waste. The least recycling countries were Poland, Lithuania, and Slovakia. In the case of the larger producers, only Denmark scores among the top five in recycling, led by Germany, Belgium, and the Netherlands. The gap between old and new members in recycling levels is not alone, telling of the difference between older and new EU members since the data are to be read against the significant difference in generated waste. Also, a confrontation between generated waste per capita and population points out this imbalance. Confronting equivalent countries in population, such as,

respectively, Belgium–Czech Republic, Denmark–Slovakia, and Austria–Hungary, it is possible to obtain a more complete picture of the difference between old and new member states. The 2008 data of kilograms per capita generated waste are 493–306 for Belgium–Czech Republic, 802–328 for Denmark–Slovakia, and 601–453 for Austria–Hungary. This confrontation reveals that in principle eastern European countries recycle less than Western European state members, but the former also generate comparatively much less household waste. The gap between old and new member states is telling of the difficulty of implementing a common policy of prevention and recycling in the EU. Although the complex body of community regulations (over 60) concerning waste management have set up the legislative and organizational framework for preventing harmful treatment of waste, several questions and problems remain unsolved. The two pristine EU projects of self-sufficiency and free circulation of goods have proven particularly porous to the spread of scarcely accountable and even illegal practices.

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See Also: Economics of Waste Collection and Disposal, International; Politics of Waste; Recycling.

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Externalities

Externalities are uncompensated costs or benefits, also known as interdependencies, central to environmental economics. Arthur Pigou, a British economist, is credited with initiating discussions about the theory of costs and benefits in the early 20th century. As such, the benefits of production and profit are weighed with the costs of production (assuming perfect knowledge).

A lack of perfect information means that there are outcomes outside the production and market environment that remain uncalculated. Pigovian economists suggest that indirect taxation should be used to correct for losses associated with these uncalculated outcomes, thereby enabling competitive allocation of resources in a market economy. This tax, levied on the externality producer, is then passed on to the consumer but not necessarily or typically distributed to those affected most directly by detrimental externalities. Environmental externalities, generally considered at the societal rather than the individual level of analysis, occur when natural resources are affected by nonnatural occurrences such as emissions from vehicles or industrial waste. Such emissions are considered external to the polluter's pricing and production decisions.

Detrimental Externalities

Most often considered when studying the impact of environmental externalities are negative, or detrimental, effects. Scarce natural and public resources, such as air and water as well as public and private lands, may be negatively impacted by the by-product pollutants of industrialization. For example, logging not only extracts wood for profit to produce salable products such as furniture and building lumber but also may create loss of habitat for wildlife, soil erosion, and an increase in pollutants from logging machinery, including air pollution from exhaust emissions, ground and water pollution from cast-off oil and gasoline, and noise pollution from the engines of logging equipment.

While logging produces products with economic value such as furniture and lumber, the uncompensated losses from techniques such as clear-cutting can include a loss of habitat for wildlife, soil erosion, and an increase in pollutants from logging machinery. Environmental externalities such as these, according to Pigovian economics, are generally considered at the societal rather than individual level of analysis. Indirect taxation on the externality producer is a suggested method of correcting for losses associated with these uncalculated outcomes.

Similarly, while increased retail development brings new jobs and purchasing power, detrimental externalities often emerge. From the increase in consumerism comes increased consumer traffic, bringing noise and light pollution, increased carbon dioxide output, increased crime, and decreased property values. There may, however, be beneficial or positive externalities that occur as a result of increased industrialization.

Environmental Racism

Environmental racism—the imposing of a disproportionate amount of pollutants on minority and low-income communities—represents a great injustice: having to choose between health and of economic stability or the acceptance of hazardous pollutants. Denials about the impacts of environmental discrimination continue largely due to the effects of NIMBYism (Not in My Backyard) in more economically advantaged communities, a structural lack of education and resources, and economic reality. Rather than merely convenient and easy, it has become economically expedient to dump in disenfranchised areas. The reality is in the economic correlation between dumping fees and profits. If manufacturers were to pass on the true cost of waste disposal, including the cost of externalities, the loss of profit would result in an increased retail cost that most consumers would not willingly accept.

Beneficial Externalities

Less often considered but viable issues are beneficial externalities. These occur when a nonmarket benefit affects the public but remains uncalculated in the traditional cost-benefit model. Extrapolating from the above examples, new plantings from reforestation might be enjoyed as both a wildlife

area and a recreation area not suitable for logging due to premature growth. Light pollution, artificial light that brightens the night sky, disrupts stargazers and the natural activities of nocturnal creatures. While light pollution may be aesthetically displeasing to humans and endangering to wildlife, the extra traffic and lighting in the area may serve to deter criminal activity or bring new home buyers to an area not previously considered. Once accounted for and compensated, the emissions become internalized and cease to exist as externalities, leading to Pareto efficiency.

Internalization and Pareto Efficiency

Pareto efficiency occurs when allocation alternatives have been exhausted, with no individual better or worse off. This is not, however, the same as equity. Pareto efficiency merely indicates that there is no way to further benefit one party without further harming another. To reach Pareto efficiency, environmental externalities may be internalized through the implementation of any of four commonly used policy instruments, such as emissions fees, tradable emissions allowances, offset requirements, or source-specific standards.

With emissions fees, polluters such as industrial manufacturers pay for specified measurable pollutants. These manufacturers may elect to produce fewer pollutants, either through decreased output or through use of technological advancements that decrease emissions, thus receiving a lower abatement fee. Alternately, polluters who opt to not decrease emissions will pay relatively higher emissions fees to compensate for their abundant emissions.

The Environmental Protection Agency's (EPA) Clean Air Act of 1990 established a tradable allowance system by limiting levels of pollutants while creating a market for polluter rights. Those manufacturers who were low polluters, using less than their allotted amount of emission credits, could sell allowances to high polluters. In this way, high polluters could continue producing emissions above the governmental threshold without governmental penalty and the environment would not be polluted above the governmentally established limits. Similar program initiatives, such as the EPA's Federal Water Pollution Prevention and Control Act (Clean Water Act), sought to limit waterborne pollutants by enforcing water-quality standards and encouraging technological innovation to limit emissions. Similarly, offset requirements place a maximum threshold on emissions, but the penalty predominantly falls on new entrants to the market. Existing polluters consume a larger portion of the available emissions threshold, decreasing the proportional level of pollutants permissible to newcomers.

Although similar in intent to the Clean Air and Water Acts in its attempts to limit excessive noise pollution, the Noise Control Act of 1972, while not abolished, lost funding and so does not currently serve to limit auditory externalities.

Finally, source-specific standards are based on specific technologies that are expected to be able to control emissions as a means of forcibly diminishing pollution and, thus, externalities. For example, the utilization of smokestack scrubbers designed to minimize sulfur dioxide emissions decreases the detrimental externalities by decreasing emissions.

Conclusion

Environmental externalities, generally considered at the societal rather than individual level of analysis, occur when natural resources are affected by nonnatural occurrences. Such emissions are considered external to the polluter's pricing and production decisions. While the use of policies embracing Pareto efficiency enable the public to recapture compensation for some of the external, previously uncalculated costs, this is less likely to occur in areas in which people are disenfranchised, furthering environmental racism.

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See Also: Air Filters; Carbon Dioxide; Clean Air Act; Clean Water Act; Emissions; Environmental Justice; NIMBY (Not in My Backyard); Noise Control Act of 1972; Race and Garbage; Scrubbers.

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Farms

Farm operations in the 21st century have vast potential to not only produce waste but also serve as sinks for wastes. In this way, farm operations can contribute to environmental and human health or illness, depending on the scale and the technologies utilized to grow food. Farms are typically located long distances from where the food will ultimately be consumed, leading to an increase in the inputs consumed in order to get food distributed. These inputs include the transportation infrastructure and fossil fuels.

As food crises have all too clearly demonstrated, as the price of oil increases, so too does the price of food, which leads to increased instability and food insecurity around the globe. The scale of farms and the use of a variety of technologies lead to disparate outcomes in terms of consumption of resources in farming operations and their associated waste products.

Farms also compete with alternative uses for limited and necessary resources. Water resources are of particular concern in arid regions as agriculture use often conflicts with other potential uses (such as residential and industrial) of water resources.

Centralization and Intensification

Scale and use of technology are quite evident in confined animal feeding operations (CAFOs), which centralize the production of animal foods like never before in the history of humanity. In CAFOs, intensive methods rely heavily—if not exclusively—upon the consumption of outside resources in order to grow animals in the most cost-effective manner possible. In essence, this heavy reliance upon outside sources as well as mechanized facilities allow for even less labor investment. Labor is a key component in the cost of food production; with increased intensification in mechanized, industrial agriculture, there are fewer farmers who are responsible for the majority of foods produced. These CAFOs are ideal sites for the spread of diseases, as animals live in very close proximity to one another, often living in a number of waste products including feces, bodily fluids, and sometimes corpses. CAFOs raise several ethical questions about the consumption of their products. In CAFOs, animals themselves become waste, sometimes as mistakes are made (downer animals), and sometimes as a part of the normal course of operations. An extreme example of the animals as waste mentality is evident in examination of egg production facilities where live male

chicks have literally been disposed of in plastic garbage bags.

The intensification of agriculture in mechanized industrial agriculture farms brings with it several challenges in terms of waste and inefficiencies. Large monocultures of crops are incredibly vulnerable to disease and pest infestations. Oil, fertilizers, and pesticides are necessary inputs into these mechanized, industrial systems of food production. Increasingly, genetic modification of plants as well as animals also contributes to these systems. Most of the research and development in terms of genetic modification has been toward developing herbicide-resistant plants.

In this strategy, broad-spectrum pesticides can be utilized to control for undesired plant species, ideally wiping out all competition for water, sunlight, and nutrient resources. In reality, these interventions continue the technology treadmill as weeds and other agriculture pests adapt to these chemical control regimes, leading to a continuous cycle wherein further development of agricultural technologies is needed in an attempt to combat pests and increase food production. There is a particular philosophy of separation from and control over nature that goes along with these industrial systems of production: its (bio-)technologies and techniques are not neutral; rather, they are the result of a particular way of looking at the world.

Commodity Foods

Since former secretary of agriculture Earl Butz encouraged farmers to plant from fencerow to fencerow and "get big or get out," U.S. agriculture has remained nearly singularly focused on commodity food production. This emphasis on commodity food production has not only led to an overproduction of commodity foods in the United States but also overconsumption of a number of foods. This overproduction of commodity foods, particularly grains in the United States, has contributed to a number of human health impacts, including high rates of diabetes and obesity, both in the United States and globally. At the same time, overproduction of grains in the United States has led to grain dumping, wherein imported and subsidized U.S. commodities undercut the price and agricultural sectors of many other states.

Pollution

In terms of environmental health, farming creates pollution of the land, water, and air. A large part of this pollution is the result of excessive nutrients in the agroecosystem. Artificial fertilizers are particularly vulnerable to nutrient loss. Excessive nutrients can cause a number of issues, both locally and regionally. This manifests locally with high levels of nitrogen in local sources of drinking water and regionally with the zone of hypoxia caused by excessive nitrogen in the Gulf of Mexico. On-farm nutrient management strategies include building organic matter in the soil, conservation tillage, and maintenance of riparian buffer zones, which can prevent the loss of these nutrients and lead to greater on-farm nutrient capture. Smaller, labor-intensive farms utilize a number of tight nutrient cycling strategies, including composting or using worms to eat organic materials.

Subsidies

Farm subsidies structure the fundamental shape of 21st-century U.S. agriculture. These supports are necessary to many U.S. farmers in order to maintain a viable business and have led to vast areas being planted in single-species monocultures. The issues of scale in farming and increased food production cannot be overstated. In popular imagination, farms remain idyllic locales filled with the abundance and diversity of nature.

Biodiversity

Plant genetic resources play a major role in supporting industrial systems of food production. Globally, humans rely on a very narrow range of species to provide for 90 percent of the food supply. Well over half of the world's food supply comes from corn, rice, and wheat. These grains have been bred to produce high yields, with breeders selecting the traits that ensure the greatest increase in yields under a specific set of agronomic conditions, usually high-input conditions, including chemical fertilizers. The overemphasis on yield has in the past resulted in a degree of genetic uniformity and, hence, susceptibility to diseases and pests. There have been several documented crop failures due to genetic uniformity from the 1800s through a failure in 1984 in Florida, where 18 million citrus trees were destroyed. Crop failures, coupled with market structures of food dis-

U.S. agriculture is primarily focused on commodity food production like corn, soybeans, and wheat, which has led to an overproduction of commodity foods in the United States and overconsumption of a number of foods, particularly grains. Monocropping also relies heavily on commercial fertilizers, which leach into water sources. Excess nitrogen causes hypoxia in water bodies such as the Gulf of Mexico. On-farm nutrient management strategies can focus on building organic material in the soil and increase its water holding capacity.

tribution, can result in large loss of both income and human life, as happened during the Irish potato famine. Pesticides have been utilized in order to compensate for the lack of genetic diversity: however, their application has been largely ineffective in increasing yields because, in part, of pesticide resistance of insects as well as the negative impacts of pesticide application on soil biodiversity and beneficial insect populations.

On-farm biodiversity is conceptualized at the species, ecosystem, and genetic levels. On the farm, humans are the cultivators and destroyers of biodiversity. At each level of biodiversity, benefits accrue, regardless of whether these benefits are recognized (named) or acknowledged (valued) in cost-benefit analyses. There has been increasing international interest in the genetic level of biodiversity, particularly since the 1970s, because of the rise in utilitarian applications of genes in agricultural, industrial, and medical biotechnology product development. The value of these genes in agriculture is in the tens of billions of dollars in the United States alone.

Alternatives

Alternatives to the neoliberal model of food production continue to emerge. These challenge the dominant paradigm of food production, hence mitigating much of the consumption and pollution caused by larger-scale, mechanized approaches to food production. Many of these are community-based initiatives wherein participants are, to a varying extent, actively participating in food production through arrangements such as farmers markets and community-supported agriculture. Although small, the impact of these arrangements continues to be explored by researchers in both the social and natural sciences.

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See Also: Carbon Dioxide; Certified Products (Fair Trade or Organic); Dairy Products; Food Consumption; Organic Waste; Pollution, Air; Pollution, Land; Pollution, Water; Slow Food; Sustainable Development; Water Consumption; Worms.

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Fast Food Packaging

Fast food packaging generally refers to an assortment of portable, disposable wrappers, containers, bags, boxes, and cartons of various shapes and sizes that are used to transport ready-cooked foods purchased from a quick-service restaurant (QSR). The terms *takeout*, *take-away*, *carryout*, and *to go* all reflect this intended portability. Fast food packaging has evolved over time to include more nuanced adaptations for functionality, product branding, and ease of use. Foil-lined wrappers treated with special coatings ensure that hot food items not only remain at temperature but also prevent grease from seeping through. Insulated paper cups keep coffee and other hot beverages hot; reusable plastic cups are designed to hold icy drinks without leaking. Cup lids prevent spillage in transit, while cup bottoms are sized to nestle comfortably in standard automobile cup holders. The fast food experience is expedited by the fact that these packages can be embossed with company logos, product information, or other promotional details; quickly filled with the assembly-line-produced item; and placed in a bag, box, or carrier when purchased. Fast food packaging has changed over time to better accommodate how, where, and why people eat out.

Early History

In premodern, rural societies, the average person did not regularly venture far from home. When people did travel, they usually stayed with relatives and acquaintances and consumed their meals there. As people began to trek farther from home and were unable to dine with people they knew, eating out transformed into a commercial venture. The restaurant, as it is experienced in the 21st century, is a modern, urban phenomenon that evolved as a result of the concentration of people, money, and commercial activity in urban hubs. Unlike fine dining restaurants, fast food restaurants responded to the perceived need for inexpensive, hot meals that could be quickly prepared, served, and eaten on the go; fast food packaging became the transport mechanism for these meals.

Like most innovations, the fast food wrapper was born out of necessity. While people tend to associate the term *fast food* with any number of U.S. QSR chains like McDonald's, Taco Bell, and Pizza Hut, the earliest fast food was street food, peddled to pedestrians in urban cities throughout the world by independent vendors. Some fast food packaging was—and remains—edible. In the preindustrial world, a fast food wrapper may have been a type of leaf, gourd, bread product, dumpling, or seafood shell.

The Industrial Revolution brought about major changes in fast food packaging. The same wood-pulp technology that made it possible for newspapers to be more widely circulated throughout Europe and the United States was eventually adapted to make disposable paper bags, boxes, food wrappers, and containers. The same workers who labored in the factories that produced these products likely ate the fast foods that they wrapped; they worked grueling hours and often did not have enough time to return home to eat at mealtimes. Small fish stands selling quick-fried whitefish and sliced potatoes served in a rolled-up piece of newspaper (later inserted into a paper bag) became a mainstay in London factory districts. Pushcart vendors, lunch wagons, and temporary food counters fed factory workers and railroad travelers with foods that could be wrapped in paper and quickly eaten without utensils. Leisure and recreational destinations like the World's Fairs and Coney Island also provided opportunities for carryout "novelty" foods. Hot dogs, sandwiches, hamburgers, and ice cream could also be conveniently contained in edible packages—buns, waffles, and the like.

Modern Fast Food

The production of paper goods increased throughout the 19th and early 20th centuries. In 1921, the White Castle System of Eating Houses Corporation was founded in Wichita, Kansas. White Castle is credited with revolutionizing the fast food industry. In addition to establishing the first operational model for the chain restaurant, White Castle developed the unique idea of packaging its hamburgers in individual boxes designed to keep them hot. One of the founders, Edgar Waldo "Billy" Ingram, is also credited with developing the technology to create the company's paper packaging products. Learning from White Castle's success, a number of entrepreneurs seized the opportunity to sell carryout food to the U.S. public, and the hamburger was their star product. Eventually, all manner of packaging—butcher paper, wax paper, small boxes, aluminum foil, paper trays, and inserts—were manufactured to keep takeout foods hot and convenient to carry and eat.

Fast food business continued to flourish during the Great Depression. However, during World War II, fast food restaurants were especially hard hit, experiencing an overall decline in sales because of food and material shortages, low unemployment rates, and the refocusing of industrial manufacturing technologies to the war effort. Wartime did yield the development of expanded polystyrene foam (EPS), the nonbiodegradable material from which styrofoam peanuts, coffee cups, and "clamshell" containers are made. Global food shortages continued to haunt the industry at the war's end, and the U.S. fast food industry struggled to regain its former glory. A cultural shift accompanied postwar prosperity in the United States. By the 1950s, more families were able to afford cars and suburban homes. Successful fast food franchises relocated to suburbia or established highway outposts. Roadside drive-ins and drive-thru restaurants became popular, and food packages were eventually designed so that drivers could eat, drink, and drive at the same time.

Waste

Despite the popularity and convenience of takeout foods, much criticism has been levied against the fast food industry for the quality of its food, low wages, and hiring practices. Critical attention has also been directed toward the health risks and environmental impact of fast food packaging. The coated wrappers that many chains use because they are resistant to oil and water are called polyfluoroalkyl phosphoric acid diesters (diPAPs). According to some researchers, these chemicals break down into perfluoroctanoic acid (PFOA) or perfluorcoctane sulfonate (PFOS), members of a class of perflurochemicals that may be carcinogenic.

Fast food packaging also generates a tremendous amount of litter and waste. Significant numbers of restaurants have attempted to counter the garbage problem on several fronts; most make a point of keeping their properties especially clean. Some also provide additional trash receptacles outside their locations, hand out certain items (such as napkins or ketchup packets) only by request, and have switched to more environmentally friendly packaging materials, eschewing styrofoam containers for BPA-free plastics and biodegradable paper. A number of leading fast food chains—most notably, McDonald's and Starbucks—are credited with adopting sustainable paper-purchasing policies and making some efforts to protect forests.

For better or for worse—much like fast food itself—fast food packaging is an iconic marker of U.S. popular culture.

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See Also: Culture, Values, and Garbage; Food Waste Behavior; Restaurants.

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Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide Act of 1910, the first pesticide control law, was created primarily to protect consumers from ineffective products and deceptive labeling. On June 25, 1947, the U.S. Department of Agriculture (USDA) enacted the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). This statute was created to regulate the use and intentional release of pesticides into the environment with a focus on the efficacy, not use, of pesticides.

Section 2(u) of FIFRA broadly defines pesticides as chemicals and other products used to kill, repel, or control pests that harm crops and reduce yield. This includes insecticides, herbicides, fungicides, and other pest eradicators. Pesticide products used in food production are also regulated under the United States Federal Food, Drug, and Cosmetic Act (FDCA).

FIFRA was amended regularly (1959, 1961, 1964, 1972, 1973, 1975, 1978, 1983, 1984, 1988, 1990, 1991, and 1996) to contend with potentially harmful environmental effects and to improve precautionary labeling. FIFRA was functionally rewritten in 1972 after having been moved to the jurisdiction of the newly created Environmental Protection Agency (EPA), when it was amended by the Federal Environmental Pesticide Control Act (FEPCA). Further additional amendments, such as the 1996 Food Quality Protection Act (FQPA), required manufacturers to provide information about all potential environmental and health impacts.

Review Process

Through FIFRA, the EPA is specifically authorized to (1) strengthen the registration process by shifting the burden of proof to the chemical manufacturer, (2) enforce compliance against banned and unregistered products, and (3) promulgate the regulatory framework missing from the original law.

A 1996 amendment created an expedited review process in cases where risk to human health, nontarget organisms, and environmental contamination was reduced. The 1996 amendment also required chemical registration every 15 years. If a pesticide is believed to cause potentially unreasonable environmental risks, a review process is initiated to both consider general ecotoxicological and environmental test data and determine whether the continued use of the pesticide presents unreasonable environmental risks. The burden of proof is on the manufacturer to demonstrate whether the pesticide can be used as regulated without unreasonable, adverse environmental effects. FIFRA enables the EPA administrator to issue one-year experimental use permits if needed for data acquisition unless the pesticide contains a previously unregistered chemical, which may call for additional testing.

Before the EPA registers a pesticide to be used on raw agricultural products, it either grants an exemption or establishes a tolerance (the maximum amount of safely consumed pesticide). In conjunction with the FDCA, a raw agricultural product is deemed unsafe if it contains pesticide residue unless the residue is exempt or is within the limits of a tolerance established by EPA.

Enforcement

The EPA is authorized to use a range of enforcement actions to address violations of FIFRA, including violations relating to the initial and annual production reports. Enforcement actions include notices of warning (NOWs), civil administrative penalties, termination of establishment registrations, and criminal sanctions.

It is unlawful under FIFRA to distribute or sell unregistered pesticides, use a registered pesticide in a manner inconsistent with its labeling, submit false information, or violate an order of the administrator issued under the act (with certain exemptions). Penalties include issuance of stop sale, use, or removal orders, seizure of the pesticide, and assessment of civil penalties. Intentional violations of FIFRA also subject the violator to criminal penalties.

When determining the amount of a civil penalty, several factors are assessed, including the appropriateness of the penalty to the size of the business, the effect on the ability to continue in business, and the gravity of the violation. The maximum allowable penalty in 2010 was $7,500 per violation.

Worker Protection Standard (WPS)

Generally, restricted-use pesticides must be applied by or under the direction of a certified applicator. The EPA's Worker Protection Standard for Agricultural Pesticides (WPS) is a regulation created to reduce the risk of pesticide poisonings and injuries among approximately 2.5 million agricultural and pesticide handlers working at over 600,000 agricultural establishments. The WPS contains requirements for pesticide safety training, notification of pesticide applications, use of personal protective equipment, restricted-entry intervals after pesticide application, decontamination supplies, and emergency medical assistance.

In 2004, the EPA amended the WPS glove requirements by adding the provisions for worker safety. First, the provisions permit all agricultural pesticide handlers and early-entry workers covered by the WPS to wear separate glove liners beneath chemical-resistant gloves (previously disallowed), reducing the discomfort of unlined chemical-resistant gloves, especially during hot or cold periods. Second, agricultural pilots are not required to wear chemical-resistant gloves when entering or exiting aircraft, as chemically resistant gloves were not found to add any significant protection against minimal pesticide residues found around the cockpit of aircraft.

Conclusion

Since its humble beginnings focusing on labeling, FIFRA and the EPA have come a long way in instituting environmental and health protections not only for consumers but also for agricultural workers and pesticide handlers.

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See Also: Environmental Protection Agency (EPA); Farms; Pesticides; Toxic Wastes.

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First Principle of Waste

According to official Environmental Protection Agency (EPA) and U.S. Department of Agriculture (USDA) estimates, approximately 25 percent of prepared food is wasted in the United States. Other estimates of total food waste from food produced in the United States are as high as 50 percent. Such discrepancies may be the result of varied measurement tools and methods as well as the large differences between what people report they waste and the actual amount of food waste produced.

In the 1970s, archaeologist William Rathje, along with colleagues and students at the University of Arizona, founded the Garbage Project. The project sought to use archaeological methods of inquiry in order to understand current society by studying the garbage people produce. While archaeologists often delve deeply into the waste of past cultures, this project was different in that it was looking for insights into the present nature of contemporary society by sorting through households' freshly discarded garbage.

Through this process, they came upon a number of interesting and surprising discoveries that led them to develop the concept of the First Principle of Food Waste (FPFW). The FPFW states that food products that are used on a regular basis are wasted at a much lower rate than specialty ingredients that are used less frequently. The more repetitive one's

diet—the more one eats the same foods day after day—the less food waste will be produced.

The FPFW explains why sliced bread is hardly wasted at all, while specialty bread items, such as hot dog buns and bagels, are wasted at a rate of 30–60 percent. The FPFW also helps to explain why garbage collected from Mexican American census tracts had as much as 20 percent less food waste than garbage from Anglo census tracts. Mexican cooking offers a diverse array of dishes, but there are few ingredients in them. Tortillas, beans, beef, chicken, pork, avocados, tomatoes, lettuce, onions, chili sauces, and salsa are all used in many dishes. These staple ingredients are used constantly, with leftovers easily incorporated into new dishes.

Through continued and diligent recording of fresh household garbage, the Garbage Project fully investigated household maintenance waste. The intimate knowledge acquired about everyday products like detergents and cleansers, as well as more episodically used products like paint and varnish, led them to expand the FPFW to include other consumer products such as household maintenance products and hazardous waste. This led to the development of the more general First Principle of Waste.

Social Contexts

Insights from the Garbage Project led to realizations that seemed counterintuitive to general human behavior. During times of shortages, food is wasted at a higher level than usual. This seems to be due to crisis buying and hoarding behaviors that lead to increased food waste. The waste may be the result of people buying either foods they would otherwise not buy (for example, certain cuts of meat or sugar substitutes) and, therefore, do not know how to prepare, or foods that they simply do not like. These insights are helpful in better understanding consumption and waste patterns that may be contrary to common knowledge about food waste. Additionally, these archaeological methods are useful in understanding actual behavior, since peoples' self-reported behaviors are quite different from reality.

There has been an increasing awareness in the 21st century of waste and its related social and environmental impacts. As part of the rise in attention toward waste, the EPA and USDA have developed recommendations for households and institutions to reduce food waste that include a Food Waste Recovery Hierarchy, which advises certain ordered actions, including the following:

- *Source separation*: reducing the amount of food waste being generated
- *Feed people*: donating excess food to emergency food organizations
- *Feed animals*: providing food scraps to farmers
- *Industrial use*: processing waste food into fuel or industrial animal feeds
- *Composting*: recycling food into nutrient-rich soil amendments
- *Landfill and incineration*: disposing of food is the least desirable option

In 2008, according to the EPA, at least 12.7 percent of total municipal solid waste in the United States was food waste, with less than 3 percent of food waste being recovered or recycled. Thirty-one million tons of food waste were disposed of in landfills or incinerators. Landfilling food waste or any organic matter is problematic due to the anaerobic conditions in landfills. These conditions lead to the production of methane, a greenhouse gas more problematic than carbon dioxide.

Implications

The FPFW conflicts with current dietary advice from nutritionists and public health officials who encourage diverse dietary intakes. At the same time, recommendations for the FPFW parallel food movements, which encourage food consumption that focuses on local and seasonal diets. As of 2010, there has been limited research in this area beyond the Garbage Project. Further research into the specifics of food waste may lead to a more-nuanced understanding of it and may help in its overall reduction. While the Garbage Project focused on North America, this field would benefit from additional study that includes other regions of the world and incorporates various cultural contexts.

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See Also: Beef Shortage, 1973; Food Waste Behavior; Garbage Project; Garbology; Sugar Shortage, 1975.

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Fish

Fish remains are readily identifiable components of garbage worldwide, if for no other reason than their smell, yet the contribution they make to the amount of garbage that accumulates is difficult to calculate. Fish bones are relatively delicate compared to those of land animals and do not stand up as well to post-depositional chemical and mechanical processes.

If one were to excavate, for example, a five-year-old garbage dump and tally up the number of fish bones recovered, they would be underrepresentative of the original number. In addition, an unknown—but large—percentage of fish never make it to land but are dumped dead back into the waters from which they were caught. Likewise, fish are often processed on or near the water, with the by-products never reaching land.

Calculating Waste

Perhaps the only method available for calculating the contribution of fish remains to garbage is to use catch figures as a baseline and then examine those figures against known or suspected patterns of human consumption. Annual worldwide fish production, including wild capture and aquaculture (farm) production (excluding shellfish) averages around 140–150 million tons. This figure is susceptible to the vagaries of any number of variables, including price and ecosystem disruptions, especially climate anomalies such as El Niño. Although precise production figures from China are unreliable, that country accounts for approximately 30 percent of the world's fish production, followed distantly by Peru, the United States, and Japan. Of the total tonnage of fish processed each year, 70–75 percent are for human consumption and 25–30 percent are for reduction into fishmeal and fish oil. Fishmeal, which is a coarsely ground powder made from cooked fish, was once important as a fertilizer but is used primarily in pet food in the 21st century. Peru is the leader in fishmeal production, using the Peruvian anchoveta, which is the leading fish caught in the world in terms of tonnage.

Worldwide, annual per capita fish consumption is about 35–40 pounds. In some Asian and African countries, where fish provide 50 percent or more of the animal protein, annual per capita consumption can run as high as 45–50 pounds. In some small island states, such as Seychelles, the annual per capita consumption can exceed 165 pounds. In other countries, especially meat-exporting countries such as the United States and Argentina, annual per capita consumption of fish is under 20 pounds. Based on these figures, one can roughly estimate that annual per capita fish waste worldwide is about 10 pounds.

Fish Smell and Its Effects on Garbage

Rotting fish produce one of the most noxious smells imaginable, in large part a result of adaptations that fish have made to aquatic environments over millions of years—adaptations that are vastly different than those made by land-living animals. Fish contain an odorless chemical called trimethylamine oxide (C_3H_9NO). Once a fish dies, bacteria in the body begin breaking down the compound into two foul-smelling compounds, putrescine ($C_4H_{12}N_2$) and cadaverine ($C_5H_{14}N_2$). The meat of land animals contains far less trimethylamine oxide than that of fish and hence does not smell as putrid when decaying. There is considerable variation in trimethylamine oxide levels even in fish, with cold-water species, especially those that feed near the surface, having the highest levels.

The presence of noxious compounds plays a role in the contribution of fish remains to garbage regarding two variables: (1) changes in human dietary preference and (2) how fish are handled immediately upon and after death. It is becoming increasingly clear that omega-3 fatty acids, found

Fishmongers are selective in determining the quality of their catch and discarding fish that lack freshness. Improper disposal, such as tossing on beaches, can negatively impact tourism. For this reason, the United Kingdom requires complete incineration of fish waste.

in fish oil, have medical benefits, including prevention of psychotic disorders in high-risk children and heart disease in adults through a reduction in blood-triglyceride levels. What is not clear is the range of health problems that omega-3 fatty acids prevent or ameliorate—although if one were to believe the hundreds of claims made in television and magazine ads, they prevent everything from male-pattern baldness to impotence. Not surprisingly, given Westerners newly found emphasis on eating supposedly healthy foods, cold-water fatty fish such as herring, sardines, and salmon have assumed a more important part of their diet. Salmon, for example, contains roughly five times the amount of omega-3 fatty acids as either cod or catfish and only slightly less than that amount compared to either mahi-mahi or canned light tuna. Oily fish also often contain heavy metals, such as mercury, and fat-soluble compounds, such as dioxin and PCBs, but Westerners tend to accept the risk in the quest for the much-heralded omega-3 fatty acids.

But Westerners, for the most part, also have a natural avoidance of any "fishy" smell and taste. Freshly killed fish lack any odor other than what normally is thought of as a "sea" smell. If prepared and consumed immediately—or if kept on ice or refrigerated for a short period—bacteria do not have time to break down the trimethylamine oxide into putrescine and cadaverine. Fishmongers tend to be highly selective in determining the quality of the fish they sell and are constantly culling their offerings and tossing out fish that are beginning to decay. In many nonindustrialized areas, the remains are either collected for disposal in a garbage dump or simply cast aside. Some Caribbean countries are becoming concerned over the negative impact on tourism caused by improper disposal of fish remains on beaches.

In contrast, many developed countries prohibit meat and fish from being dumped, even in landfills. In the United Kingdom, for example, which has stringent disposal laws, all raw meat and fish trimmings, including bones, heads, scales, and skin, must be disposed of in accordance with what are called "Category 3" requirements, which means complete incineration within an approved incinerator or processing for pet food at an approved plant.

Archaeology

Fish remains might be problematic for modern health concerns and aesthetic reasons, but they are excellent tools for discovering more about what went on in the past. Fish bones from archaeological sites, for example, indicate not only what past peoples ate but also what kinds of fish were common in a region at a particular time. Ecologists can use archaeological fish bones to examine how the diversity, distribution, and abundance of marine life has changed over time. For example, fish bones from the Mesolithic levels of Franchthi Cave in southern Greece show that the bluefin caught in the Aegean Sea in the 21st century pale in size compared to those caught some 8,000 years ago—a result of modern overharvesting of larger fish.

Conclusion

Fish will always be an integral part of the human diet and their remains will remain a component of garbage. The goal is to minimize the impact they have

on the social and natural environment by disposing of them in ecofriendly ways. One area with considerable potential is the biodiesel industry, which is beginning to use fish remains as a renewable energy source. With some fish-processing plants in southeast Asia producing over 250,000 pounds of waste daily, there is no present shortage of raw material.

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See Also: Dating of Garbage Deposition; Food Waste Behavior; Meat; Ocean Disposal.

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Floor and Wall Coverings

The first hand-knotted pile carpets were woven in prehistoric central Asia, probably for protecting nomadic tribes from the cold, temperate-zone nights. Following the Crusades, carpets and rugs entered Europe as luxury items and were only used as floor coverings in royal and ecclesiastical settings, often being hung or covering furniture. By the end of the medieval period, carpets were woven in Europe "in the Turkish manner." Being woollen, these carpets generally remained in use for around 200 years and are mainly studied via depictions in paintings.

In the 21st century, carpets are usually nylon or polypropylene. The vacuum cleaner was first marketed to clean carpets in the late 19th century. This was a luxury item until after World War II; they are ubiquitous in the 21st-century Western world.

Floorcloth

Stone and timber floors in larger houses were artisan-created works, intended to be seen. Painted and stencilled floors were augmented by floorcloths, hard-wearing painted canvas. Floorcloth (also known as floor oilcloth or painted floorcloth) first appeared in the early 18th century, but there are 15th- and 16th-century references to a similar material.

Floorcloth became popular despite its expensiveness and tendency for patterns to wear off. It was used in high-traffic areas, such as entrance halls and stairways, where easy cleaning was important. It was also favored in ground-level rooms in the summer, although it became malodorous and tacky when hot. Manufacturing was labor intensive and dangerous, using painting frames six storys high on which workers balanced to coat the canvas. The processes of drying and curing meant that production took several months. By the close of the 19th century, floorcloth had fallen in price enough to be available to the working classes.

Linoleum

The next significant development in flooring was Linoleum, which developed from a product called Kamptulicon. In 1855, Frederick Walton peeled the skin from the top of a can of oil paint and used this skin, produced by oxidation of linseed oil, to develop a product he called Kampticon, but later rebranded as Linoleum. Walton started the Linoleum Manufacturing Co., Ltd., in 1864. At first, the company ran at a loss as the fierce competition between floorcloth and Kamptulicon continued. A large advertising campaign and the opening of two Linoleum shops in London reversed the situation and sales skyrocketed.

The success of Linoleum spawned its imitation by floorcloth companies. Walton began legal action against Nairns of Kirkcaldy in 1877, but lost, having never registered the trade name. The word *linoleum* became the first product name to be ruled a generic trademark in court.

Linoleum's heyday was from the 1860s until after World War II, when the do it yourself (DIY) boom saw other hard floorings overtake linoleum, which was seen as old-fashioned and vulnerable to damage from the fashionable high-heeled shoes of the time. The "poor man's carpet" was undermined by

the appearance of cheap carpeting. By the 1960s, linoleum was almost completely replaced by cheaper vinyl flooring and struggled throughout the 1970s when environmental change increased the price of linseed oil. A recovery in the late 1970s and 1980s credits linoleum's natural ingredients, durability, and nontoxic breakdown and combustion products. Linoleum has enjoyed resurgence as a green product since the 1980s, when it became possible to recycle linoleum for linseed oil, making it 100 percent recyclable. Natural lino production also recycles all remnants back into the production process.

Linoleum remains popular in the 21st century, but it suffers from a preconceived image of being déclassé and has a bad environmental reputation because of the term *lino* being applied to other flooring such as vinyl. It is actually one of the modern world's oldest natural floorings, being made from renewable materials. Lasting up to 40 years, linoleum is biodegradable and can be used as fuel since it is similar to coal in terms of energy and releasing CO_2 roughly equivalent to the uptake of its ingredients. Linoleum is therefore a closed loop system, where energy from incineration equals or exceeds energy used in production.

Polyvinyl chloride (PVC), or vinyl flooring, still holds most of the market because of its brightness and fire-retardant properties. However, vinyl's monomers are associated with occupational cancers, combustion products are highly toxic, and phthalate additives are a suspected health risk. Post-consumer PVC recycling is possible but was still in its infancy as of 2010 and not widespread.

Having few obvious reuses, sheet flooring is often fly-tipped. In Dresden in 1905–13, Die Brücke created the Linocut printmaking technique, applying the woodcut technique to linoleum. In Hip-Hop culture of the late 1970s and early 1980s, linoleum was used to provide a dancing surface for b-boying, or breaking (the preferred terms for breakdancing).

Wall Coverings

Woodcut-printed wallpaper became popular with the elite of Renaissance Europe, replacing tapestry and paneling as a means of decoration and insulation. The expense and import availability of tapestries led to the lower echelons of the elite adopting wallpaper, which featured similar designs to tapestry and was hung loose like tapestry. Prints, which were collectible artworks at the time, were often pasted to walls instead of being framed. They became common during the 15th century, and their price fell dramatically. The largest prints by prominent artists covered several sheets and were pasted on walls and hand colored. The Triumphal Arch, commissioned by Holy Roman Emperor Maximilian I, measures 2.95 by 3.57 meters and was printed using 192 separate woodblocks. The 1517–18 first edition was gifted to princes and cities of the empire to hang in palaces and city halls, a classic example of Habsburg propaganda.

England and France led European wallpaper production. One of the earliest known examples is printed on the back of a recycled 1509 London proclamation. Wallpaper became widespread in English homes of status when Henry VIII's excommunication curtailed tapestry imports from Catholic Europe. The Puritan government of Cromwell's Protectorate halted wallpaper production, but the Restoration saw demand rise after the dull material culture imposed by Puritan luxury-item bans. Britain became the European leader in wallpaper production, both supplying the large British middle class and exporting.

A wallpaper tax was introduced to Britain in 1712 and abolished in 1836. This tax was avoided by buying plain paper and having it hand-stencilled or decorated. During this period, flock wallpaper was developed, the same technique (using adhesive to coat a surface with fiber particles) having been used on walls in medieval Germany. A cheaper "mock flock" was developed by printing a deeper shade over a lighter shade of the same color. Jean-Baptiste Réveillon imported flock wallpapers into France from 1753. When the Seven Years War stopped this trade, Réveillon began manufacturing and created some of the most successful wallpapers ever.

The Napoleonic Wars caused Britain's wallpaper industry to decline. Their conclusion, in 1815, caused a massive European demand for British goods again, including cheap wallpaper. The development of steam printing presses in the interim made wallpaper cheap enough for the working classes.

Post World War II, the DIY boom made wallpapering accessible to ordinary householders; prior to this, it had been a luxury item that had to be

hung by skilled tradesmen. Old wallpaper in great houses seems to have been simply papered over as sequences going back to the 18th century have been recovered. In some houses, wallpaper cannot be papered over and has to be removed, initiating a new range of hardware products designed to remove wallpaper and culminating in strippable wallpaper, which can be simply peeled off.

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See Also: Fly-Tipping; Industrial Revolution; Paint; Paper Products.

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Florida

Florida is one of the largest states in the United States by population and by size. It provides a glimpse into the nature of consumption and waste in the United States. Florida also has unique issues associated with waste management.

Perhaps what sets Florida apart in the cultural landscape of the United States is its appellation as the "Sunshine State." As the southernmost of the conterminous states and the one with the most coastline (over 1,200 miles), it is widely known as an international vacation spot with world-class destinations such as Orlando, Miami, Key West, and the Gulf Coast beaches. However, it is not only a vacationer's paradise and is also home to nearly 20 million people who live and work in the state. As the fourth-largest state by population, Florida is part of the broader U.S. consumer culture; however, its subtropical climate sets it apart from all other U.S. states.

Consumer Activity in Florida

The size of the state has a significant impact on the overall national economy. The gross domestic product (GDP) in Florida is the fourth-largest in the country. The most important economic activity in the state is tourism, which brings millions of visitors each year from throughout North America and abroad. Several major attractions include the Walt Disney World Resort, Busch Gardens, SeaWorld, and the Universal Orlando Resort. However, the beaches and warm weather are the main natural attractions that draw visitors from cooler climates. Tourism produces a tremendous waste burden on communities. Visitors' garbage, sewage, and their voluminous presence must be managed by local governments so as to ease encumbrances placed on the local environment.

The second most important economic activity in the state is agriculture. Florida is the largest producer of citrus in the United States and is an important source of winter fruits and vegetables. Copious volumes of Florida tomatoes, strawberries, blueberries, and a variety of other seasonal crops are shipped all over the world. In addition, unique crops, such as sugarcane, mangos, orchids, tropical fish, and landscape plants add to the state's agricultural diversity.

The greatest problem with agricultural waste in Florida is the runoff of agricultural nitrogen and phosphorus from fields. As most ecosystems in the state are low-nutrient environments, nutrient-rich

agricultural runoff poses particular problems for these bionetworks. One particular ecosystem, the Everglades, has received particular attention because of these issues. Water used in agricultural processing is also an important waste product that must be managed with great care. By-products of agricultural processing, such as orange rinds, dead tomato vines, and leftovers from sugarcane processing, are sometimes taken to landfills, left to rot or burn, or enter a waste-to-energy stream.

The third most important economic activity in the state is phosphate mining. The Bone Valley Formation, the source of the phosphate, is present in many areas throughout central Florida. The phosphate is mined in complex strip-mining operations, where voluminous piles of waste known as "gypsum stacks" are left behind. In addition, many acres of acidic and poisonous wastewater ponds are present. During a 2004 hurricane, water from one of these ponds breached its banks and flowed into the Gulf of Mexico, where untold damage impacted the environment.

Florida is also home to some of the nation's most important ports and interstate highway systems that bring in consumer goods destined for Florida's homes. Although consumerism remains strong in the state, double-digit unemployment rates and plummeting real estate values have dampened consumer confidence, and many businesses have been forced to downsize or close.

Waste Management

Waste in Florida is managed by the state's Department of Environmental Protection, which ensures that state and federal laws are enforced, although local governments may have more specific rules that local entities manage. Each day, tons of solid waste from homes and commercial operations are picked up by local workers or by waste collection operators and transported to local and regional landfills. Most large communities in Florida have curbside recycling pickup or access to recycling drop-off centers. Specialized waste, such as medical and hazardous waste, requires specialized handling and disposal.

Prior to state and federal involvement in waste management, hundreds of unregulated garbage dumps existed throughout the state. Waste from these facilities often leaks into the environment, vexing environmental managers. Most problematic are old industrial dumps, such as those associated with battery manufacturing, which leak hazardous materials into the soil and groundwater. Some abandoned garbage dumps also lead to community redevelopment problems. These sites can be classified as brownfields, which are sites that have real or perceived contamination and lead to lower property values in communities.

Florida's unique geology requires special attention from waste managers. The underlying bedrock in most of the state is a highly porous and permeable limestone. The holes in the rocks are highly interconnected and allow easy flow of water from the subsurface into the aquifer. Therefore, a contaminant released at the surface can easily find itself miles away from its source very quickly. There are numerous examples of waste products entering the drinking-water system in Florida. These wastes can also leak into freshwater or saltwater wetlands.

Special Issues With Florida Waste

There are several issues associated with waste management in Florida. These include waste-to-energy facilities, Superfund sites, and waste associated with storms.

Located throughout Florida, there are several waste-to-energy facilities that provide a significant amount of energy to the state. These plants typically take in household garbage and convert it into electricity. The remaining ash is separated magnetically so that metals can be recycled. There are also several biodiesel facilities in Florida that convert plant material to a biodiesel product or ethanol. Originally conceived of as a scheme to deal with waste vegetation and agricultural by-products, biodiesel has created a new agricultural niche in Florida.

The state of Florida contains several Superfund sites. These are sites with complex environmental contamination problems associated with poor handling of waste products. Many of the sites are associated with old or abandoned factories that produced a variety of products, including chemicals and pressure-treated wood. For example, the Stauffer Chemical Company site in Tarpon Springs, Florida, produced a variety of products from raw phosphate ore, including elemental

phosphorus for weapons, between 1950 and 1980. During this time period, nearly half a million tons of wastes were disposed of in unregulated landfills and unlined ponds on the 160-acre site. The site is particularly dangerous because it contains a variety of hazardous chemicals in the subsurface that can leak directly into the aquifer, nearby rivers, and wetlands.

Another waste challenge for Florida is debris associated with tropical storms and hurricanes. A tremendous amount of debris, including tree limbs, furniture, construction waste, and hazardous waste, is produced when hurricanes damage communities. Lacking adequate forewarning, managers are faced with finding ways to deal with thousands of tons of excess debris. Safety issues associated with downed power lines and trees and purification of refrigerated items due to loss of electricity compound these challenges. During such events, waste managers work hard to educate impacted communities on how to separate their waste into tree limbs and yard waste, construction debris, household waste, and hazardous waste. It may take months for waste to be entirely cleaned from some of the most impacted communities.

The 2010 Deepwater Horizon oil spill in the Gulf of Mexico is of concern to many associated with waste management. Cleaning a large oil spill produces a significant amount of oily contaminated waste that includes contaminated sediment, cleaning supplies, and protective clothing.

Conclusion

Florida's diverse economy produces different wastes in varied amounts. Federal and state rules that govern the management of waste are overseen at the state level by the Florida Department of Environmental Protection. Florida has a number of waste-to-energy facilities that provide electricity to consumers. The state must manage a number of special wastes, including hurricane debris, phosphate mining waste, and agriculture waste.

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See Also: Alabama; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Georgia; Pollution, Land; Pollution, Water; Weather and Waste.

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Fly-Tipping

Fly-tipping, originally a British term, refers to the illegal dumping of waste anywhere other than an officially licensed site such as a landfill or municipal tip. Material may be dumped onto public or private land, in the city, or in the countryside. In the United Kingdom, those who permit, rather than carry out, the dumping of waste onto ground that

Fly-tipping (or illegal dumping of waste) in a private parking lot in Tottenham, United Kingdom. The vast majority of fly-tipping material is domestic waste. Limited hours and accessibility at public dump sites are cited as reasons for the prevalence of this practice.

does not have a waste management license are also culpable. That both offenses are potentially punishable by a fine and imprisonment is an indication of the seriousness with which the practice is viewed. However, the proportion of successful prosecutions to reported instances of fly-tipping is minuscule. Fly-tipping constitutes an eyesore, may have serious environmental impacts, and can often be a danger to health and safety.

Less obvious effects occur when areas prone to repeat fly-tipping start to suffer declining property prices or decreased economic activity. Moreover, the costs of clearing fly-tipped material can be high, ongoing, and divert much-needed resources from elsewhere. To fully explore the phenomenon of fly-tipping, it helps to know who tips, the nature of the material dumped, the various sites favored for fly-tipping, and varied rationales invoked to justify the practice.

Fly-Tippers

A varied range of fly-tippers can be established. A significant majority, around three-quarters in the United Kingdom, of all the material dumped is identified as domestic waste, and the presumption is that individual householders dump general domestic waste and unwanted items that they are not willing—or able—to dispose of in other ways. Fly-tippers also include small businesses that illegally tip in order to circumvent official, highly legislated, and costly methods and sites of disposal. Larger business fly-tippers comes in two varieties: those who simply illegally dump larger quantities of their own material, such as building waste and hazardous chemicals, and those operators who make money by illegally dumping waste collected from third parties. Such third parties may or may not know that the waste they pay to have removed ends up illegally disposed of.

Composition and Purposes

While the majority of the material dumped is domestic waste, what is surprising is that over half of this constituent comprises plastic sacks containing general household waste, which is the kind of waste that would also be disposed of via municipal waste collection. That it is dumped instead brings to attention various waste collection issues that remain unresolved for many householders. These include both lower levels of domestic waste collection than that of waste generation and a lack of proper disposal facilities such as local recycling points. The next most common items comprising fly-tipped domestic waste include old mattresses, broken refrigerators, washing machines, and vehicle tires. While much of the motivation for such illegal dumping may well be based on ignorance, convenience, or the avoidance of specific charges related to the disposal of such items, this material too draws attention to some oft-noted issues, which may be seen with some sympathy. These include limited opening hours at civic amenity sites, the strictly enforced banning of vans at those sites, and unaffordable charges for bulky, dangerous, and specific items of refuse collection. While much fly-tipped waste may occur as the result of actions designed to avoid charges for trade waste collection or to avoid paying landfill taxes, this is not necessarily the case for much dumped domestic waste.

Urban and Rural Issues

Fly-tipping is predominantly an urban phenomenon, although instances of rural fly-tipping are often more highlighted in the news media. This may be because the countryside is seen to be more pristine in principle than the city, such that any despoiling is judged to be more offensive and antisocial. It may also be the case that a greater material contrast can be usefully exploited, that between the domestic waste of the city and the supposedly natural materiality of the countryside. Moreover, the contrast between discarded, disordered, and defunct waste and green, managed, and productive nature is powerful. The costs of removing dumped waste and of identifying those responsible for fly-tipping also pose greater challenges in the countryside.

Within urban centers, fly-tipping can be viewed as a quite-complex social phenomenon. For example, it may be regarded as one of a series of commonly designated social problems, particularly those practices that despoil the urban environment. These include fly-posting, graffiti, noise pollution, littering, and dog fouling; the latter two generate far more public complaints to local authorities than fly-tipping does. Other forms of disposal of domestic waste may also be confused with fly-tipping. For example, legisla-

tion specifically excludes from its definition of "illegal tipping" waste dumped on domestic land with the owner's permission. However, a good deal of domestic waste dumped in the urban and suburban environment remains on domestic private property, often rear and front gardens. While not technically illegal fly-tipping, such practices, nevertheless, give rise to the same problems and safety issues with the added potential to cause acrimonious neighbor and neighborhood disputes. The difference between semipermanent, visible storage and tipping is often tenuous and contested.

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See Also: Culture, Values, and Garbage; Household Consumption Patterns; Midnight Dumping; Sociology of Waste.

Further Readings

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Food Consumption

Humans eat food for a variety of reasons. On the most basic level, food provides the macro- and micronutrients necessary for life. Humans also experience food through a multitude of means, consuming food not only as it is ingested but also in the variety of meanings humans attach to ingredients, meals, cuisines, sharing, celebrations, and even being seen with foods. Humans experience food beyond the meal not only while consuming it but also in the selection of certain products over others in meal planning and preparation. Humans experience foods as both a biological necessity (nutrition) and within a social context through which people ascribe meaning and value to foods as cuisine, as tradition, as identity, for creating and maintaining relationships, through food's preparation, presentation, packaging, cost, and within and throughout its social context. There are a variety of ways of reflecting taste at the individual, group, social, and cultural levels. Meals and the way they are shared both physically and ideologically inform people of who they have been, who they are, and where they might be going.

The meaning of foods, even at the most base level of what constitutes proper food, varies through space and time. Foods that at many times of the year might be considered inferior have historically been readily consumed in times of resource scarcity. Food is not only a matter of individual, household, or community preferences but is also rather intertwined in overlapping and often conflicting values and ideologies. As such, the production, distribution, preparation, and consumption of foods is increasingly legislated and contested in a variety of political and economic contexts. The notion of what is good to eat and what is possible to eat is a product of these processes.

Food Variety and Domestication

Most humans eat a rather narrow variety of foods. This may be a product of several factors, including cultural preferences, cost of food acquisition in terms of money and time, and overall availability of a diversity of foods. For the most part, humans believe—depending on the cultural context—there are substances that are good to eat, those that will be eaten in less than ideal circumstances, and substances that should never be ingested. This can include utilization of certain parts of an animal or plant. In addition, how food makes its way to the mouth and the process surrounding this have a tremendous amount of influence upon how much waste is created in the process of making food.

The innovation of domestication dramatically altered human relationships to other species. With the adoption and utilization of these technologies, humans came to rely on fewer and fewer species with greater and greater intensity. This reliance created anatomical and physiological changes in other species, which, in turn, made them more reliant upon humans for their propagation and continuance. The overall impact of these innovations

has been a decrease in the variety of foods readily available to large segments of the population. These processes also led to the continuing separation of humans from both the plants and animals consumed and the suite of physical, geological, ecological, and biological processes that allow for the production of food.

This is not to say that other food consumption patterns did not lead to the landscape modifications. Foraging activities, including hunting and gathering, have historically resulted in landscape modifications, although the scale and intensity of modification increased with the introduction of agriculture. The overall decrease in the variety of foods has been explored to determine the nutritional consequences of agriculture.

Food Rituals

Food consumption has become a distinguishing factor in identity, particularly along the lines of cultural and national identity. Historically, certain foods were ritualistically consumed in a variety of cultural events. In some instances, the ritualized consumption of certain foods marks a change in season. In the context of indigenous peoples of North America, these foods have been examined by scholars and activists as part of cultural revitalization movements, which encourage a return to remembered ways of doing and being. These foods have, in some instances, been viewed as a means to perpetuate health and confront disease in a number of cultural contexts. They are symbolically important in that they represent a return to traditional ways of eating and thinking in an effort to decolonize diets.

The consumption of traditional—sometimes conceptualized as precontact foods—is hence viewed as a response to contemporary health epidemics, most notably the type II diabetes that is prevalent in many 21st-century Native American communities. The call to consume more traditional foods is for some a resistance to the colonization of both food systems and the body. In other instances, indigenous peoples readily use traditional foods and methods of healing in unison with biomedical and other approaches to health and healing. At the same time, conceptions of traditional foods vary intra-culturally as the meaning of traditional foods can vary dramatically between and within households, communities, and nations.

Fusion

In some instances, these foods are twinned with other nontraditional or postcontact foods to produce fusion cuisine. Contemporary chefs continue to expand the offering of fusion cuisine by combining regional cuisines in new and interesting ways and integrating "new" foods in familiar dishes. This occurs in both high-end restaurants and resorts as well as in local communities in order to make the foods more exciting for younger generations who may not have grown up consuming traditional foods. One notable example of this is on the Tohono O'odham Nation of southern Arizona, where cholla cactus buds are now combined with spinach, pineapple, and dressing to produce a healthy and nutritious example. Other popular combinations among those promoting traditional foods on the Tohono O'odham Nation include tepary bean hummus and raspberry chia seed smoothies. These serve to entice non-O'odham to eat traditional O'odham foods and offer a new and unique way to experience traditional foods for O'odham peoples.

The mixture of traditional with nontraditional foods has appeal for many Tohono O'odham. At the same time, there has been a marked interest in these foods among outsiders who wish to try new foods. Depending on the context, this can lead to an increased interest in and capacity to grow traditional foods at the local level or to a siphoning off of traditional foods to fulfill the desires of consumers in other regions. Hence, traditional food enthusiasts and organizations such as Slow Food USA must also consider the impacts that their making traditional foods readily available to the general public might have on indigenous peoples who are working to revitalize traditional food systems.

International Exchange and Markets

This contemporary example of the circulation of plants and animals and their subsequent utilization in different locations, each with their own suite of judgments regarding the value of the food, mirrors earlier exchanges. The term *Columbian Exchange* (coined by historian Alfred Crosby), or the exchange of plants and animals for a variety of

uses, including food, beginning with the voyage of Christopher Columbus in 1492, has had tremendous impacts on cuisine throughout the world. The most readily recognizable 21st-century foods are themselves products of interaction and exchange of plants, animals, and ways of preparing these for human consumption. The Columbian Exchange had dramatic impacts on the diets of those in the New World and those in the Old World. One of the starkest examples is the overreliance upon one type of potato for subsistence utilization by the Irish people. This crop failure, coupled with British control over Ireland, led to the Great Hunger, or Great Famine, which led to the starvation or emigration of over 1 million people. The Columbian Exchange was a product of colonialism and can be viewed as an early intensification of global flows of goods and people, a precursor to globalization.

In the 21st century, goods, people, and ideas flow through and across borders with varying ease via instantaneous and enveloping communications. Products come with their own biographies that are coproduced by both employees and, increasingly, in conversation with consumers. In the consumption of food—or any other consumables for that matter—humans are consuming the physical products based on sensory taste as well as perceptions of taste. Hence, the consumption of foods is also necessarily social in nature.

Food and the meanings that humans attach to it vary over space and time. Some of this can be related to the cost of products, which fluctuate over time. In its early years as a commodity, sugar was so expensive that only the elite could afford it. As sugar plantations expanded in the New World, aided with the forced labor of the transatlantic slave trade, the price of sugar dropped. This price drop allowed for consumption by the masses. Market fluctuations of commodities can dramatically impact farms of various scales. This can translate into increased vulnerability in terms of economic and food security.

Consumption Levels: Overnutrition and Undernutrition

Quantity of food consumption can be problematic at multiple levels if too much or too little food is consumed. The question of too little food being consumed in its most dramatic form occurs in large-scale collapse of the food system's ability to meet the dietary requirements of large segments of the population. In order to prevent large-scale famines, international monitoring systems coupled with news media coverage can mitigate the impacts of caloric shortfalls by assessing food insecurity. Food security, according to the 1996 World Food Summit, "exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life." In order for this model to work, enough food has to be available for either direct assistance or for purchase to vulnerable populations. Often, foods that are utilized to confront food insecurity on a large scale are commodity foods.

The United States has focused on commodity production and has historically made claims of feeding the world through agricultural development in the Great Plains, or what has historically been referred to as "the breadbasket" of the United States. Despite this optimism and the tremendous historical growth in U.S. agriculture production, there are still numerous food security issues globally and in the United States. Both urban and rural populations suffer from a lack of food security as defined in international law and policy.

There are a number of health and nutritional disparities in the United States surrounding both undernutrition and overnutrition. One phenomenon has been the occurrence of both over- and undernutrition in the same individual, such that the person consumes an overabundance of calorie-dense, nutrient-poor foods. Hence, there is overnutrition in terms of calories and fat consumed and undernutrition in terms of key vitamins and minerals. These health disparities are particularly apparent when examining ethnic and poor communities in the United States and England, where there have been reports of food deserts. Food deserts, variously defined in the literature, refer generally to those communities that do not have ready access to fresh foods, notably fruits and vegetables. Neighborhoods with lower per capita income tend to have less access to these nutrient-dense foods and more access to foods that are relatively calorie dense and nutrient poor. A policy response to this has been to promote the

construction of large supermarkets in food deserts in an effort to increase consumption of fruits and vegetables. According to preliminary reports, this has been successful by encouraging those in former food deserts to consume more fruits and vegetables and greater quantities of all types of foods.

In some instances, deficiencies in key nutrients have been viewed as government responsibility and in other instances corporate opportunity, although the two are not necessarily mutually exclusive. Government-permitted and industry-sponsored fortification of foods has helped to alleviate some health concerns caused by nutrient deficiencies. In 1969, the U.S. government allowed fortification on a wide scale, such that nutrients could be added to foods of any kind—whatever their preprocessing nutrient levels—if it was thought that the diets of a significant number of people were deficient in them. Attempts have also been made to increase the health potential of staple foods, hence meeting nutrient shortfalls. In one case, genetically modified rice has been promoted as a means to target vitamin A deficiency in children. Rather than attempt to ameliorate the conditions that led to a consumption of a narrow range of foods, technical expertise is seen as the "magic bullet" to alleviate suffering in an attempt to legitimate gross disparities that may arise in commodity production.

Caloric shortfall has been a major concern throughout the world, even in the United States, particularly during times of economic crisis, such as the 2008 "heat or eat" crisis in western Alaska, where some residents of rural communities were paying very high prices for fuel oil relative to those in urban areas of Alaska and those in the "lower 48." These can be mitigated through community-based safety nets such as food banks, as well as government-based food assistance programs.

Consuming too many calories can also lead to a number of health concerns. The increase in the number of calories consumed in relation to caloric expenditure leads to weight gain. Weight gain over time can lead people to become overweight or obese. This increase in weight is a risk factor for a number of diseases that have been collectively referred to as "diseases of affluence." Films, including *Supersize Me!*, *Fast Food Nation*, and *Food Inc.*, have done much to increase public understanding of the health risks inherent in contemporary food systems. These films are a means through which greater segments of the population are able to consider the impact of the food system. According to one recent study, fast-food consumption has strong positive associations with weight gain and insulin resistance, suggesting that fast food increases the risk of obesity. While these accounts may raise awareness among specific segments of the population, mere recognition of potential health consequences does not necessarily translate into actual dietary modification, particularly for those with neither the time nor monetary resources to make dietary modifications.

Obesity and Diabetes

The majority of people over 30 in the United States are either overweight or obese and the prevalence of overweight or obese individuals is likely to increase. The vast majority of deaths in the United States are due to chronic illnesses. These conditions are a product of lifestyle choices in terms of diet and exercise and environmental or structural factors that limit access to ready means of exercise and fresh food options. Narratives that emphasize personal responsibility in lifestyle decisions, or a "you've got it coming mentality," and minimize factors that are outside individual control do a great disservice to the promotion of health and wellness, as they ignore the multiple actors and entities that attempt to capture bodies for their own political, economic, and ideological ends.

These narratives become internalized at the individual, community, and societal levels with a cultural logic that emphasizes personal responsibility and freedom. Since individuals have the choice whether to consume foods that are deemed by a number of experts to be "bad" for them, individuals must have the strength to resist consuming these foods out of care for the self. The ramifications of dietary consumption patterns are staggering in terms of their cost to life expectancy and quality of life. Among the illnesses that result from lifestyle patterns, type II diabetes may present the most serious challenge to community health professionals worldwide. The worldwide incidence rate of diabetes continues to rise, likely leading to an increase in the overall number of people living with type II diabetes. In the 21st century, the highest inci-

dence rates are in more affluent countries such as the United States, which had over 20 million cases of diabetes in 2005. Diseases of affluence, such as diabetes, increase premature mortality of the population, medical costs, disability, and individual and family suffering. Medical interventions are made to both save someone's life and affirm poor individual choices and the redemptive power of medical interventions. In this manner, environmental and structural elements of health outcomes are made invisible, yet they are ever present.

Production

Food consumption impacts personal health and the amount of resources that are consumed in order to bring foods to consumers. Food choices at the individual, household, community, and national levels regarding law and policy surrounding food production produce demands on net primary productivity, water, and soil resources. These choices have dramatic environmental impacts at the local, regional, national, and global levels. Included among these is local infiltration of nitrates into groundwater, aquifer depletion, soil erosion, the dead zone in the Gulf of Mexico, and human-induced climate change. Given the nutrition transition in several regions of the world where consumers are demanding greater quantities of resource-intensive foods, these impacts are likely to continue and expand unless there are dramatic shifts in policy and economics.

Despite these impacts—and potentially because of them—continuing efforts by multiple actors are being made to promote myths of agriculture and food production in the United States. The dominant myth of agricultural history in the United States is that it was built by family farmers, intrepid pioneers wresting sustenance from the soil. Alternatively, farmers are portrayed as working in unison with the natural environment to produce food in idyllic, pastoral scenes. These images are frequently employed in the marketing of farm products from a variety of production systems and scales. Effective advertising and marketing has led to the close affiliation people have with particular products as well as brands. These efforts dwarf media campaigns of both public health professionals and agencies that stress the importance of fresh-food consumption and environmental groups who call into question the ecological costs of food production.

Idyllic modes of production are quite separate from the realities of commodity-oriented production systems, which concentrate singularly upon yield maximization of one species to the detriment of others. This disconnect between the idyllic representations of the U.S. family farm and reality in food production continues to be contested among a variety of actors who agitate for continued change in food production systems. Consumers in grocery stores are thus faced with a number of claims made on the packaging—or rather the representation of reality—as idyllic and pastoral. Hence, the imagining of the farm as holistic and integrated with natural systems may be thought of as the first level of consumption. This imagery is not lost on advertising executives and public relations firms that work to maintain scenes of plenitude, the wealth of nature, and harmonious human–environment interactions. This obfuscation of farm practices is in part a product of geographic distance. This physical distance leads to a decrease in an understanding of the processes that go into the making of food. Since foods are consumed hundreds or thousands of miles away from where they are grown, consumers rely upon a number of third parties to certify food quality. Consumers concerned with quality have led a number of movements for more government and independent oversight of food. It is assumed through a series of labeling regimes—some state regulated, while others are promoted by nongovernment or industry organizations—that consumers will have an indication of the process that went into the production of the foods they are eating. This information serves as the basis for consumer decisions regarding whether foods will be purchased, how they will be prepared, and to whom and how they will be served. Hence, consuming foods that are labeled in a particular manner confer value to the consumer. This is not to say that various regimes of food labeling are entirely aligned with one another, as product manufacturers in the United States may make health claims concerning their food production with the caveat that a statement appear on that same label noting that the U.S. Food and Drug Administration has not evaluated the claims made. This includes the products themselves and the processes behind the products,

such as the injection of recombinant bovine growth hormone (rBGH) in dairy cows.

In addition to health claims, food labeling serves to confer other domains of knowledge to the consumer. Presumably, questions regarding how the food was grown, how the animals were treated, and how the workers were treated can all be answered through reference to product labeling. As an example, the label *Fair Trade* confers to consumers a sense that they are reconciling their consumer wants and needs with their personal or household beliefs regarding equity and social justice. The U.S. Department of Agriculture's "Organic" certification also indicates to the consumer that the product was grown using organic methods. This label is increasingly questioned by some scholars and consumer watch groups who note the shifting nature of organic agriculture practices and industrial organic food producers and processors.

The amount of food available remains a pressing concern. Food is consumed through a web of political and economic relations. Consumer agency regarding food choices is always contingent upon a number of overlapping factors, including cultural preferences, accessibility, availability, convenience, and price. Increased industrialization of food production leads to increasing disparities in consumption and allows those affluent enough the luxury of not having to be concerned with where food comes from. However, concern is ever present in grocery stores whose burgeoning shelves hold a plethora of heavily labeled products claiming to represent a myriad of just and equitable relations. As anthropologists have shown, these products are never static and never fully consumed but, instead, are contingent and aspired to in a myriad of consumption practices.

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See Also: Carbon Dioxide; Certified Products (Fair Trade or Organic); Consumerism; Dairy Products; Environmentalism; Farms; Food Waste Behavior; Grocery Stores; Meat; Organic Waste; Pollution, Air; Pollution, Land; Pollution, Water; Population Growth; Slow Food; Sustainable Development; Underconsumption; Water Consumption; Weather and Waste.

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Food Waste Behavior

Food waste can occur during the production, storage, distribution, consumption, and nonconsumption of foods. This occurs from both human action and inaction. In terms of food production, foods can be wasted in the actual harvest process where food is not harvested through the initial harvest process or otherwise gleaned. In terms of storage, inadequately designed storage systems and storage for too long a time period can lead to waste. From the food distribution aspect, food can be wasted through accidents, too long a time period for distribution, or overdistribution, when too much food is distributed at the same time.

Food consumption depends upon a number of factors and varies from country to country and culture to culture. Decisions are made at multiple levels as to whether or not foods are good to eat and what portion of the animals and plants will be consumed. Hence, some parts may be deemed culturally inappropriate for human consumption. At the same time, individual preferences regarding food consumption also impact the amount of food waste produced. Foods that are not consumed may either be shared with other people, fed to animals,

composted, sorted, or disposed of in trash bags and eventually landfills. Some municipalities concerned with shrinking landfill space and subsequent costs of landfill development or waste shipment are making efforts to reduce the overall waste stream by combinations of recycling programs and organic waste diversion.

Food Production Waste

In terms of food production, foods can be wasted throughout the growing process; in particular, food losses are readily apparent in the actual harvest process. Food waste during food production can occur from a number of factors and is often the result of farm management choices, including tools and techniques used in growing food, geology, or weather-related factors. Specifically, crops can be lost to pest infestations, climatic variations in temperature and water access, and soil fertility issues (which decrease the ability to plants of attain the water and nutrient sources needed for growth, thus leading to greater vulnerability). Mechanical harvesters may be inefficient in harvesting food in its prime, hence leading to waste of crops that are not yet mature. Crops that are missed through mechanical harvesting methods can be utilized through gleaning efforts and hence do not contribute to overall food waste. In addition, foods that are unfit for human consumption may be utilized to feed animals.

Postharvest events can also create food waste. This can occur in transit or in the multiple areas where food is stored. In terms of storage, inadequately designed and managed storage systems can lead to waste. Spoilage can occur in regions with high temperature and humidity. Another consideration that leads to food waste is loss to pests, including insects and microorganisms. These are a concern primarily in high-temperature and high-humidity regions.

Industrial systems of production are further vulnerable to weather and geologic events. Perhaps the most easily recognized vulnerability is created through confined animal feed operations (CAFOs). CAFOs centralize production using industrial methods in an attempt to control every aspect of an animal's life toward the goal of maximizing yields. This centralization of production creates serious health vulnerabilities for animals, which are often subject to large doses of antibiotics. Further, CAFOs are intensive in terms of their management, inputs, and waste. There is a heavy concentration of animals and, hence, animal waste in one area. Flooding events, as well as everyday operations can lead to damage to marine life as well as to water quality and safety. Even where these waste products are properly collected, there are potential water pollution issues associated with the utilization of liquid manure from CAFOs.

Regulation

In addition to the food waste associated with the actual production of foods, food waste can also occur due to government regulation and policies. The scale of agricultural systems can also produce vulnerabilities in terms of loss. Food safety regulations act to protect the public from potential negative health outcomes. Recalls are widespread in the food system. This leads to the waste of massive quantities of foods on an annual basis. To illustrate the scope of the food recalls, in November 2010 alone, there were food recalls on potato chips, chocolate, cheese, chicken pasta salad, dried taro, eggs, turkey, cookie dough, apple cider, meat and poultry canned products, ready-to-eat pork products, beef sticks, and tuna. During a food recall, attempts are made to ensure that all of the improperly labeled, contaminated, or potentially contaminated food is collected and destroyed. Food safety is not the only instance where governments become involved in regulating the distribution of foods. Government policy may in some instances be counterproductive in protecting the health of its population. This was particularly apparent when the U.S. government, in an effort to control the price of food during the Great Depression, deliberately destroyed hogs, produce, and milk despite chronic malnutrition of the population. This example highlights the political and economic relations through which food distribution and food waste occur.

Food Consumption Waste

After food makes its way without incident from producers through various distributors and means of transport to the grocery stores and then to consumers, there is still vast potential for loss. Food waste during consumption can occur through the selection of foods that members of the household may not eat,

storage of foods in the household both before and after cooking (including temperature, humidity, and presence of pests), and in the cooking process. Some of the loss can be attributed to consumer food preferences. Food preferences are a result of a number of factors. These overlapping factors include cultural preferences, accessibility, availability, convenience, and price. Convenience in terms of time spent preparing meals was a theme that dominated advertising for food in the 1950s. Hence, Americans as a whole were spending less time dealing with food, either its production or processing, around and in their homes. But ready-made meals and convenience foods can hide the waste produced in making meals.

Cooking times are generally shorter than in the past, and as a whole, those who consume processed foods spend less time dealing with food, either its production or processing, around and in their homes. These ready-made foods contribute in other ways to the overall waste stream. In particular, packaging of heat-and-eat meals, snack foods, and prepared fruits and vegetables contributes plastics and paper to the waste stream. Efforts continue to be made to reduce packaging of food products in order to mitigate food-related waste related to consumption practices.

Convenience is not always a motivating factor in decisions regarding food consumption and food waste. According to one study done by Ann Allison, food consumption in Japan is a measure by which the state can assess the performance of women. Allison describes obento boxes as an ideological state apparatus, noting that children must quickly consume all of the obento that their mother has prepared for them. Food waste post-mealtime is viewed as a failure of mothers to properly care for their children.

Uneaten Food

The absence of strict codes of compliance for finishing a meal, coupled with increasingly larger portions of meals, often leads to excess prepared foods in the United States. A number of approaches have arisen in attempts to mitigate food waste at the household level. One of the simplest approaches is managing foods that are not utilized immediately after they are cooked for later consumption. There are recipe books to assist those who, out of necessity, desire, or a combination of both, seek to create additional meals from leftover foods. These cookbooks include *Waste Not Want Not: A Cookbook of Delicious Foods from Leftovers* by Helen McCully, *The Use-It-Up Cookbook, A Guide for Minimizing Food Waste* by Lois Carlson Willand, *The Use it Up Cookbook: Creative Recipes for the Frugal Cook* by Catherine Kitcho, and *The Thrifty Cookbook: 476 Ways to Eat Well With Leftovers* by Kate Colquhoun. The use of leftovers can lead to real savings for households that need to maximize their utilization of resources. However, some purchased foods are not utilized by many households. According to one study, a majority of consumers in the United States reported purchasing foods that they never use. This was matched by a study in the United Kingdom, which found that unused foods cost households substantial sums of money.

Several studies have been conducted to measure waste as well as waste behaviors in institutional settings, such as schools. These studies utilize a number of methods to examine not only the amount of food being wasted but also which foods are being wasted. One measure is the amount of overall waste generated. Institutions can establish a baseline by which to quantitatively measure, in terms of food weight, efficacy of waste reduction strategies. This has been utilized in several universities to show that the total amount of food waste produced in cafeterias can be dramatically reduced by simply eliminating the use of trays. Since students are limited to taking only what they can carry in their hands, acquiring the same amount of food requires more trips than it would otherwise with a tray. Further, it gives someone the opportunity to consider whether or not they would really like an additional plate or drink.

A more qualitative and nuanced approach is conducting plate, or plate-waste, studies. These studies specifically address that foods are being taken but not consumed. Plate waste studies are of three primary types, each yielding particular data sets: weighed, visual, and recall. In general, data from these studies are valuable not only in terms of eliminating waste at the institutional level but also in targeting nutritional interventions at both the individual and institutional levels. Through utilization of this information, it is possible for cafeterias to reconfigure their menus in order to

A number of approaches have been developed to attempt to lessen household food waste. One of the simplest is to encourage proper storage and use of foods for later consumption that are not utilized immediately after they are cooked. Cookbooks aimed specifically at leftovers cite the cost savings from using up these items. However, most U.S. consumers reported in a survey that they never use some of the foods they purchase. A United Kingdom survey had similar results; in addition, wasted food added up to a great deal of lost money.

reduce waste and contribute to better nutritional outcomes for children.

According to the U.S. Department of Agriculture's Economic Research Service, nutrient-dense foods such as fruits and vegetables comprise 20 percent of food waste. Among U.S. primary and secondary students, waste of salads and vegetables can range from one-third to half of the foods served to them. Taken together, this work indicates a pressing problem for nutritionists and other professionals dealing with health outcomes. Further, children, as well as adults and institutions, are likely to waste some of the best sources of nutrients and hence increase vulnerability in both the long run and short term to illness and disease.

Food Archaeology

Archaeologists have also attempted to address food waste, as food waste behavior can be assessed utilizing the archaeological record. Waste sites can serve as rich sites for data collection for archaeologists. These prehistoric and historic dumps or kitchen middens preserve organic remains for analysis by archaeologists who can determine historic consumption patterns. Data such as these can assist archaeologists in their attempts to reconstruct past diets as well as give clues to subsistence systems and trade networks. These techniques also lend themselves to analysis of contemporary waste. Archaeological studies have been conducted to analyze contemporary food waste behaviors; this study of garbage is known as garbology. The information gathered from landfills can be valuable in determining the composition of household waste as well as overall waste behaviors. This information is crucial to policy intervention to decrease the overall burden on landfills and the pollution potential of landfills, as well as to capture economic and environmental benefits.

One example of garbology is a waste characterization study in Phoenix, Arizona. This study noted that most of the residential waste stream is comprised of near-equal proportions of organic

waste and recyclable materials. Further, 16.8 percent of the waste was determined to be food waste. Although the percentage of the residential waste stream comprised of food waste varies from municipality to municipality, it is fair to say that food waste comprises a significant percentage of residential waste. The amount of the food waste produced in the preparation of foods may not necessarily be captured in studies that examine only trash, because garbage disposal units in many households are the means by which people dispose of their unutilized portions of food. Some studies suggest that this figure may be much higher for some households.

Food Reuse

While archaeologists utilize waste in academic and practical applications, it is viewed as a resource in order to learn about specific behaviors regarding waste. Quite distinct is the utilization of waste as a food and livelihood resource. Scavengers position themselves to make valuable use of resources. Some do so out of economic necessity but they are not necessarily the most impoverished people in society. Scavenging of resources can provide high economic returns. Some scavengers or dumpster divers will utilize waste for their own purposes, including food. The act of dumpster diving varies in legality among countries and jurisdictions. In some areas there are laws, but these are infrequently enforced. In some instances, supermarkets, which contribute large amounts of food waste, will gate and lock their dumpsters to prevent dumpster diving. In some municipalities, work continues to capture as much of this food as possible through institutional arrangements, such as food banks, homeless shelters, and religious organizations. In many of these settings, the wasting of food is seen as an ethical as well as a moral issue.

Food waste can be captured and utilized in a number of ways to produce both economic and environmental benefits. Properly sorted food waste and other organic materials not only can be utilized on the smaller scale to enrich the soil but can also be utilized post-collection by either institutions or municipalities. University campuses and citywide programs have adopted separation of food from other waste products in order to minimize the amount of food waste that needs to be transported to landfills. Some residents may choose to bypass these systems of collections by handling their food wastes at home. At the household level, food waste can be converted through composting or vermiculture to produce soil amendments. Further food waste can be fed to animals on a farm in order to recycle nutrients. On a larger scale, it can be collected and utilized to feed animals in agricultural operations. Regardless of the scale, this reduces the amount of overall waste, decreasing economic and environmental costs, including water pollution, as well as recapturing nutrients that might otherwise be lost.

Collection of food waste may be problematic. Municipal collection programs may face severe challenges from residents, as food and other organic wastes may produce a nuisance. In order to prevent this, municipalities need to pick up organic waste materials frequently. This is particularly true in regions that experience hot temperatures and humidity, which may lead to nuisances such as a rotting smell or attract animals and insects. This can lead to decreased support of separate collection programs for organic and non-organic materials.

As food waste is typically organic in nature, during its decomposition, methane, an extremely potent greenhouse gas, is produced. This presents both a challenge as well as an opportunity. Food waste in landfills can produce methane, which contributes to global warming; but food waste can also be utilized as an energy source. Anaerobic digestion plants burn methane produced from organic waste materials. Another energy source derived from spent fryer oil or yellow grease is biodiesel. Efforts are also being made to utilize brown grease, which includes oils and other residues, as biodiesel. This conversion of food waste into a usable fuel for transportation not only decreases the amount of waste that the food system produces but also allows for a smaller carbon footprint.

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See Also: Archaeology of Garbage; Archaeology of Modern Landfills; Arizona Waste Characterization Study; Biodegradable; Carbon Dioxide; Consumption

Patterns; Dairy Products; Dump Digging; Dumpster Diving; Farms; Food Consumption; Garbology; Organic Waste; Pollution, Air; Pollution, Land; Pollution, Water; Water Consumption; Worms.

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France

Quand c'est usé, je jette, je jette et je rachète (when it's worn, I throw it, I throw it and buy another) was the chorus of a popular song ("quand c'est usé, je le jette") of a popular singer, Jacques Dutronc, broadcast in 1969. It was an ironic charge against the consumer society and its abuses. Like in other industrialized countries at the same time, France was in the 1960s in the paradoxical situation of advanced development and significant economic growth, with one of the highest standard of living in the world. However, the Western counterculture movement was contesting the bourgeois ideals of progress and consumption, pointing at the forthcoming disastrous effects on nature. In the early 21st century, the last years of the so-called Glorious Thirty (years of economic growth), this division between the logic of economic and industrial development and the promotion of more ecological values remains strong. France's 65 million people continue to enjoy a high standard of living. But what has changed in the meantime is the haunting resonance of ecological motives in French culture and society.

Ecological Debate and Programs

In the French contemporary ideological context, the matters (and problems) of environment, pollution, overconsumption, and waste management are embedded in two broader issues: sustainability and ecology. Political ecology and the consciousness of the human threat against nature began to gain visibility in the early 1970s (after the United Nations' first Conference on Human Environment in Stockholm, 1971). But it had, at the time, limited impact on society, despite continuous official status of environment and ecology in the French state administration after 1971.

However, the two oil crises (1973 and 1979) suddenly highlighted France's dependence on energy and fragile economy and left room for the expression of alternative scenarios of development. Pollution, the greenhouse effect, biological diversity, and impacts of overconsumption largely infused French society and compelled economic and political sectors to adjust to these new cultural models in the 1980s. France was engaged in the first international Earth summit in Rio de Janeiro in 1992, and from the 1990s onward, national institutions promoted "green" labels to motivate ecologically oriented behaviors (in food, industry, consumption, automotive, energy, construction, and waste).

Issues of waste and consumption are rather new in France but crucial debates on the relevance of the "ecological crisis" theory and the economic and social costs of converting the country to other economic models have occurred. Since the late 1990s, the political force of green movements became more significant—although still having a modest demographic surface in the political landscape. The social pressure on the French government to allow more ecological policies brought about a series of symposiums and conferences. Held in October 2007, the "Grenelle de l'environnement" (relating to the "Accords de Grenelle" that took place in the 1968 political crisis) was supposed to define new parameters for agriculture, transportation, energy, health, and biodiversity in order to adjust government policies to the worldwide ecological crisis. It was quickly followed by the first policy (also labeled "Grenelle 1") in August 2009, but this did not succeed in convincing ecologist movements and parties. The setting up of ecological programs in the

political agenda of France gave rise to bitter controversies, and the French government was accused of political duplicity. While France was supposed to champion, in the international arena, the defense of standards of development more respectful of the ecology, it reversed and eventually did not apply these same standards to the domestic economic agenda. Intellectuals and scholars are thus divided between the supporters of radical sustainability, based upon a significant reduction of industrial production (degrowth, or *décroissance* theory), and the promoters of an "ecofriendly" economic growth. Far from closed, the debate is still topical in the early 21st century, but at least all decision makers agree on the need for transformation.

The environmental policies of France are torn between domestic issues in growth, sustainability, ecology, and the normative standards of the European Union (EU), which has urged the countries of the continent to align with dramatic reduction of waste and energy consumption. As Claude Allegre—a much-debated geochemist and former minister of education who refutes the global warming theory and degrowth—put it in a 2007 opus, "we have to make a clear distinction in between worldwide scale problems, and the ways France can contribute to their resolution, and those which are typically French, whose solution depends essentially on us." The solutions are threefold: organization (management of waste), innovation (the search for alternative modes of consumption), and communication (broadcasting messages for the prevention and the collection of waste).

Funding

The expenses for protection of the environment have dramatically increased, from 30 billion euros in 2000 to 44 billion euros (according to the National Institute of Statistics and Economic Studies) in 2010. The most important sources of pollution and waste are, in order of importance, agriculture (43 percent), industry (41 percent), and households (3.5 percent). State administration (public sector) and industry (private sector) have therefore devoted considerable effort to the improvement of chains of waste prevention, production, collection, and recycling, and allowed important funding for research and development (3.5 billion euros in 2008). In the mid-2000s, the national expense for the management of waste amounted to 11.5 billion euros (14 billion euros in 2008), of which 63 percent was funded by households and collectives. Taxes for the collection of waste make up to 83 percent of the total amount. Public expense for waste management has increased up to 5 percent per year. While the major sources of waste and pollution are located in systems of agrarian and industrial production, public campaigns and media coverage of information on pollution, waste, and other ecological topics, as well as systems of collection and recycling, mainly target households and consumers.

Waste Sorting

If Eugène Poubelle was the first to introduce the dustbin—and waste sorting—in France in 1884, (his name has since then been associated with the garbage can), the very first attempts to establish a nationwide system of waste sorting occurred in the mid-1970s, following the first oil crisis. Substantial progress did not come before the 1990s and the 1992 legal dispositions for the creation of recycling channels for every type of waste. The aim was to reduce landfills and incineration of waste, and these witnessed a slow but significant decline.

The recycling of packaging (5 percent of waste) ranges among the fastest expanding (up to 57 percent of the total amount in 2007), but the household consumption of manufactured goods has nevertheless increased (almost twofold) since the 1990s (up to 22 billion euros a year in 2010), and waste generated by individuals increased consequently (7 tons per year, including 425 kilograms of domestic waste).

Innovation

As for research, the foundation of the Agency for the Environment and the Management of Energy (ADEME) in 1990 offered a chance for decision makers and enterprises to design their ecological policies on reliable information. The missions of the ADEME encompass prevention, management, and research for ecological purposes. This is one of the main nonacademic sponsors for research on pollution, alternative sources of energy, and waste in France and is one of the main sources of infor-

mation. The ADEME's publications provide regular reports and databases, for instance, on the evolution of green behaviors in France and innovation in new energy.

Attitudes

The impact of campaigns in the broadcast media had qualitatively observed impacts on individual attitudes toward environmental crisis, consumption, and waste. But inquiries conducted or funded by the Ministry of Ecology, Sustainable Development and Energy or by the ADEME unveil ambivalent responses.

They demonstrate that only half of the French population (52 percent) is explicitly inclined to introduce dramatic change in ordinary life and habits as a response to the environmental crisis and in search of new models of behaviors toward consumption and waste. The appeal of new technologies for low-consumption energy is high (more than 80 percent) However, the sense of individual responsibility in the ecological crisis and responses is decreasing (from 87 percent in 2005 to 83 percent in 2009) and the sense of guilt for a lack of active participation in ecological behaviors remains low (33 percent), and most people (73 percent) are reluctant to be sermonized. They nevertheless claim to be attentive to sorting their waste (92 percent), and half of them do it in accordance with the norms of sorting (45 percent) in their area of residence or by bringing sizable or hazardous waste to civic amenity sites. The same also have the feeling of participating in a widespread movement (84 percent) but recognize they throw small waste in public spaces (10 percent), whereas they recycle their unused medics (59 percent) in the proper way (bringing them back to the chemist's store).

Overall, France has taken the issue of waste seriously in an attempt to arrange a nationwide system of waste management, but the lack of information or the misunderstanding of the directives often fetters the act of recycling. When available, local information on waste arrangements is preferred by households (74 percent of respondents in a 2010 poll).

Little attention has otherwise been paid to the existence and development of unofficial channels for recycling, based on free gifts, or alternative modes of the "motion" of waste and its reuse in specific circuits of redistribution. However, a few renowned nonprofit organizations (like Les compagnons d'Emmaüs, or Les Restos du coeur), and many more socially discreet ones, epitomize a widespread movement of civil society in the management of the distribution of surplus, the management of waste under the "umbrella" idea of reducing economic inequalities, and the reduction of consumption, in a voluntary, often community-based social economy in the direction of the deprived strata of society. Studies demonstrate that, for individuals and households, the very nature of waste determines its destination and confirm that furniture (33 percent of respondents of a 2010 poll) and especially textiles (67 percent) live a second life in these circuits (an often-discussed point, since the figures are highly controversial).

Conclusion

These few examples illustrate the way France has captured and tackled the issue of waste by means of active politics and the mobilization of economic and social (state and nongovernmental) actors in a debate and movement toward a green economy. Moreover, the infusion in French cultural, economic, and industrial sectors of the values and ethics of environmentalism and its corresponding practices, while flourishing, renders a complex mosaic of sometimes conflicting policies and behaviors.

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See Also: Economics of Waste Collection and Disposal, International; European Union; Politics of Waste; Recycling Behaviors.

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Freeganism

Combining the words *free* and *veganism*, *freeganism* suggests an alternative economy, diet, and worldview. Freeganism can be best described as a loosely bound movement of individuals who protest consumer society and the market economy by living a life that produces no demand for goods. Born out of the antiglobalization and environmentalist movements of the 1960s, freegans take the expression "waste not, want not" to an extreme. Freegans feed upon economies of excess and luxury that produce loads of waste. This social movement is redefining what is meant by the term *waste*. What is considered waste is relative in the world of freeganism—someone's garbage can be another person's next meal or home furnishings.

Freegans

Freeganism has been described as a reaction to "industrial eating." This can mean a rejection of process and heavily processed foods. However, this is not always the case; many freegans will eat just about anything that they find that is still comestible, whether it is Twinkies or carrots. Some freegans are devout vegetarians or even vegans. What the individuals of this diverse group have in common is a desire to break from the capitalist cycle—they are opting out of consumer society. At the same time, freegans are often skeptical of charity and government programs. They have also spoken critically about the foods made available through government aid. Ultimately, freegans realize that the majority of a person's life is spent working for money to buy consumer goods, something that often takes them very far from food production. In their own way, freegans are connecting with their food source through foraging. Anthropologist Joan Gross has noted that this group models its subsistence strategy on preagricultural hunter-gather societies. At the same time, there are many aspects of the freegan movement that are distinctly contemporary.

Methods

Many freegans are outspoken political activists, while some individuals use freegan tactics as a survival strategy to overcome social and economic exclusion and others substitute their diets and consumer habits with some forms of freeganism. Freegan activities include dumpster diving and other forms of foraging. Some people also include guerrilla gardening (planting crops on unclaimed land) and growing food in community gardens as part of their freegan activities. These activities, unlike stealing, underline resourcefulness and a degree of self-sufficiency. Most importantly, freegan subsistence tactics stand in direct opposition to consumerism and mainstream distribution channels.

Organization

There are freegan gatherings such as the Really, Really Free Markets, where individuals can give away their excess foraged goods rather than disposing of them. Many freegans may choose to forage alone, but in cities in the United States and the United Kingdom, a sense of community grows among freegans.

One of the more organized expressions of freeganism is a group called Food Not Bombs (FNB). Founded in Boston in 1980, this group gathers vegan food through donations and from dumpsters and distributes meals to the homeless and poor each week. There are hundreds of FNB groups operating throughout the United States and Canada. FNB has been seen by authorities as a symbol of anarchism for its nonconformist food distribution activities.

Groups such as FNB and freegans more generally raise the question of what waste is and who it belongs to. Why is dumpster diving and getting things for free so offensive and even appalling for much of mainstream society? Milton Friedman is famous for saying "There is no free lunch," and people believed him. Perhaps this is why freegans rub mainstream society the wrong way—there is a free lunch, if one is willing to go out and look for it. That said, there is great debate over who waste

belongs to and whether it is a crime to skim off the leftovers of an overconsuming, wasteful society. Freegans bring into question and challenge this wastefulness, whether through anarchic political statements or peaceful community gatherings. North Americans and Europeans may begin to question if it is ethical or even legal to produce so much waste or to dispose of the excess when people are going hungry each day.

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See Also: Consumerism; Crime and Garbage; Definition of Waste; Dumpster Diving; Food Waste Behavior.

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Fresh Kills Landfill

Staten Island's Fresh Kills Landfill, which first began receiving New York City's trash in 1948 and officially closed in 2001, is the largest landfill in the world as of 2010 and, arguably, the largest human-made structure as well. Due to the awesome size of this mound and the equally daunting scope of the waste disposal problem confronting the world's most affluent industrial societies, Fresh Kills, in popular literature and environmental discourse alike, has become an imposing material reminder of the consumption and waste driving consumer culture and economy. It is a towering monument to the everyday practices contributing to the maintenance of a materially prosperous and environmentally careless U.S. society.

Plans and Operation

The symbolic potential of Fresh Kills was recognized and discussed from its very inception, albeit in a less critical vein than is commonly taken up by 21st-century critics of the site. From its origins, Fresh Kills was meant to serve as a model facility that showcased advanced strategies of municipal waste disposal. The landfill's charter subscribed to a modern code for "sanitary" landfills that called for the placement of a clean daily cover (such as dirt) over the working face at the end of each day, the construction of a 24-inch-thick final cover, and the prevention of waste material from entering open water.

The landfill occupies 2,200 acres and, at the peak of its operation in the late 1980s, received around 29,000 tons of waste every day. The landfill closed on March 22, 2001, but was temporarily reopened later that year following the terrorist attacks of September 11. Approximately 2 million tons of rubble from Ground Zero, which included the remains of more than 3,000 people who died in the attack, were brought to Fresh Kills for sorting, identification, and disposal.

Despite the high hopes of certain New York officials that appropriate management of the site would make it a positive example of waste disposal, a good deal of resentment has attended the operation of the landfill over the years. Residents of Staten Island have grudgingly borne the brunt of New York's steadily mounting waste output since the 1950s, especially after it was discovered that the landfill, initially unlined, was failing to live up to its promise of keeping toxic leachate out of the water (alterations in the landfill's design have since been incorporated to address the problem).

Controversy

Residents of Manhattan Island's lower-income neighborhoods have also had sufficient reason to complain. Garbage from Manhattan and its neighboring boroughs travels to the landfill via the Harlem transfer station where the traffic from nearly 100 heavy trucks converges on a daily basis. The diesel exhaust generated by this traffic has created concern about air quality in the area, with many environmental justice advocates arguing that the increased risks of Harlem residents acquiring diseases like childhood asthma,

Vehicles destroyed in the September 11, 2001, terrorist attacks in New York City are heaped at Fresh Kills Landfill, which was officially closed in March 2001 but was temporarily reopened following the attacks. Approximately 2 million tons of rubble from Ground Zero, which included the remains of more than 3,000 corpses, were brought to Fresh Kills for sorting, identification, and disposal. A proposed park on the site would be three times the size of Central Park and would provide amenities such as walking trails, a memorial, and a wildlife refuge.

bronchitis, cancer, and emphysema have become too great to ignore. Though the landfill has closed, the Harlem and Staten Island transfer stations continue to process most of the city's solid waste, which is (as of 2010) exported by rail to distant states rather than buried.

The resentment certain New York residents have felt toward this landfill is ironic in light of the optimistic rhetoric espoused by the site's original architects. In the early years of the landfill's operation, New York City parks commissioner Robert Moses proposed that Fresh Kills Landfill offered a singular opportunity, not only for waste disposal but also for community planning. A substantial portion of lower Manhattan, as well as several other once-marshy areas in the metropolitan area, had already been constructed on top of landfill. The Fresh Kills Landfill therefore promised to create even more habitable real estate on previously water-logged stretches of Staten Island. Moses's development project for the island envisioned the creation of an integrated community of residential, recreational, and industrial sites all built on the solid foundation of New York's discards.

Moses's plan, however, was based on the assumption that the landfill would only be in operation for a short period of time. The landfill was supposed to close once the salt and interstitial marshes had been filled, a process expected to take anywhere from three to 12 years; its operation, however, continued unabated for the next 50 years. The land created from dumped garbage not only filled in the marsh

but it also eventually came to tower above it in four mounds that range from 90 to 225 feet high.

Closing

Following the site's official closing in 2001, at least a part of Moses's vision—that of building a large park—has been revived. Thanks to its relative isolation and lack of development, Fresh Kills offers an unexpected refuge for wildlife in the midst of the nation's largest urban center—birds and bird watchers, in particular, have flocked to the site. Plans for an official Freshkills Park were announced in 2003 (the subtle name change attempts to distance the site from the negative connotations attending its original use). The proposed park will be three times the size of Central Park and, when completed, will include walking, biking, and hiking trails as well as wildlife refuges, a 9/11 memorial, and other recreational amenities. The conversion from landfill to public green space is expected to take 30 years to complete, a period of time that coincides with the number of years that the city of New York is responsible for monitoring changes to the site's topography that stem from the slow decomposition of organic material contained within.

Apart from its continuing utility as a transfer station, the site also captures and sells a portion of the methane it produces (a by-product of decomposition) to utilities that use the gas to generate electricity. The landfill gas recovery operation claims to process enough methane to power more than 20,000 homes on Staten Island. Though to some the site is still an eyesore and a public health concern, considering the concerted efforts of its curators today, the site—as an energy producer and recreation area—may yet transcend its negative association and live up to the optimistic expectations of its founders.

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See Also: Archaeology of Modern Landfills; Garbage Project; Landfills, Modern; New York; September 11 Attacks (Aftermath).

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Fuel

The word *fuel* describes a material employed to produce heat, power, or light. Wood, coal, oil, natural gas, uranium, and biomass are currently the most used conventional fuels. Because the processing of these materials generally involves continuous combustion, the word has lent itself to the idea of revitalizing emotions. The word *fuel* can represent an inner force that motivates humans, a force that boosts activities and emotions.

A key difference between "material fuel" and "fuel of will" stems from the fact that the latter is supposed to be strong enough to sharpen the everyday life of ordinary humans so that it is renewed time and again. In contrast, the most important materials employed in the 21st century to produce heat, power, or light are exhaustible, nonrenewable, and have pollution as a side effect: they cannot be used without paying the corresponding costs.

Finite Fossil Fuels

Coal, oil, and natural gas are called fossil fuels because they are formed when decomposed plants, animal matter, and marine organisms are combined with heat and pressure beneath the surface of the Earth. A process of chemical change sustained over millions of years transforms the fossil remains into carbon and compounds of carbon and hydrogen, which release a large amount of heat under combustion. They therefore constitute the fixed stock of fuels on Earth, a stock that, once expended to produce energy, cannot be restored. To keep track of the world's fuel reserves, an array of specialized institutions that operate in the private sector and in international forums publish annual assessments of the proven reserves, probable (recoverable) reserves, and

unknown or undiscovered resources. "The World Energy Council Survey," the "International Energy Agency Information Report, "The Oil & Gas Journal Report," and the "BP Statistical Review" were the most quoted sources of information as of 2010.

In spite of its technical dimension, the estimation of the stock of fossil fuels was hotly debated in the past. The possibility that the world might be running out of oil provoked great concern among both the authorities and the public at large. Two moments stand out in the trend for geological pessimism: the first quarter of the 20th century in the United States and the 1960s and early 1970s across Europe, Japan, and North America. Fears of an oil shortage played an important role in triggering public awareness of the need to conserve natural resources. Ultimately, the conservationist currents, which ripened within the wealthy, educated segments of the population, evolved toward more politically oriented ecological movements. To face Earth's challenges, they called for energy-saving policies on the demand side and tighter regulation of private business on the supply side. However, the gloomy predictions of a looming age of scarcity were dashed by unfolding events: first, untapped oil reserves were discovered in the United States, which turned anxiety about a shortage into glut management (1926–29); and second, the price hike triggered by the Middle East Arab oil embargo and production cuts (1973–74), whereby long-term ecological pessimism was replaced by a critical, immediate energy crisis.

Climate Change

Although these political questions have not vanished, they have been displaced by the more urgent, overarching, and globalized problem of climate change. In the late 20th century, fuel economy and fossil fuel economy, in particular, became closely linked to the fate of the planet and this led to a redefinition of previous agendas. Burning coal, oil, or natural gas to produce energy releases large emissions of carbon dioxide (CO_2) into the atmosphere and is a major source of the greenhouse gases that contribute to global warming. Multilateral settlements on reducing CO_2 emissions thus became a part of the agenda of international diplomacy, even though the concrete results achieved at the 1997 Kyoto and 2009 Copenhagen summits fell short of the expectations of leading European nations and the scientific community.

Fuel Consumption

Apart from the United States, the phenomenon of "addiction" to fossil fuels goes back as far as the 1950s. This golden era of reconstruction and recovery from war spurred a phase of industrialization in developing countries, favoring further technological innovation in Europe and Japan and increasing investment in heavy production within the Soviet Union, followed by some stimulus to light industry. Moreover, economic growth became progressively grounded on trade liberalization, financial stability, inflation control, and full employment. Together, these forces prompted an increase in the global demand for energy, which henceforth could be provided from the Middle East at very low production costs. This was accompanied by a downward trend in the price of coal and natural gas and by incentives to substitute coal with liquid fossil fuels. Overall, the effects of low energy prices on economic growth revealed a bidirectional causality, with each factor reinforcing the other.

Up to the first oil crisis (1973–74), world consumption of energy grew at an annual rate of 5.2 percent. On a per capita basis, this evolution translated into a twofold increase in the average per capita world fuel consumption, from 5 barrels of oil equivalent (BOE) per year in 1950 to 10.5 BOE in 1973. Because of the disturbing macroeconomic effects of the sudden rise in fuel prices, this was followed by a deceleration in primary world energy consumption to 1.7 percent per year, and it continued around 1.6 percent per year even after readjustments that drove fuel prices lower in the second half of the 1980s. At the turn of the 20th century, world per capita consumption had reached 11 BOE per person per year, which means that energy growth had almost paralleled population growth. Later, another industrialization boom generating from the late-starter countries (notably Russia, India, and China) increased the pace of growth. By 2004, China was the largest coal producer in the world, well ahead of the United States, and the acceleration of its energy demand placed increasing strains on the multilateral agenda for CO_2 reduction.

Changing Lifestyles

The urgency of changes in patterns of fuel consumption went far beyond the agenda of governments and international institutions to become a core political issue and a matter of citizenship and individual behavior. How big is one's ecological footprint? That is: what is the fuel consumption and related CO_2 emissions that result from one's lifestyle? Once in the realm of individual-collective options, a difference in lifestyles matters, because personal vehicles and residential energy are responsible for about 40 percent of energy end-use in Organisation for Economic Co-operation and Development (OECD) countries.

The U.S. way of life has been in the spotlight because of its high-energy regime based on sprawling cities with outlying areas; the dominance of single-family households, large cars, and exurban living; sizable air-conditioning and high-quality energy services; affluent consumption; ever-rising consumer expectations; and extensive packaging of goods. The result is that the United States exceeds all boundaries in energy demand, even after the necessary adjustments for relative levels of development. On a per capita basis, in 2009, U.S. consumption was nearly twice that of the French and the English, three times that of the Polish and Iranians, four times that of the Argentineans and Romanians, and around 20 times that of Pakistanis and Indians. In addition, the benefits of a high-energy regime have proven highly addictive. Moral calls for the U.S. public to practice restraint in order to save energy, such as Jimmy Carter's speech delivered by television in 1979 when the oil crisis was at its peak, have produced little or no effect.

Energy-Efficient Technology and the Rebound Effect

Technological improvements combined with incentives for clever behavior provide another path for cutting fuel demand. The "energy efficiency" concept has been put forward to describe the delivery of larger amounts of useful work, heat, or light from decreasing quantities of fuel.

If this goal is pursued systematically and successfully through every stage of energy conversion, global fuel reductions are likely to occur without a loss of consumer welfare. The energy efficiency solution has nonetheless been rebutted by some sectors of the scientific community. They have argued that the effect of improving the efficiency of a productive factor, like energy, is to lower its implicit price and hence make its use more affordable, which in turn leads to either greater consumption or the purchase of other goods and services that also require energy.

More specifically, if the price of gasoline per mile steadily declines for some technical reason, the driver is likely to increase mileage, anticipate the purchase of a new car, or buy goods with the money saved. Although increased energy efficiency at the microeconomic level fosters a reduction of energy use at this level, it does not necessarily bring about a reduction at the national or macroeconomic level. In the worst-case scenario, microeconomic savings are completely offset by macroeconomic rebounds.

The view that economically justified, energy-efficiency improvements will increase rather than reduce energy consumption was first proposed by British economist William Stanley Jevons in 1865. The effect he singled out is dubbed the "rebound effect" and its foundations are known as Jevons's paradox. An economy-wide rebound effect of 100 percent means that 100 percent of the potential energy savings are "taken back" through the above-mentioned mechanisms.

Much of the debate on the rebound effect is encumbered with difficult technical questions, including discrepancy in basic assessment criteria, noncomparability of empirical studies, and different methodologies to assess the macro implications of microtechnological events. However, two conclusions stand out from the debate. First, the global rebound effect is not high enough to completely outweigh the importance of energy efficiency as a means of reducing carbon emissions.

Second, the rebound effect is likely to be greater in the early stages of development and diffusion of the technology, under conditions of increasing returns, in the presence of network externalities, and when the technology is used in a wide array of economic applications. In other words, political action and international economic regulation do not alleviate the need for individual action and community endeavors. Reducing CO_2 emissions

and the demand for fuel is as much a concern for the individual as it is for nations.

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See Also: Carbon Dioxide; Clean Air Act; Gasoline; Power Plants; Resource Conservation and Recovery Act; Sustainable Development.

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Funerals/Corpses

Human corpses are treated as garbage only in exceptional circumstances. Ritualized disposal of human cadavers is standard fare around the globe and has been so since the beginning of humanity. Why is it that corpses have rarely been viewed as waste? The answer to this question deals with notions of dignity and being human.

Furthermore, the ambiguity of feelings toward the corpse—both love and fear—qualify it for special treatment. In addition, it is generally believed that departure from life is followed by an assumed, continued existence in one way or another. The condition of the corpse, according to Robert Hertz, stands for the fate of the soul. The awe inspired by corpses relates to the human body as a root metaphor. When alive, it is the only intrinsic symbol, referring to itself. On the occasion of death, however, a rite of passage is required to mark its change of status, referring to something else. It implies a shift from the category of the living to the category of the dead. Funerals mark this transition.

The journey or initiation of the spirit of the dead takes some time and may (if one accepts Hertz's theory) correspond with the decomposition of the corpse or the process of emotional detachment by survivors. Nothing was more intimately related to the once-living person than their body and nothing resembles that person more; therefore, magical properties are attributed to the corpse. The veneration of relics provides a good example. Human remains as relics are perceived of as contact points with another realm of existence. The dead, so it is believed, can still exert their influence on the living. Consequently, corpses should not be tampered with. The idea of the returning dead, revenants, illustrates this point. To curb the danger of mixing up the living and the dead, corpses are ritually disposed of.

"Improper" Disposal

The denial of a proper funeral counted as a severe additional punishment of executed criminals in the European past, for it meant a denial of the transition to the afterworld. These criminals were buried at crossroads, a ritual gesture to prevent the soul from moving elsewhere. Occasionally, their corpses were left hanging at the gallows to decompose. Early anatomists also preyed on these corpses for the purposes of dissection. Survivors frequently fought over the executed corpse with the authorities in order to give the deceased relative their last respects. This was a matter of dignity, of course, but given the close relationship, it might also have been motivated by the fear of a haunting ghost. Ritual measures most probably were also taken with ancient corpses discarded in peat swamps, later discovered by archaeologists, in northwestern Europe. The bog bodies, some strangled with a noose, seem to have been ritually killed. Their disposal in an uninhabitable area indicates their social exclusion, but the places concerned did not serve as garbage dumps. The intentional mutilation of enemy corpses left on battlefields, such as the noses being cut off—a literal and symbolic "loss of face"—is another form of humiliation and dehumanization. Makeshift mass graves resulting from war atrocities come close to the treatment of corpses as garbage. Unintentional occurrences, such as floods, earth-

quakes, and other disasters with mass loss of life, might at times give the impression of the corpses floating or lying around being merely waste—even more so when it takes considerable time to recover them. There are also historical examples of epidemics in which the death toll was too great for the survivors to organize proper funerals. Recently, Sherpas and others decided to clean the garbage left behind by mountaineers on Mount Everest. The corpses of some 200 climbers who had died and remained there at great height were finally recovered. The exposure of the dead mountaineers to the elements had been the unavoidable result of their tragic deaths in places from which they could not easily be removed.

An intentional exposure of corpses to the elements occurs at a so-called body farm. Most famous is the Forensic Anthropology Center of the University of Tennessee in Knoxville, Tennessee, founded by William Bass. Volunteers donate their bodies to the center, and these are placed in the open air at the "body farm," allowing scientists to establish the nature and various rates of decomposition. No matter the increased visibility of corpses in popular television series, such as the *CSI* series, sensitivity toward real-life confrontations with human remains seems to have increased. In the Netherlands, for instance, a man who near his wife's tomb stumbled upon an open communal grave containing bones, skulls, and the remains of coffins and clothing founded a Vigilance Committee. This committee drew attention to the presumptuous way in which human remains were deposited in communal graves in Dutch graveyards, and a change of policy took place. Furthermore, publicly accessible collective monuments have been raised for reburied human remains in several graveyards across the Netherlands.

In the same vein, media reports on discoveries of human remains (such as fetuses, organs, and other body parts) from hospital waste that ends up at garbage dumps tend to provoke scandals. Such exceptional incidents that were reported on indicate increased sensitivity. In Basel, Switzerland, cremated human remains from hospital waste are buried in a special field at Hörnli cemetery. For the lack of alternative procedures, the city allows a certain measure of pollution to be caused by the burning of body parts preserved in formaldehyde, especially those of body donors to medical science. At the field, an Anatomical Monument has been created to commemorate the body donors. Besides two sculptures in the back, it has a flat memorial stone in front. Freely translated, the inscription reads "The dead who helped you, the living," and below these words it says, "Anatomical Institute of the University of Basel." The commemorative monument is part of a general trend that also applies to previously neglected remains of fetuses and stillborns. Such monuments on graveyards provide the survivors with a place of remembrance. At the same time, they entail a redefinition of the status of the remembered ones through a recognition of their humanity.

Regulations and "Proper" Disposal

Regulations concerning bodily disposal vary from country to country. Environmental concerns increasingly influence these regulations with regard to materials used and grave gifts allowed. The aim is to prevent pollution of the environment with unwanted and damaging substances. Preparation of bodies for burial may include toxic embalming fluids such as formaldehyde. Cremation may release toxins in modern bodies, such as heavy metals found in dental fillings and pacemakers. The desire for a more "natural" treatment of the dead, in addition, is exemplified by the recent popularity of woodland burials in the United Kingdom. The scattering of ashes in forests and nature reserves of people wanting to be "close to nature" in death as well as commemorative objects brought to the respective places by survivors, however, have been a nuisance in the eyes of conservationists.

In India, environmentalists have been alarmed by barely cremated bodies (due to the scarcity and costs of firewood) floating downstream in the holy Ganges River. In the ethnographic record, there are various examples of the disposal of human cadavers, such as on charnel grounds or higher platforms, by leaving them exposed to the elements.

In Tibet, so-called sky burials are practiced by Buddhists where the dead are left on mountaintops, exposed to the elements, animals, and birds. Both burial and cremation are not feasible in the high altitudes. Exposure of the dead by the Parsi of India, following their Zoroastrian tradition, occurs on top of Towers of Silence to the sun and

birds of prey. As the number of birds has rapidly decreased due to a poison used in agriculture, the custom has come under pressure.

Funerals vary according to the nature of death as well as the social status, age, and gender of the deceased. Religious ideas affect the means of bodily disposal considered appropriate. Belief in bodily resurrection, for example, mostly coincides with earth burial. In general, notwithstanding mortuary variation, human cadavers are rarely seen as waste. The move of graveyards to the borders and outskirts of the community in 19th-century Europe did, however, have to do with beliefs among sanitary reformers in miasmic or polluting air causing disease that later proved to be wrong. Contemporary concerns relate to increasingly popular cremation, particularly its energy use and production of carbon dioxide and other pollutants, so that in the future it may be replaced by more environmentally favorable techniques. Lynn Åkesson speaks of a moral dimension of waste, and probably the riddance of human corpses most strongly expresses this dimension of "wasting" as a cultural process. Ritualized disposal of human cadavers, rather than doing away with them like garbage, is accepting by most people.

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See Also: Culture, Values, and Garbage; Human Waste.

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Furniture

The term *furniture* usually refers to movable objects that support the body (for example, a bed, chair, or sofa) or provide storage for smaller objects like books, clothes, or kitchen tools. Furniture is everywhere—in homes, offices, schools, shops, and restaurants. Furniture is so embedded in everyday life that people often forget how important it is. In fact, the presence or absence of furniture determines the function of a room in a house. For example, bedrooms contain beds and dining rooms contain dining tables. Working spaces are also defined by furniture; offices consist of desks, chairs, and bookshelves. Furniture has both functional and symbolic roles. For instance, the larger chair and desk of a teacher in a classroom symbolize a hierarchical position between the teacher and students. Although some authors affirm that there is a homogenization of furniture in the world due to the growing success of global furniture brands, many differences can still be noticed between different cultures and countries. For example, dining tables have different heights in Western countries compared to Asian countries, such as Japan, where traditional tables are relatively low and people do not use chairs but instead sit on the floor when they eat. Although furniture is part of everyday life, certain examples of furniture are very valuable and are considered to be pieces of art for display in museums and art galleries. Valuable furniture can be contemporary, produced by famous designers or artists, or antique, handcrafted masterpieces from past eras and cultures. Given that furniture is so important in daily life, it is important to understand its life cycle—how it is produced, consumed, and disposed.

Production

Data related to the production and export of furniture are varied, but production trends can still be analyzed. Since the production of furniture became global, Asian countries such as China, Taiwan, Malaysia, and Indonesia have become the dominant producers and exporters. Raw materials and cheap labor forces make these countries very competitive, attracting foreign investment. During the 1990s, a number of U.S. and European companies started moving their production to these countries and to China in particular. According to the China

Building Decorator Association, in 2006, Chinese furniture exports reached $17.4 billion, ranking it first in the world; exports for 2010 are expected to reach $48 billion. China competes fiercely with both Western countries such as Canada, Germany, and Italy, and Asian countries such as Thailand, Taiwan, and Malaysia. During the first decade of the 21st century, China overtook Canada as the largest exporter to the United States, providing more than half of the furniture consumed by Americans. In 2000, China became the largest supplier of furniture to Japan, overtaking Thailand. Besides the U.S. and Japanese markets, China's export targets are Europe, Hong Kong, and the Middle East. According to the Statistical Office of the European Community (Eurostat), in 2005, China supplied almost half of the furniture consumed in European Union countries. Although China leads the export of furniture, countries such as Indonesia, Malaysia, and Thailand are aggressive competitors. In fact, in these countries, the cost of labor is cheaper than in China, causing Chinese companies to move their production to these countries.

Consumption and Consumers

Richer countries are bigger consumers of furniture. Among them, the United States is the largest consumer, accounting for one-quarter of the world's furniture consumption. According to the American Furniture Manufacturers Association, U.S. consumption of furniture increased significantly before the 2008 economic downturn and recession. In 2007, China exported 43.5 percent of its production to the United States. With the 2008 recession, U.S. demand for furniture decreased, but (as of 2010) the United States remains the largest consumer. Some consider this to be a temporary scenario, however. Because of stringent environmental regulations in the United States and the downturn of the U.S. housing market, some large Chinese companies are looking to other markets. Similarly, in the European market, consumption of furniture has been hit by the 2008 economic downturn. Because of this shift in the U.S. and European markets, Chinese companies are looking at domestic as well as Middle Eastern and African markets. The Chinese domestic market is growing rapidly. In fact, the booming economy and the consequent higher disposable incomes and improved living standards caused an impressive growth in the internal demand for furniture, which consumes most of the industry's output. Given that Asian markets are growing, Sweden, Italy, Germany, Spain, and the United States are trying to increase their furniture exports to these countries and to China in particular.

According to various marketing studies in the United States and Europe, women ages 25–45 are most interested in buying furniture. The most popular reason for buying furniture is the purchase of a house. Because of the 2008 economic downturn and consequent recession, fewer people bought houses in the United States and Europe, meaning fewer people bought furniture. Compared to other areas of household expenditure, buying new furniture is often a low spending priority. In other words, people preferred going on holiday or buying a new television to buying a sofa, which seems to be purchased only for a new home or to replace a damaged one. According to some sociological studies, many people no longer regard furniture as a long-term investment, and thus fewer people buy antique or designer furniture. People regard furniture as a short-term investment, opting for low prices and good-quality brands. This explains the increasing success of globally famous companies or do-it-yourself chains highlighting the low prices and durability of their products.

Disposal

The disposal of furniture is particularly relevant in rich countries where people change furniture more often than in poor countries. In the 21st century, reusing and recycling furniture are more popular practices than in the past, in both rich and developing countries. The secondhand-furniture sector size in the United States is $100 billion per year. In Ghana, the secondhand sector employs over 15,000 people. In the United Kingdom in 2006, over 3 million items were donated to charity shops, two-thirds of which were household furniture. In the 21st century, people reuse their furniture more than in the past (through charity shops, friends and family, Websites, garage sales, and for-profit retails), but they also seem to change it more often. Although furniture styles change less frequently than clothing and shoes, its relatively low prices

(compared to past years) encourage people to change furniture. A variety of furniture disposal methods exist, and people decide the best method based on what they are disposing of. For instance, an antique chair is likely to be either donated to family members or sold for a profit through retail or through a Website; a low-value chair can be donated to friends or charity shops; and a broken chair is generally thrown in the garbage. Because people are more aware of the value of their furniture, they donate fewer objects to charity shops than in the past and they sell their objects through garage sales or Websites. This means that fewer people are helping charitable organizations, but it testifies to a cultural shift in looking at disposed objects as sources of income as well as valuable purchases. This also shows that, although people increase their consumption of furniture, they are becoming more aware of environmental and ethical concerns about the management of waste in their household.

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See Also: Appliances, Kitchen; Consumerism; Home Appliances; Materialist Values.

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Fusion

Most nuclear power, including all current commercial nuclear reactors, uses nuclear fission—the absorption of a neutron by an atomic nucleus, resulting in its splitting into two or more smaller nuclei. Fusion power, which has been pursued experimentally since the early atomic age in the 1950s, generates power instead through nuclear fusion in which two atomic nuclei fuse together to form a single, heavier nucleus, releasing energy in the process. As with fission reactors, most fusion power plant designs use nuclear fusion to generate heat, which operates a steam turbine, which in turn drives generators to produce electricity. Fusion power has successfully been generated in small amounts. However, a fusion power plant design had not yet been devised and implemented as of 2010 that was efficient and commercially viable. This is in contrast to the brief period from the inception of fission power to its first commercial applications, which took less than a decade.

Fusion Designs

Early fusion power research revolved principally around the idea of the "pinch," the compression of plasma by magnetic forces. When an electric current is run through plasma, a magnetic field is generated, which creates an inward-directed force that causes the plasma to collapse and become more dense. Denser plasmas then create denser magnetic fields, increasing the inward force further in a chain reaction. Carefully controlled, this can generate the right conditions for nuclear fusion. However, even running the current through the plasma in the first place is no simple task; usually, it is induced by an external magnet. Pinch devices were used experimentally in the 1940s and 1950s, including the imaginatively named "Perhapsatron series" of fusion power devices developed at the Los Alamos National Laboratory in 1952. However, the Perhapsatron devices, like other pinch devices, became unstable at critical points, and beginning in the mid-1950s, the suggestion was made that pinch devices might be inherently unstable. Most work on them ended by the 1960s, but the flurry of experimentation and exchange of ideas laid the groundwork for fusion research.

Various other designs have been attempted since. Some fusion designs attempt to reach a level of high temperature and density for a short period, like the pinch designs or the inertial confinement devices, which initiate fusion through heating and com-

pressing a fuel pellet. One such inertial confinement fusion device was designed by Philo T. Farnsworth in 1968, 40 years after his invention of the electronic television. Inertial confinement remains one of the two most popular areas of fusion research; the other is magnetic confinement, which attempts to confine hot fusion fuel in the form of plasma and maintain a steady state. Occasionally, there is also work on devices that approach fusion from neither of these angles, but instead focus on producing low quantities of fusion at a low cost. While physically possible, these approaches have not proven fruitful or to have many useful applications. The term *low cost* is relative to the cost of the larger fusion power plants, not to other existing energy options.

Safety and Containment

The safety of nuclear fusion was not fully understood as of 2010 because of the lack of full-sized fusion power plants and the ability to study their operations. However, because of the differences between nuclear fusion and nuclear fission, the catastrophic accident that fission reactors are capable of (such as experienced in Chernobyl in 1986) is not a possibility with a fusion reactor. Fusion reactors require precise temperature, pressure, and other parameters in order for energy to be produced. Damage to the reactor would upset those parameters and cease the production of energy. Fission reactors, in contrast, produce fission products that will continue to generate heat even after the reactor is shut down, which can result in a meltdown of fuel rods as heat accumulates. The dangers of a fusion reactor would involve radiation exposure of staff and the release of radiation to the immediate vicinity but not the calamitous disasters of a Chernobyl-like incident. Further, unlike the fission reaction, the fusion reaction cannot "run away" and produce excess heat and waste products—fusion only works in a narrow window of parameters and exceeding them will simply result in the fusion process ceasing. No failsafe mechanisms such as the many implemented in fission reactors are necessary; further, the amount of fuel used is very small.

Magnetic containment fusion reactors could theoretically explode in the event of a failure of the structure that holds in place the coils where the magnetic fields are generated. A containment building would be sufficient to confine the damage of such an explosion, which would be similar to the explosions of MRI machines. It is also possible that the liquid lithium suggested as a coolant for fusion reactors could add to the damage caused by a fire, as it is highly flammable.

Radioactivity

The by-products of fusion reactors are helium (which is harmless) and tritium, an isotope of hydrogen. The amount of tritium released by a single fusion reactor's operations is thought to be negligible in its effect, but it is not clear what the cumulative effect would be of an energy economy based significantly on the operations of fusion reactors. Tritium is both volatile and biologically active, but it has a short half-life of 12 years. Also, unlike many other radioactive contaminants, it does not bioaccumulate.

Operating a fusion reactor causes the structural materials of the reactor to become radioactive from the flux of high-energy neutrons. The half-life of the radioisotopes produced is shorter in general than those associated with fission reactors, and the most dangerous part of the reactor—the reactor core—will be reduced to low-level waste after 100 years, and at 300 years will be as radioactive as coal ash. In comparison, fission reactor waste remains radioactive for thousands of years. However, for the first 50 years, the reactor core is much more radioactive than any fission waste and would need to be stored very carefully. Helping this process, though, is the fact that fusion reactors can be made from a broader range of materials than fission reactors, including many like carbon fiber and vanadium, which becomes less radioactive than the stainless steel used in fission designs. It seems fair to estimate that overall, fusion reactors are less dangerous and produce less dangerous waste than fission reactors.

Production

The greatest benefit of fusion power is that it provides significantly more power per weight of fuel than any current method of generating power. Further, while fission reactors use radioactive materials like uranium and plutonium, fusion reactors rely principally on deuterium—an isotope of hydrogen common in seawater. Working large-scale fusion reactors could provide the world's energy needs for

hundreds of thousands—perhaps even millions—of years. Further, there is no reason to think that fusion power suffers from the diseconomy of scale that many alternative power sources suffer from (wind and solar, for instance, become increasingly expensive per unit of electricity generated, once their use reaches the point that all the optimal locations have been used). Using seawater to fuel fusion reactors would also make it easy to use desalination plants to produce fresh water, an anticipated problem for future generations. The Fusion Torch concept introduced in 1968 by Atomic Energy Commission program managers Bernard Eastlund and William Gough also suggests ancillary benefits for fusion power. The Fusion Torch is the use of the plasma of a fusion reactor to break down waste materials and convert them into useful elements, such as hydrogen fuel.

Cold Fusion

For a time, especially in the 1980s and 1990s, cold fusion received the lion's share of attention, both public and scientific. Cold fusion is nuclear fusion that takes place at temperatures close to room temperature, rather than in the high-temperature, high-pressure conditions within stars and known fusion reactions. The idea received a good deal of publicity in 1989 when Martin Fleischmann and Stanley Pons conducted an experiment using heavy water and a palladium cathode that they believed generated energy—through fusion, they hypothesized—that could not be accounted for through chemical reactions. Both the public and the scientific community were receptive to the idea of such a breakthrough because of the recent similar breakthrough in the discovery of high-temperature superconductivity. However, attempts to replicate the Fleischmann-Pons experiment were unsuccessful or problematic, and a special panel convened by the Department of Energy concluded that no convincing evidence could be established for cold fusion or for a useful energy source based on the experiment. Interest had been stimulated, though, and cold fusion supporters within the scientific community continue to pursue their experiments and present their papers, including Nobel laureate Julian Schwinger, who resigned from the American Physical Society when his paper on cold fusion was rejected from its scientific journal. Twenty years later, cold fusion continues to be a matter of study, though considered a dead end by the bulk of the scientific community. Researchers sometimes use the terms *low-energy nuclear reactions* or *condensed matter nuclear science* to refer to their work to avoid what has become a disused label.

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See Also: Atomic Energy Commission; Environmentalism; Hanford Nuclear Reservation; Hazardous Materials Transportation Act; High-Level Waste Disposal; Nuclear Reactors; Uranium.

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Garbage! The Revolution Starts at Home

Garbage! The Revolution Starts at Home is a 2009 documentary film directed by Andrew Nisker. The title is partially taken from a conversation between Nisker and Bob Hunter, the founder of Greenpeace, who said "The revolution starts at home." Nisker's film chronicles the consumption and waste patterns of Toronto residents Michele and Glen McDonald and their three children. During a three-month period, Nisker asked the family to store all of their garbage in their garage. A goal of the film is to raise awareness in the viewer about the garbage they produce and to see the impact they have on the environment. In addition to chronicling the garbage and consumption practices of the family, Nisker aimed to connect these practices to other issues, each a segment of the film. These included organics, garbage, packaging, recycling, transportation, water, electricity, and the "human dump."

Film and Pollution Issues

In the first segment of the film, the patterns of the McDonald family are analyzed through their consumption and resultant organic waste, including leftover food, pet waste, and diapers. The practices of an organic recycling center are profiled, including efforts to sort and remove plastic garbage bags from the materials so that they can be recycled. According to the film, nearly 1 trillion plastic bags are used worldwide for an average of only five minutes, and in the United States, 100 billion plastic shopping bags are used annually. Next, the film focuses on the issue of garbage. Specifically, there are over 3,000 landfills in North America, and one of the major issues faced in Toronto is the lack of space for storing garbage. Toronto, like many other major cities, ships its garbage elsewhere—specifically to the state of Michigan. Huron Township is profiled. The multiple dumps in the township have created massive increases in traffic and have severely impacted the quality of resident's lives. Dump dust, which often contains asbestos, is one of the many environmental issues associated with such landfills. The film then turns to the issues of packaging and recycling. In the first case, Nisker points out that families like the McDonalds are overly reliant on convenient and overpackaged foods, and that many of the packages of such products are not recyclable. In addition, families often overconsume during the holidays, and this has a major environmental impact. In terms of the second area, the film emphasizes that while recycling

has a positive effect, many items, such as toothpaste containers, are made of composite materials and thus cannot be recycled. Some plastic laminates cannot be directly recycled back into the same product and are instead downcycled into other, often less-useful, materials.

The film then focuses on issues related to transportation, including the McDonalds' two SUVs, their CO_2 production, and the problem of road runoff, which is petroleum and water. Water is the next emphasis, with attention to the pollution caused by the family doing the dishes, flushing the toilet, and doing laundry. Household cleaning products (including bleach, phosphates, and others) are profiled for their negative impact on marine life. The case for moving away from bottled water is also made. The impacts include a depletion of indigenous aquifers in other parts of the world and the amount of plastic that is used to produce the bottles. The film then focuses on the issues of electricity (profiling the environmental impacts of West Virginia coal mines) and the "human dump" (focusing on dangerous chemicals, such as brominated flame retardant, that are impacting the human body).

At the start of the project, the family estimated that they would produce 42 to 65 bags of trash during the three months. In actuality, they produced 83 bags of trash (including landfill garbage and recycled garbage) and 320 pounds of wet organic waste. By requiring the McDonald family to focus intently on every piece of garbage that they throw out, as well as on the consumption practices that produce such garbage, the viewer gains an awareness of how much of consumption is invisible to people. As Nisker explains, "when the garbage man picks [garbage] up, it disappears like the rest of my pollution—out of sight and out of mind."

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See Also: *Garbage Dreams*; Household Consumption Patterns; Shopping Bags.

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Garbage, Minimalism, and Religion

Discussions of minimalism immediately call to mind the religious renunciant—one who eschews worldly possessions, relations, and passions to abide by "high-living" principles. Renowned renunciants include St. Francis of Assisi, Buddha, Mother Theresa, and Mahatma Gandhi. However, the renunciant is only one of the most recognizable figures rejecting worldly things for religious or spiritual reasons. There are, in fact, a variety of ways to examine the complex relationship between religion and the stuff called "garbage" or "waste," including household trash, human excrement, industrial waste, airborne pollutants, and other undesired, obsolescent, putrid, or worn things. Well-established connections exist between religious stewardship and "saving the Earth," recycling, and consumer waste, as well as the spiritual qualities of conservation. But waste is much more than simply discarded stuff: it is a dynamic cultural category. Perhaps the more interesting discussion arises when one looks closely at the symbolic, moral, and religious values attached to waste forms, such as impurity; their relationship to advanced capitalism; and the everyday practices of handling, expelling, or avoiding waste forms across religious traditions.

What motivates practices of minimalism, restraint, or asceticism among religious practitioners? Much of the answer to this question requires an appreciation of the individual body as a site of rich symbolism and cultural instruction within religious traditions. As temple, gift, or vessel, scholars have shown that the body sometimes operates as a model and microcosm of the cosmic universe and a physical foundation for the individual's relationship to a divine force. It is widely recognized that behavioral restrictions in a variety of religions attempt to impose order on processes of decay and death. Bodily impulses, sensations, and experiences, ranging from eating to sexual activity, therefore become

important places for demonstrating self-control and mastery over desire, hunger, disintegration, suffering, and, ultimately, human mortality. Concepts of waste derive meaning through associations with decay, death, and degeneration. It is important to note at the outset that approaching religion only as a static body of tenets, rules, or symbols yields limited insight. While practitioners strive to live according to such authoritative models, religious engagement is filled with multiple points of ambiguity and cultural variability. This should not dissuade anyone from proceeding; rather, it simply shifts the focus to human behavior and makes religion about much more than a series of rites, creeds, or traditions.

One way to explore the relationship of minimalism, garbage, and religion, therefore, is by investigating how laypeople navigate religious forms of taboo, prohibition, and moral censure concerning waste forms. Anthropologist Mary Douglas has shown that dirt and other waste matter derive their power through not simply being waste or having a kind of negative value. Rather, as "matter out of place," things deemed dirty, spoiled, or noxious carry polluting effects for the person, transmitted through bodily substance or through touching. By avoiding impure or defiled forms, practitioners shore up purity and associate themselves with a path of holiness or sacredness. Hindu-inflected caste hierarchy in India historically associated the handling of garbage and waste forms with impurity and relegated this work to the "untouchables," or *dalit*. Though formally banned by the Indian state in 1950, the caste structure reinforced status differences in those who had the greatest ability to spiritually elevate themselves and avoid forms of contagion.

Food Taboos and Regimens

Food regimens, dietary rules, and their "abominations" can also been seen as a way religious practitioners reduce hazardous associations with polluted, impure forms. Scholars of religion point out that these practices simultaneously fashion religious identity, group allegiance, and social distinctiveness. For example, pious Muslims abstain from alcohol and pork according to halal; observant Jews abide by kashrut, or keep kosher; and strict Mormons prohibit the intake of tobacco, alcohol, caffeine, and other unwholesome foods. These dietary practices are not only motivated by a concern with waste, impurity, and pollution but they also demonstrate self-restraint and piety. Food taboos form simply one area of behavioral restrictions concerning purity and impurity, which extend to religious bans on using profanity ("trash talk") and abstinence from premarital sex and lustful thoughts (for example, getting one's "mind out of the gutter").

Sometimes, eating practices also serve a poignant critique of social inequities, symbolically linking the individual body to the social body with each bite. In the late 1960s and early 1970s, Elijah Muhammad of the Nation of Islam banned among followers such foods as mustard greens, corn bread, refined sugars and flours, and scavenger fish. Instead, African American Muslims were encouraged to eat fresh vegetables, brown rice, prime cuts of beef and lamb twice per week, navy beans, butter, and milk. Building on a vibrant debate on southern cuisine among African Americans, anthropologists Carolyn Rouse and Janet Hoskins describe how Muhammad connected eating directly to the adversity and struggle of slavery in which many slaves wrested access to whites' discarded cuts of meat. Muhammed argued that southern cooking was a tool of racism, sapping the vitality of African Americans. He delineated a classification scheme for healthy, dangerous, and sacred foods in his regular written column, "How to Eat to Live." By politicizing eating and radically altering consumed foods, Muhammad worked to cleanse his followers of the pollution and profanity of enslavement and racism.

Fasting, hunger strikes, frugality, and specific diets, such as vegetarianism, veganism, and locavorism (eating locally produced foods), have also used religious justifications to call attention to food and resource waste, labor conditions, and inequalities of the world food system. The American Jewish World Service encourages the purchase of kosher-certified, Fair Trade coffee and chocolate for celebrations and events, linking "ethical consumption" to the Torah's vision of just society. Beginning in 1998, People for the Ethical Treatment of Animals (PETA) debuted the controversial slogan "Jesus Is a Vegetarian" to persuade Christians to adopt a new dietary model and spread awareness of the conditions of industrial meat

slaughter and resource use. Fasting has long been a religious practice plumbing the depths of human discipline. Scholar Carolyn Bynum tells famously of how pious women refused the carnal pleasures of food in late medieval Christianity through harrowing periods of voluntary starvation. Contrasted with these severe fasts, comprising daily watered wine or a bite of apple, was the largesse of a heavenly banquet, which starkly revealed the deep symbolism and metaphor of food as divinity in Christianity.

Rituals and Waste

Still other religious communities, movements, and practices overtly stress certain behaviors to align their faith with pressing social concerns involving waste. Like rich, tempting foods that can lead to gluttony, excess money or wealth can also induce polluting effects for the person (for example, greed, sin, and wastefulness) if withheld and left unshared. According to Islamic law, Muslims should participate in almsgiving, or *zakat*, ranging from 2.5 to 10 percent of their annual income, which is redistributed to "the needy." Social reformers identify religion's influence on personal conduct as the foundation for tremendous social change in a number of areas, from ethical consumption to political environmentalism. Among Hindus, the Ganges River is known to be a sacred waterway; pilgrims bathe in the water's purifying substance and some place deceased loved ones on floating pyres to ensure their safe passage to heaven. Yet, much has been written about the polluting effects of rapid industrialization on the Ganges's water quality. Anthropologist Kelly Alley describes conflicts between officials designing waste management programs for such pollution (*pradushen*) and the more widely used ritual notion of pollution (*gandagi*) among river workers and pilgrims, who argue for the Ganges's essential purity. She suggests that the contentious public debate in Benaras misses the significance of varying cultural knowledge of waste drawn upon by officials, boatmen, merchants, and pilgrims.

Minimalism and Donations

Often times what one might call "minimalist" practices are embedded in an intricate moral economy, where the practitioner receives seemingly immaterial returns, such as blessing, purity, prosperity, or nobility, for their discipline and piety. While encouraging the scrupulous use of material things, some religions simultaneously promise great material wealth for pious behavior or imagine the afterlife as a place of staggering material abundance. A crop of U.S. televangelists earned media scorn in the mid-1980s as seductive swindlers, banking on their followers' willingness to make immediate financial sacrifices for promises of great riches. Scholars point out that the oscillating orientations (for example, sacrifice and prosperity, minimalism and excess) widely attributed to the prosperity gospel in Pentecostalism need not be contradictory for the practitioner. Donations form part of a sacred economy of giving, where self-sacrifice pays dividends in frequently unpredictable ways. Some suggest increasingly well-documented attempts to control unpredictable market forces through recourse to spirits, witches, or divine beings reveal pervasive contradictions of capitalism in contemporary life.

Religious practitioners, however, engage in a continual process of reinterpreting and emphasizing some principles and behaviors over others according to their cultural context. German sociologist Max Weber famously observed the historical relationship between capitalism and the spiritual "calling" to work in Calvinism. But even in Protestant Christianities, the unflinching embrace of capitalism has not been a foregone conclusion. Early 20th-century Christian charity organizations in the West, such as the Salvation Army, Goodwill, and St. Vincent de Paul, salvaged discards like scrap textiles and secondhand clothes for the benefit of the "less fortunate" in their home countries and a variety of non-Western locales. Saving and reusing was not simply an economic boon but also a moral practice confirming thrift and worth. Charity donations offered middle classes the privilege of feeling good about getting rid of worn or old things. Such programs, however, tacitly acknowledged long-emerging inequities of Western capitalism and material abundance.

Simple Living

Some religious movements practice a collective version of renunciation by spatially separating themselves and forming what scholars call "intentional

communities." Nineteenth-century communitarians in the United States, such as Shakers, Millerites, and Oneida Perfectionists, espoused principles that restricted individual wealth and material possessions at a time when the factory-industrial complex was being established and a growing cash economy quickened consumerism. For example, Shakers living across some 18 settlements took a vow of celibacy and practiced communal landholding and profit-sharing in their agrarian business ventures, including seed selling. Old Order Amish continue to observe the *ordnung*, the communal body of rules that limit individual status goods, especially automobiles and electric-powered radios and telephones. Amish theology contests modern individualism and places value on *gelassenheit*, the clustered ideals of submission, obedience, and self-sacrifice. Scholars like David Shi maintain that, while they perhaps appear to distance themselves from "mainstream" U.S. society, communitarians actually exemplify the widely found themes of "simple living," self-restraint, and frugality long circulating in U.S. political and social life.

Social scientists point out that the desire for a simplified existence, which Old Order Amish exhibit and perform for tourists, is a particularly modern condition. Unrelenting material accumulation (prompted by planned obsolescence) and the marketplace's impersonal nature bring into relief the absences produced by "conspicuous consumption." Getting back to basics—to a more simple life unencumbered by material abundance and filled with the "real" values of friendship, sharing, and community—has been an increasingly pervasive theme in some quarters of Western societies.

Anxieties encircle not only people's relationship with their cast-off things but also the moral implications of the "throw-away society," including fleeting relationships, a weak social fabric, and hyper-individualism. The skeptical argue that nostalgia for a simpler life assuages middle-class concerns over abundance in advanced capitalism. Still others imply that simple living rings hollow without the guiding hand of organized religion. It is important to recognize, however, that even broad cultural messages against "affluenza's" hazards contain distinct spiritual qualities, origins, and underpinnings.

Simple living, or the voluntary simplicity movement, is embraced by a wide range of practitioners in the United States and western Europe, from seekers of heightened spirituality to concerned conservationists observing industrial capitalism's environmental costs. Specific practices can include buying and wasting less, growing one's own food, making hand-produced objects, limiting use of technologies like computers, eating a vegan or vegetarian diet, and adopting other ecofriendly activities, like bicycling. Voluntary simplicity draws loosely from a diverse array of Eastern and Western religious influences, such as the teachings of Buddha and of John the Baptist. Ironically, marketing in the United States and elsewhere, ranging from the magazine *Real Simple* to the banal Calgon Bath commercial (and its tagline, "Take Me Away!"), capitalizes on simple living's popular goals. Such advertising frequently appeals to a middle-class (feminized) desire for near-transcendent experiences of simplicity, austerity, and tranquility begotten from one's release from material possessions, time pressures, and responsibilities.

Conclusion

The renunciant frequently operates as a moral exemplar for the layperson, symbolizing discipline, completeness, and piety. The renunciant's life is especially intriguing and desirable, yet elusive in an era of staggering consumption (e.g., the invitation to "shop till you drop"). What the image of the religious renunciant obscures, however, are the small yet momentous struggles of restraint in the religious actor's everyday life. By examining the moral dilemmas of waste, wastefulness, and pollution, one can better appreciate the position of the religious practitioner assessing taboos, prohibitions, and other behavioral restrictions as well as their hard-earned, luxuriant rewards. Ethnographers maintain that religious practices do not simply oppose capitalist accumulation, or "materialism," wherein the spiritual is contrasted with the material, religion to economy, and spirit to flesh, but often coexist in an ambivalent relationship with them.

Garbage is an ongoing human process of classifying, sorting, and reordering. Middle-class Americans spend much time and money extricating themselves

from waste's immediacy, visibility, and physicality: scheduling weekly municipal trash collection, moving garbage swiftly to an opaque bag; installing quick-flush toilets, and building bigger and bigger out-of-sight dumps. But lingering moral problems remain. Practitioners use their religious engagements to question, mitigate, and make sense of capitalism's advance and the oft-neglected aspect of consumption: waste.

Through the robust and varied research concerning garbage, religion, and minimalism, anthropologists propose that the much-less grand, more-ordinary lives of practitioners striving for purity, holiness, sacredness, or oneness hold perhaps the greatest intrigue and warrant our undivided attention.

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See Also: Consumerism; Culture, Values, and Garbage; Food Waste Behavior.

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Garbage Art

Garbage art (alternatively known as trash art or recycled art) is art created from materials including post-consumer and other waste, collected debris, or objects previously used for other purposes. It can be viewed as a special form of recycling, and the growth of this genre is a reflection of the increasing importance of environmentalism in all segments of society, including the arts. Creating art from garbage involves transforming the meaning of objects by placing them in new, aestheticized contexts. This practice is not new; tribal peoples have adapted bits of trash from industrialized societies into their traditional arts since coming into contact with products of the developed world. Reworking worn-out or otherwise-useless materials into new objects with aesthetic or functional value also has a long history in folk art traditions around the world. What is relatively new is the widespread popularity of garbage art in industrialized consumer societies in both fine art and community art contexts. Burgeoning interest in the new genre of garbage art is countercultural in several ways; work in the genre expresses critical perspectives on the materialism, commodification, environmental destructiveness, and individualism characteristic of modern consumer culture. Despite its critical political associations, garbage art has enjoyed rising popularity with the broad acceptance of environmentalist ideas that were once considered "radical" into mainstream society.

Garbage art may be seen as a subset of the broader category known as environmental art. The latter also includes works created from natural materials or designed to interact with environmental forces, rather than only those using waste-stream media. Sculpture that produces musical tones when the wind blows through it, or work that decoratively enhances natural objects, are examples of environmental art. Even more broadly, environmental art includes pieces designed for display or performance in natural settings, work inspired by nature, and other conceptual art about environmental relations.

Creation and Materials

Creating art from trash involves "consuming" garbage in the sense that artists appropriate and rear-

Garbage art (or trash or recycled art) has been in practice for centuries but has remained on the fringes of the art world. It is often seen as a subgenre of what is known as environmental art. Dumpster diving is a popular method of gathering materials.

range the materials in personal ways, transform their meanings, utilize them to their own ends, and represent them in new ways. It involves taking unwanted materials out of their "waste" context and recontextualizing them as "art." The previous uses and effects of such objects may be symbolically employed to evoke meaningful associations and to communicate messages about consumer society or environmental damage. This remaking of the meaning of objects is a defining characteristic of the garbage art genre and it is often what makes it so enjoyable and accessible to the art-consuming public. The playful and surprising effects of recombining evocative and often familiar objects in ways that transform their meanings provoke a high level of engagement in viewers that does not depend on conventional art appreciation knowledge.

Broadly speaking, garbage art includes phenomena from the margins of industrialized society to its very center. The adoption of cast-off items of industrial origin for their ornamental value by people in nonindustrialized, tribal societies around the world can be considered instances of garbage art; for example, where pop-tops from beer cans, wire paper clips, or keys from sardine tins have been incorporated for their exotic novelty value into traditional jewelry forms. In postcolonial societies that are more thoroughly integrated into global systems of consumer political economy, items of industrial waste such as aluminum cans, telephone wire, and candy wrappers are used to produce artisanal creations such as toy cars, woven baskets, and handbags for both domestic consumption and the international ethnic art market. Such items are often marketed in the industrialized world as Fair Trade commodities produced in workers' collectives, and they fetch high prices for this reason as well as their "ethno-chic" associations. The reuse of materials otherwise destined for the trash heap has also had a place in folk art produced by nonprofessional artists in developed nations. Traditional quilting, for example, arose as a frugal means of recycling the material from worn-out clothing to create warm bed coverings. Other examples are rugs woven from strips of waste cloth and sculpted figures (sometimes used to advertise auto-repair shops) made by welding together scrap car parts.

Brief History and Counterculture

The use of trash as a fine art medium dates back at least to the work of early-20th-century artists such as Fortunato Depero and Kurt Schwitters. Use of found materials, including garbage, has been associated with assemblage art since the 1950s and has been practiced by other well-known artists, including graphic artist Christian Boltanski, sculptor Louise Bourgeois, and photographer Andres Serrano. Art made from garbage has since become much more common in fine arts venues such as museums, galleries, and high-profile installations, including H. A. Schuldt's famous "Trash People," which has traveled around the world since 1996.

As an offshoot of the broader environmentalist movement, the rise of garbage art as a distinct genre since the latter decades of the 20th century

has mirrored the course of environmentalism from being a marginal—and in its more radical forms a subversive—movement to gaining mainstream popular and institutional acceptance. Over the course of this period, artists working in waste media have developed the genre as a self-conscious, countercultural expression. The garbage art movement has been a countercultural force in at least three ways. First, it has served as a vehicle for critical commentary on the consumer culture and unsustainable lifestyles that characterize industrialized societies and the globalized political economy. This is the case, for example, of works that either explicitly reference the negative effects of pollution and global warming on natural ecosystems, or are linked to programmatic efforts to inspire resource conservation and recycling in the public. Second, this genre manifests a critique of capitalist culture in terms of its construction of value. In other words, garbage art can deconstruct capitalist culture as a system that depends on maintaining the appearance of monetarized value as a natural, relatively stable basis for conceptualizing worth. The artist can do so by demonstrating the mutable nature of value in taking supposedly worthless objects and revalorizing them by transforming them into art with aesthetic value, which may itself be sold as a commodity with monetary value. This sometimes-playful sleight of hand challenges the art-consuming public to view value and its construction (literally and figuratively) in new and critical ways.

A third way in which the practice of creating garbage art has been deliberately countercultural is the prominent place held by collective and community-based production, as opposed to the dominant "fine art" model of the individual professional artist. Many garbage art projects, such as "trash-to-treasure" art-making parties at community centers or ad hoc sculpture assembly in association with urban neighborhood cleanup events, are organized as inclusive productions, inviting the public to participate and involving people who do not self-identify as "artists." This model of alternative art making was nurtured in the 1960s counterculture, and it remains a strong theme in the garbage art movement linked to grassroots community and political organizing. An early example of collective trash art production is the unsanctioned, yet highly visible, Emeryville mud flats sculpture garden on the eastern shore of San Francisco Bay. Here, individuals and groups have been creating sculptures from driftwood, trash flotsam, and the toppled remains of earlier sculptures since the 1960s. Many 21st-century garbage art projects are collective undertakings, with participants recruited from all over the world to contribute sections of a large additive piece. The result demonstrates community solidarity behind the artwork's critical message and de-emphasizes the contribution of individual artists. An example is the "Hyperbolic Crochet Coral Reef" exhibit by Christine and Margaret Wertheim in Santa Monica, California, in which coral reef representations made from trash by artists in many countries were brought together to dramatize the destruction of these ecosystems by pollution and climate change. Similarly, an exhibition called "World Reclamation Art Project" (WRAP) in Syracuse, New York, organized and assembled by Jennifer Marsh, entailed covering an abandoned gas station with a patchwork of panels incorporating trash and messages critical of petroleum dependence. Panels were created by a worldwide network of amateurs, hobbyists, and professional artists organized by Marsh called the International Fiber Collective. Projects organized according to this collective model are characteristic of the interface between art and social movements, and they run counter to the dominant culture of the fine art world in which professional training is institutionalized and individual artistic achievement is celebrated.

Becoming Mainstream

The messages and practices of garbage art challenge conventional ideas about art and artists. It has thrived mainly on the fringes of the fine arts world. However, just as many environmentalist ideas once considered radical have been embraced by mainstream society, garbage art has gained acceptance by both the public and the fine arts community. In the 21st century, community-based "trash-to-treasure" events have become common, such as garbage art-making parties, markets, and exhibits, as well as trash fashion wearable art contests.

Government and nonprofit foundation support for garbage artists has increased worldwide, along with other opportunities for professional develop-

ment, such artist residencies dedicated to artists using waste-stream media. Garbage art is becoming increasingly institutionalized and accepted for its positive educational and transformative effects, as well as its aesthetic quality.

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See Also: Consumerism; Environmentalism; Post-Consumer Waste; Recycling.

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Garbage Dreams

Garbage Dreams is a 2009 documentary film directed by Mai Iskander. The film focuses on the *zabbaleen*, an Egyptian group of Coptic Christians who live on the outskirts of Cairo. The 60,000 zabbaleen reside in Mokattam, a "garbage village" that once served as the primary waste relocation spot for most of Cairo. Cairo's 18 million residents were highly dependent on their waste management work, especially since the city lacked a sanitation system. The zabbaleen model, which is over 100 years old, is considered by many to be the most efficient recycling system in the world.

Summary and Waste Management Methods

The film, shot by Iskander over four years, follows a biographical style and focuses on the lives of three teenage boys who inhabit Mokattam. Osama is a 16-year-old who is portrayed as moving from one job to the next. Nabil is an 18-year-old who dreams of owning his own apartment and getting married. Adham is a 17-year-old whose work involves shearing off the tops of soda cans and who strives to modernize the Zabbaleen's waste management practices. The film opens with an illustration of the Zabbaleen waste management system. The Zabbaleen take great pride in their traditions, one stating that they "turn garbage into raw materials." They collect every type of waste from Cairo residents, including paper, plastic, metal, and other forms of waste. Using plastic granulators, cloth grinders, and paper and cardboard compactors, the Zabbaleen are able to successfully recycle 80 percent of the waste they receive. The materials that they generate are sold to countries including China, Belgium, and France. While they serve an integral role in Cairo's economy, they are often shunned. In addition, the nature of their waste work results in cases of hepatitis and the need for tetanus vaccinations.

The viewer is introduced to Laila, a passionate organizer of the Zabbaleen, who warns the residents of Mokattam that their recycling work is coming under attack. In 2005, Cairo sold $50 million in annual contracts to three private waste management companies from Italy and Spain. City managers were concerned that the practices of the Zabbaleen were too traditional and argued that a new, more modern system was needed. These modern waste companies lack the efficiency of the Zabbaleen, with only 20 percent of the collected waste being recycled and the remainder being incinerated or placed in landfills. A poignant segment of the film involves a school trip to one of these private landfills. One of the teenage boys is asked what he would do if he were given a landfill. "I'd dig it out. It's all a gift from God to be recycled and reused," he replies. The boys then inspect the landfill site and are shocked to discover many useful items in the piles.

The film shifts to a study abroad trip. Nabil and Adham are sent to Wales to study contemporary advancements in recycling. Upon arrival, they discover that Wales recycles only 28 percent of its waste. They then take part in a curbside recycling program and tour a recycling center. One of the boys grabs some of the very fine bits on the center's conveyor belt, exclaiming that these, too, no matter how small, can be recycled. Their tour guide explains that these bits will be incinerated, much to the disappointment of the boys. They then understand that while Wales has new recycling technology, it lacks the "precision" that characterizes their

work in Mokattam. Upon their return home, the boys, particularly Adham, are inspired to use their experiences in Wales to solve the crisis posed by the corporate waste management firms. Adham explains to Laila that one potential solution is to conduct source separation, a practice in which residents presort their waste prior to pickup. Laila and others go door-to-door and ask residents if they would support such a practice of essentially putting out one bag of food waste and a second with everything else. Most are supportive of this idea, but the Zabbaleen discover that the modern waste firms are mixing these bags anyway.

The film also profiles the Recycling School, an effort to educate young people in geography, computers, business skills, and recycling knowledge. The films concludes with uncertainty about the future of the Zabbaleen recycling practices.

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See Also: Cairo, Egypt; Dump Digging; Dumpster-Diving; Recyclable Products; Recycling Behaviors.

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Garbage in Modern Thought

When addressed in a conceptual sense, garbage allows a deeper understanding of the human condition. Garbage has always been an integral part of society. As William Rathje and A. J. Weberman write, garbage is a form of revelation. Through material means, it allows for the understanding of the essence of human nature. Some of the specific conceptual issues associated with garbage and modern thought are garbage as a central/secondary concept, socially significant, a form of misunderstanding, categorization and separation, value/no value, as ephemeral, and excess and loss.

One issue has been the question of whether garbage occupies a central philosophical location in human consciousness, or whether it exists at the periphery, beyond the realm of comprehension. Philosophers and intellectuals have expressed the need to focus on the centrality of garbage, but for everyday individuals, the understanding of garbage is often as something "out of sight, out of mind." Rathje and Cullen Murphy express that garbage, unequivocally, represents the sign of human presence and thus illustrates the centrality of garbage to human thought. For many people, the thought that comes to mind when holding a piece of trash and preparing to dispose of it is simply a lack of thought. Modern humans, as part of their penchant for consumption and unsustainable living, often think very little about the waste that they produce. As Rathje's research in garbology has illustrated, people have unrealistic understandings of why and when they waste, and their ability to see garbage as central to their lives is lost as a result. Like many aspects of capitalist living, the person throwing away a piece of trash does not connect the various levels of production, consumption, and post-consumption involved in the trash. It becomes a secondary matter—an afterthought.

Central Concept

Martin O'Brien, among many thinkers, argues that the understanding of garbage should be a central concept, especially since garbage typically correlates with social change, social roles, and institutions. Thus, beyond the level of individuals and their relationship to garbage, there is an interest in understanding the central role that garbage plays in all of society's roles, institutions, and forms of change. Major cities depend on whether the trash gets picked up on time or not. Politicians can lose their offices if they do not effectively deal with refuse issues in their locality. Much like the minds of individuals who view garbage in a secondary light, societies (as amalgamations of individuals) proceed on the basis of viewing trash as a secondary condition. Many societies approach the idea of garbage, much like actual garbage, as an afterthought. Philosopher

Georges Bataille wrote of the ways in which early societies, like the Mayans, used sacrifice as a means of expelling the accursed share. Garbage is excess—it is a part of society that society no longer desires.

Social Roles

Dominique Laporte suggests that a major step in the transformation of the ways in which people dispose of garbage was how garbage disposal was domesticated, privatized, and essentially more intimately connected to the family as a unit. Garbage, understood in reference to social spheres, is a reflection of the relations among people. Entire social systems—of refuse collection and recycling—are dedicated to the social problems associated with garbage and its disposal or reuse. Politicians, activities, social agencies, and new social movements organize collective efforts around the issues associated with waste. Families, whether they approach garbage through effective measures or not, focus on garbage as aspects of their daily lives.

Reflection of the Individual

Garbage is also a reflection of more specific and intimate details of individuals. Weberman infamously used techniques of what he deemed *garbology* to uncover what he saw as the essential nature of people. He once said, perhaps indirectly referencing Jean Brillat-Savarin's quote about food, "You are what you throw away." Weberman saw his pilfering through the trash of Bob Dylan, Jacqueline Kennedy Onassis, and others as a means of evening the score with the powerful. Through clandestine methods, truths could be uncovered, and secrets could be discovered. Perhaps a document discovered in the trash of a politician could expose a hypocrisy, or a lack of documents could illustrate how an artist-activist was politically inauthentic.

Misunderstanding

Garbage, as Rathje has argued, expresses a disconnect. Even though people are connected to their waste because they produced or consumed what is eventually thrown out, reused, or recycled, they somewhat ironically are often unable to accurately understand the significance of what they waste and what is actually wasted. When asked about their own garbage, people give inaccurate answers; when asked about their perceptions about what is present in landfills, they overestimate certain products (like diapers) and underestimate others (like construction debris). Garbage, then, is misunderstanding. It is believing one thing when another is actually true. It illustrates how contemporary societies often value lifestyles that are governed by "invisibility," or a way of living that promotes looking only at the immediacy of the things around an individual. A person is never encouraged to investigate the natural and human resources used to produce things or to focus on the harms that a product will pose to the environment after its use. One of the dangers of thinking of garbage in such incomplete and incorrect ways is being unable to critically reflect on, and alter, dangerous consumer lifestyles.

Categorization and Value

Garbage is categorization, according to Susan Strasser. Societies devise entire conceptual systems that are geared to delineate between objects that have value and objects that are without value. The latter set of items is referred to as garbage, trash, and rubbish. Just as the world of valuable objects is subject to intense forms of categorization (sometimes called "folk taxonomies"), the world of garbage is subject to the same forms of ordering. In recycling programs and in places of refuse disposal, items of trash are categorized depending on their potential value, possible environmental harm, or time of decay. Consumers have become accustomed to the categories that are often applied to garbage. Many cities require people to dispose of their garbage in an orderly fashion—perhaps separating wet household waste from dry—and recycling programs ask individuals to divide their recyclable items into sets (such as plastic, glass, aluminum, and paper) and smaller subsets (such as PET or 01, PE-HD or 02, and PVC or 03). Garbage is an illustration of how humans use mental categories to order the material world.

According to John Scanlon, garbage is indicative of a separation of the world—the desirable from the unwanted. Michael Thompson uses the riddle of the rich and poor person's approach to snot (one keeps his in a handkerchief, the other disposes of it with a tissue) to underscore the curious ways in which garbage is connected to the issue of value. While garbage is universal—all societies, extinct

and extant, have produced or produce garbage—the conditions under which garbage is understood are culturally determined. Many non-Western societies attach a much greater value to items after they are discarded. In the United States and many other nations, garbage often results not because something no longer has utilitarian value but because the item in question is defined as something of no value. Thus, garbage is not only an objective condition of material culture, but also a subjective one of mentalist culture. People define what is trash and what is valuable.

Popular Culture

In popular culture, the terms *garbage*, *trash*, and *rubbish* have an especially potent semiotic context. In popular writing (such as novels), in television, films, music, and other forms of mass expression, the term *trash* is used to signify work that is of especially low value. A novelist who writes work that is considered too popular and is without literary merit may be referred to by the terms *garbage* or *trash*. Individuals who read "trashy" novels may do so because they desire escape and, thus, their time expended may be considered "wasted." In rock and roll music criticism, the term *trash* is also used to indicate an artist who either had potential but did not effectively express it or sells out to commercial interests. The Scottish/American rock group Garbage, in part, took their band name because of a comment that their music sounded like garbage.

In popular linguistic idioms in the United Kingdom and the United States, the terms *rubbish* and *trash* are also commonly used. In the United Kingdom, rubbish is the term used to describe forms of argument that are nonsensical or without value, while in the United States, "trash talking" refers to a form of competitive discourse (sometimes found in sports) that reflects an excessive boastfulness or hyperbole. The pejorative term *white trash* originated in contexts of U.S. slavery in which black slaves referred to white servants using the term. In contemporary social contexts, the offensive term refers to European American (white) people who are considered to be of low socioeconomic class and who lack education and sophistication.

Garbage is commonly associated with the idea of the ephemeral—of something that lasts only a short amount of time. In modern societies, people often throw their household items away without regard for the consequences, and thus they promote a form of living that emphasizes the ephemeral. Poets, including Derek Mahon, use the subject of garbage in their work to draw attention to the condition of modern life, including transiency, waste, and alienation. Author Don DeLillo also uses the idea of garbage in his book *Underworld*. One of the characters in the novel describes the state of garbage and the world, saying "We make stupendous amounts of garbage, then we react to it, not only technologically but in our hearts and minds. We let it shape us. We let it control our thinking." There are cases of famous artists, including Marcel Duchamp and Damien Hirst, who found their art objects—sometimes called "ready-mades" for the fact that they appear to be everyday, household objects—being thrown out in the trash. It turned out that people did not understand that they were not trash and were, in fact, art.

Garbage also indicates issues of excess and loss. Georges Bataille's "The Solar Anus" uses the image of the sun to reflect on the inherent tendency of all things being geared toward excess. While the sun can be viewed as a source of energy, another interpretation is that the sun, as an anus and through excretion, is involved in massive expenditures of energy. Garbage is often viewed as a form of society's excess—as the unwanted things that are thrown out without regard. Even foreign policy, such as a country's invasion of another, could be viewed as garbage, or the state's excess of political and military energy that is released outside its territories. Garbage can also be thought of as a form of loss. According to John Scanlon, once a product losses its ability to be a useful product, and once it is defined as garbage, it loses its ability to stand as something related to something else. Once something is identified as garbage, unless it is reclaimed by someone prior to disposal, it loses its material and conceptual value. In the world of computer science, the term *garbage* also refers to situations of loss in which data or objects in memory go unused in computer operations.

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See Also: Culture, Values, and Garbage; Hoarding and Hoarders; Sociology of Waste.

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Garbage Project

The Garbage Project was founded in 1973 by William Rathje and a group of students at the University of Arizona. Since its inception, it has produced numerous studies supported by a variety of government agencies, nonprofit institutions, and private companies. Over the years, the Garbage Project has examined samples of fresh sorts—garbage fresh off the garbage truck and landfill sorts across the country—by meticulously sorting, coding, and cataloging their contents. Garbage, while a persistent consequence of human activity, is to a large extent invisible, disappearing in trash cans and landfills, and it has been subjected to numerous myths and speculation. The Garbage Project not only unearthed and shed light on garbage itself but also on the human mind and various behaviors.

The Garbage Project was inspired by an anthropology class at the University of Arizona in 1971 designed to teach principles of archaeological methodology. Students undertook independent projects to show links between various kinds of artifacts and various kinds of behavior, which included a comparison of garbage samples from different households, an approach that seemed to hold great promise. By 1973, the Garbage Project entered an arrangement with the city of Tucson, whereby randomly selected household pickups from designated census tracts were delivered to a site for analysis. The garbage was sorted into 150 specific coded categories. For each item, the information recorded included the date collected, the census tract from which it came, any information available from packaging (such as original weight or volume, its cost, or brand), and weight. In 1987, the Garbage Project began excavations of landfills.

Fresh Sorts

Several interesting insights in what and how people consume have been provided by the Garbage Project. Health trends have been reflected in the discards, with a certain irony: attempts to restrict consumption of certain food contents are often counterbalanced by extra consumption of the same food contents in hidden form.

At the beginning of 1983, a sudden widespread increase in the percentage of fat trimmed off and discarded was noticed. This correlated with the publication at the end of 1982 of the National Academy of Science's report and subsequent media reports identifying fat in the diet—particularly fat from red meat—as a significant cancer risk factor. These findings indicated that people made efforts to reduce their fat intake from fresh, red meat.

However, as people bought less fresh meat, their consumption of processed red meat, which tends to

The Garbage Project study found that foods eaten on a daily basis are much less likely to be wasted. For example, the relatively few ingredients in Mexican cuisine are easily reused, producing less waste. Ingredients for very specific uses are wasted at higher rates.

have an even higher fat content in hidden forms, increased.

A common way to study consumer behavior has been via self-report measures. However, an inaccuracy of self-report measures has been suspected, as people's memories tend to be unreliable and biased. A comparison between the reported behavior and sorted garbage revealed these discrepancies. Alcohol consumption tends to go underreported. Reported food consumption tends to be skewed in ways that have been labeled the Good Provider Syndrome and the Lean Cuisine Syndrome. The Good Provider Syndrome is reflected in the tendency of homemakers to almost uniformly report that their family consumes more than sorters can find evidence of in the garbage. Also, homemakers tend to underreport the amount of prepared food. The Lean Cuisine Syndrome is reflected in the tendency of people to both consistently underreport the consumption of items high in sugars and fats and overreport the healthier foods.

Through the examination of garbage, the traditional model of ethnic assimilation—the assumption that immigrants to a new culture will exhibit a cultural style lying somewhere between the normatively prescribed behavior prevalent in the culture of origin and those prevalent in the culture of residence—was challenged. A study conducted by Michael Reilly and Melanie Wallendorf, focused on the daily household consumption of Mexican Americans in Tucson, Arizona, and a comparison with the households of Anglo Americans in Tucson and Mexicans in Mexico City, revealed some surprising findings. With regard to beef consumption and sugar-based soda, the average Anglo American household consumed considerably more than the average Mexican household. However, the average Mexican American household consumed considerably more of those items than the Anglo-American households; this was also the case regarding coffee, convenience foods, high-sugar cereals, and white bread. At the time of the study, Anglo-Americans became more health conscious about their foods, while it appeared that Mexican Americans had overassimilated to their prior conceptions of the U.S. lifestyle encountered before migrating and influenced by inferences drawn from the mass media. This also has been referred to as the Hollywood Hypothesis.

Principles of Waste

The examination of food wastes, or, more specifically, the amount of edible or once edible food that has been thrown away, revealed a counterintuitive tendency to waste more of what is in short supply than what is plentiful. One example comes from examining beef waste, an ideal subject for investigation, because meat packaging is labeled with detailed information such as the type of cut, weight, price, and date. Beef waste was determined by not counting fat or bone. During a widely publicized beef shortage in the spring of 1973, a comparison of the amount of beef waste during the shortage and after the shortage ended showed that there were much higher amounts of beef waste during the shortage. It has been hypothesized that people responded to the media coverage by buying all the beef they could find, including cuts they did not know how to cook. Coupled with not knowing how to store large amounts of beef, these behaviors resulted in greater waste.

Garbage Project studies have found that U.S. families waste between 10 and 15 percent of the food they buy and that various factors account for food waste. One of these factors is called the First Principle of Food Waste: the more repetitive the diet—the more is eaten of the same things day after day—the less food is wasted. For example, waste of standard breads—the most common sandwich bread continually used for many meals—is virtually

nonexistent. Specialty breads, such as hot dog buns, are wasted at high rates because they are used for very specific kinds of meals, then are stored away, and eventually go to waste. The Mexican American census tracts have generally less food wastes than the Anglo-American census tracts. While Mexican American cuisine offers a diverse array of dishes, the ingredients are relatively few, so the same ingredients are easily integrated into a variety of meals.

The First Principle of Food Waste also applies to other items, such as hazardous waste. Products used on a regular basis, such as cleaners, are less likely to be wasted than products used in special renovation jobs. The Garbage Project discovered that about 1 percent of household garbage by weight consists of hazardous waste and that the type of hazardous waste is related to socioeconomic status. The hazardous waste for low-income households tends to be automobile care items, such as motor oil; for middle-income households, it is home improvement items, such as paint; and for high-income households, it is garden items, such as pesticides, herbicides, and fertilizers. Among the hazardous wastes in landfills coming from households, in order of amount are household cleaners and pesticides, followed by paint, then motor oil.

Efforts to reduce hazardous waste in household refuse via special collection days have also led to unexpected consequences. A 1986 study that sorted and compared the garbage a month before and two months after the first well-publicized "Toxic Away!" in Marin County, California, revealed that the garbage contained more than twice as much hazardous waste by weight after the special collection day. This phenomenon has been confirmed by studies in Tucson and Phoenix, Arizona. Homeowners, who were made newly aware of the hazardous waste in their homes but missed the collection day, rid themselves of their hazardous wastes in the conventional way.

The Garbage Project found that the rate of natural biodegradation in landfills was much slower than anticipated, even though paper contributed 40 percent of the waste and fast food containers, disposable diapers, and Styrofoam amounted to less than 3 percent.

Landfills

The excavation of landfills began in 1987 with the goals of seeing if the garbage fresh off the truck could be cross-validated by the data from municipal landfills and to seeing what happens to garbage after it has been interred. It began at a time when an adequate knowledge about landfills and their contents did not exist, and when news of a mounting garbage crisis entered into the national consciousness.

Concerns about accelerating rates of garbage generation and landfills filling up and running out of space for new ones raised questions of what fills up the landfills. This had been speculated with calculations based on national production figures and assumptions about rates of discards, but it had never really been examined by actually digging into landfills and recording with details its contents.

The Garbage Project sampled landfills from varying climates, levels of rainfall, varying soils and geomorphology, and varying regional lifestyles across the United States. Despite different environmental contexts, the contents of the landfills examined appeared relatively uniform. Variation in terms of weight percentage of different categories of the refuse samples seemed negligible. Since landfills close when they are full, consideration of volume, rather than weight of the contents, becomes more important. Since most garbage tends to expand

once it is extracted from deep inside a landfill, the garbage was subjected to compaction of 0.9 pounds per square inch in order to reflect the volume of the garbage when squashed and under pressure inside a landfill.

The actual makeup of landfills has been shown to be different from popular imagination. Common perceptions of what fills up the landfill have been fast food packaging, expanded polystyrene foam (commonly referred to as Styrofoam), and disposable diapers. Fast food packaging of any kind, including bags used to deliver food, consisted of less than 0.5 percent by weight, and no more than one-third of 1 percent of the total volume of a landfill's content. Expanded polystyrene foam amounted to no more than 1 percent of the volume of the samples. Disposable diapers amounted to no more than 1 percent per weight and an average of no more than 1.4 percent of the contents by volume. As for the possibility of effects on public health, the amount of pathogens in landfills is so enormous that the diapers seem relatively insignificant. Landfills receive sludge from sewage treatment plants and normal household garbage includes residues of personal hygiene, as well as medical wastes of every kind. It also has been documented that bacteria and viruses tend to expire in landfills.

In the 1980s, the volume of all plastics, after excavation and compaction to replicate conditions inside a landfill, was less than 16 percent. Though larger amounts of physical objects are being compared to earlier decades and the number of plastic objects has increased, the actual proportion it takes up in a landfill has not changed.

Due to "light-weighing," the process of making objects to retain the necessary functional characteristics with less material, more plastic takes up less space. For example, a PET soda bottle from 1981 in comparison to one from 1989 is considerably thicker and stiffer.

The major contents in landfills have been found to be paper, at well over 40 percent, with newspapers alone taking up about 12 percent. Construction debris takes up about 12 percent. Contrary to popular belief, not much decomposing occurs in landfills. Even supposedly biodegradable materials do not biodegrade much in landfills. Newspapers have been preserved legibly, so they are commonly used in dating garbage deposits. Organics that have been dated back two decades have remained very much intact.

While food and yard waste are most vulnerable to biodegradation, they only account for between 10 and 20 percent of the organic material in landfills and 5 to 10 percent of total landfill contents. However, even after two decades in a landfill, about one-third to one-half of these organics have been found in recognizable condition.

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See Also: Archaeology of Garbage; Arizona Waste Characterization Study; Garbology; Landfills, Modern.

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Garblogging

The term *garblogging* refers to the growing body of work by environmentally conscious bloggers (writers of online Weblogs) that addresses the political, environmental, personal, or social impact of waste, trash, garbage, and refuse. Garblogging is practiced by a broad spectrum of both professional online journalists and environmentally concerned bloggers. Although there are a few blogs that focus exclusively on trash or garbage, there are many

more blogs that include a significant number of posts about the production and environmental impact of waste and garbage. Environmental bloggers—as distinct from professional environmental journalists who contribute to newspapers like the *New York Times* or online periodicals such as Slate.com, Salon.com, or the *Huffington Post*, all of which have dedicated sections to environmental matters—produce a range of blogs. These blogs include noimpactman.com and greenasathistle .com, which are journal-like accounts about how a single individual experiments with decreasing consumption and thus wasteful practices; wastedfood .com, which is written by a researcher who evaluates the impact of wasted of food in households, restaurants, and stores; and 365daysoftrash.blogspot .com, which began as an experiment in trash reduction and has become a wide-ranging exploration of the practices of waste disposal and the global trade in garbage.

Garbloggers

Garbloggers, like all environmental bloggers, are comprised of a range of people; stay-at-home parents, organic farmers, activists, scholars, historians, and artists all keep environmental blogs that include posts on garbage. Many of these blogs have hybrid content—bloggers repost conventional environmental journalism and photographs, as well as their own observations and photos.

Although the blogs differ in focus (some bloggers are interested in simplifying their lives for personal reasons, some are interested in critiquing the wasteful economy of planned obsolescence, many are interested in how one repurposes items to keep them out to the waste stream), almost all share an emphasis on linking the problem of garbage and waste to excessive consumption in the material world. They are also especially interested in discussing the impact of household choices on global issues, linking the personal form of the blog genre to the global effects of garbage.

Environmental Role

Garblogging's role in the environmental movement as well as in environmental coverage in the media is still evolving. Media theorists and historians date the advent of blogging sometime in the mid-1990s, and according to techorati.com (an online site devoted to tracking the impact of user-generated blogs on the Web), since then, the number of blogs that are added daily has increased dramatically. As of 2010, there are well over 2 million blogs on the Internet, many of which are geared toward specialized audiences. Although critics like Andrew Keen have argued that blogging has created a culture in which poorly researched information is disseminated to and by amateurs who do not have the tools to evaluate its content, other critics like Scott Rosenberg and Clay Shirkey have argued that the Internet is self-correcting and that flawed information will be addressed and amended by users as it is disseminated more widely.

Rosenberg and Shirkey also praise the way that the Internet has spurred activism by creating virtual communities of like-minded people who share information. Certainly, blogs have formal features that allow bloggers to reach out to like-minded people; even if bloggers choose not to use these features, all blog templates allow bloggers to create a list or "blogroll" of other blogs and all allow comments on posts. More conventional online periodicals devoted to environmental issues (for example, treehugger.com and grist.com, two of the most widely read) are blends of blogs and periodicals, and they often rely on reader questions, reader-submitted posts, and "citizen journalist" responses, all of which owe as much to a blogging culture as they do to older forms of environmental media such as *Mother Earth News*.

Although garblogs might be seen to enlarge the environmental community and contribute to the creation of a lively online do-it-yourself culture, they are not generally subject to editorial control, the postings can be sporadic, and the blogs themselves are easily abandoned. They are, however, an excellent resource for those readers who are seeking accounts of how virtual green communities exchange information about environmental issues that have an impact on daily life.

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See Also: Culture, Values, and Garbage; Garbage in Modern Thought; Sociology of Waste.

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Garbology

The field of garbology involves the study of refuse and waste. It enables researchers to document information on the nature and changing patterns of modern refuse, hence assisting in the study of contemporary human society or culture. According to the *Oxford English Dictionary*, the term was first used by waste collectors in the 1960s. A. J. Weberman popularized the term in describing his study of Bob Dylan's garbage in 1970. It was pioneered as an academic discipline by William Rathje at the University of Arizona in 1973. The term is used interchangeably for the "science of waste management," and refuse workers are referred to as "garbologists."

In addition to helping municipalities understand the dynamics of the waste products generated in their communities, the best way to manage them and whether or not they have any salable value, industries and major firms are also avid followers of this research. It enables them to comprehend whether or not the packaging and other discards associated with their products are indeed harmful to the environment. The field of garbology often intersects with archaeology, since fossilized or otherwise time-modified trash may be the only remnant of ancient populations.

Garbology has also been used as an investigative tool of law enforcement, corporate espionage, and other types of investigations. This involves not just a physical sorting of papers but also files from the "trash" e-mails in computers. Journalists often use such surreptitious methods to investigate stories. Special intelligence services have also used garbology to combat crime—illegal in many countries, unless used by the government's intelligence units.

Garbology in Contemporary Times

In 1987, William Rathje initiated the Garbage Project at the University of Arizona. The goal was to determine what was below the landfills and how much of it was biodegradable. The project demonstrated that there were major disparities between what was actually in the landfills and what Americans perceived was in them. Most people mistakenly believed that the landfills were filled with fast food containers, disposable diapers, and Styrofoam, although these amounted to less than 3 percent of landfill volume. Plastic was 20–24 percent of waste, while paper contributed 40 percent. The project also surveyed different regions of the country to better comprehend what types of garbage survive under different climates and found very little difference between sites, since the garbage is compacted.

The Garbage Project found other misconceptions about landfills. Specifically, the rate of natural biodegradation was found to be much slower than anticipated. It was also found that plastic bottles that were crushed at the top were more easily inflatable than those that were at the bottom. It was also predicted that 50 percent of the landfills that were open would close within five years. Finally, in an effort to avoid large landfills, states often ship their trash to other states.

Garbology is used to assess waste and ascertain new and innovative ideas for waste management. For example, scientists are studying the best way to dispose of a floating mass of trash in the Pacific Ocean. They are also studying the impact of trash on marine life and the process of changing waste into energy. There is also the potential for using methane in landfills to generate small amounts of electricity.

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See Also: Archaeology of Garbage; Archaeology of Modern Landfills; Construction and Demolition Waste;

Culture, Values and Garbage; Dating of Garbage Deposition; First Principle of Waste; Garbage Project; Paper and Landfills.

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Garden Tools and Appliances

Given both the productive potential of domestic gardens and the scope they offer for a diverse range of activities that rely little on consumption, it is ironic that they have become increasingly unproductive and dependent for their maintenance on the consumption of an ever-larger range and scale of commodities. Many of these are garden tools and appliances and, despite their transformative and productive promise and potential, are destined to become underused, unused, or identified for disposal.

Definitions

Garden tools are implements roughly equivalent to unpowered hand tools and are used to materially work a garden for functional or cosmetic purposes. Examples of garden tools are spades, hoes, saws, and manual lawn mowers. Appliances include both powered versions of tools as well as those powered devices that are employed in the garden but are not used to materially work it. For example, both gasoline-driven lawnmowers and outside lighting systems are garden appliances. There is some overlap between these categories.

History

One marked characteristic of garden tools is the historical longevity of their form, despite much historical variation in the purposes, forms, and representation of gardens. For example, one 12th-century treatise on the subject advocated the acquisition of an essential garden tool kit, which would include knives, a shovel, a billhook, and a wheelbarrow. The recognizable antecedents of many such forms are traceable back into human prehistory and across cultures. The mattock, for example, is the tool of choice across much of the world and is used to chop, clear, dig, furrow, and weed. Appliances, on the other hand, are—with exceptions—historically recent inventions. The ability to power traditional hand tools has only come about via the development of portable power: batteries, electric cables, small gasoline engines, and gas canisters. The widespread consumption of those devices, which are not used to work the garden but have become clearly identifiable as garden appliances and accessories, is an even more recent innovation, one that has gathered pace since the 1980s. These include leaf blowers and powered hedge cutters, as well as water features, outdoor lighting, patio heaters, and even outdoor air conditioning.

The historical immutability of the material form of many garden tools is, to a large extent, inevitable. They endure because the tasks and labor associated with working the garden both for productive and cosmetic ends endures. Consequently, the proliferation of garden tools into multiple lines of increasingly differentiated forms from competing manufacturers did not gather pace until the 19th century. This was a result of the technological possibilities of industrialization, the productivity of reorganized labor, and the economic imperatives of capitalist political economy. Despite this expansion,

there were relatively few genuine technical innovations. The reworking of existing technologies and incremental technical change was the basis of most differentiation. The appearance in the mid-1800s of the manual lawn mower was a notable and, for many, very welcome exception. Throughout the 20th century, the proliferation and differentiation of recognizable tools into product lines has intensified both quantitatively and qualitatively. This includes the addition of power (such as the gasoline-driven lawnmower and later the electric lawnmower) and the development of alternative tools to achieve the same ends; for example, the widespread availability of the hover lawn mower since the 1960s whereby a cylinder of blades rotating around a horizontal axis was replaced by a flat, circular blade revolving around a vertical axis.

Waste

The problem for those who wish to profit from selling large numbers of garden tools that will be "wasted" through redundancy, underuse, or disposal is that of durability—not the durability of their largely enduring form but that of durability in use. There is a widespread expectation that garden tools should last. After all, many of them are made as a result of heavy industrial processes such as forging. Moreover, they tend to contain few, if any, moving or otherwise vulnerable parts or mechanisms. The common materials used in their construction (steel, iron, and hardwoods) also suggest durability. Despite this expectation of the material qualities associated with garden tools, they have been prey to many processes in terms of design, manufacture, materials, and parts that work against this.

First, there are several forms of identifiable, built-in obsolescence. Built-in technological obsolescence is discernible in relation to cheap or value ranges of garden tools; their relatively low price is a direct consequence of decisions to use less-durable, poorer-quality materials, inferior design, and quite often weak points, especially in the joining of components or materials. The old joke, "I've had this broom for 20 years. It's had five new heads and four new handles but I have had it 20 years" is actually a testament to the lack of durability of the tool in question rather than a testament to it. Moreover, garden tools and appliances have become increasingly styled, often with function being compromised by superficial stylistic elements. Even where functional efficacy is not compromised, highly styled garden tools are deemed by various promotional industries to have worn out aesthetically and to be in need of replacement by functionally equivalent but new and superficially differing alternatives.

The wasting of functionally intact tools via stylistic obsolescence or fashion is at odds with the idea of durability. Second, the overelaboration of traditionally simple garden tools is apparent; for example, the invitation to replace the use of twine in attaching plant stems to canes with molded plastic, spring-loaded clips.

Injunctions to replace simple hand tools with powered alternatives are also commonplace, for example, the electric hedge trimmer for hand shears, or the leaf blower for the rake. The assumed and unquestioned universal benefits of technology have played a key role in the promotion of such alternatives. Third, "new" garden tools and appliances proliferate. One garden catalogue boasts several dispensers for garden twine (both complex and functionally vulnerable), specialized tools for pruning different shrubs, and a wooden ruler for seed planting, which claims some specific garden relevance. Across all of these categories of tools and appliances there has been a general proliferation of choice—30 different kinds of bird feeders, 10 different systems of waste composting.

Given the amount and range of such less-than-durable garden paraphernalia, combined with the durability of many other garden tools, garden tools and appliances add to the amount of waste generated in consumer societies. Many garden tools and appliances are wasted through redundancy—they lay unused in sheds, cellars, outhouses, and the like.

Others are wasted through underuse; for example, the mass ownership of lawn mowers makes very little social sense, as an individual mower is likely to be used just once per week for a few months of the year. Shared ownership, lending, or hiring would be much less wasteful in such circumstances. Increasing numbers of unwanted garden tools and appliances find their way into the circuits of waste disposition: giving away, economic recycling through

rummage sales and Internet auctions, donations to charities, and disposal.

One may also argue that repeat consumption of garden tools and appliances, worth, for example, 300 million pounds annually in the United Kingdom, is wasteful, both in itself and in terms of the other consumption necessary to undertake this, such as transport costs. The result often tends to be a spiral of wasteful consumption; for example, the ownership of many duplicated or functionally very similar tools often requires further consumption of garden sheds for storage.

One development has been the increasing deployment of garden appliances that are intended solely to enhance the garden environment. The widespread rhetoric since the 1960s of the garden as an outside room underlies much of this wasteful consumption and includes the installation of elaborate outside lighting and entertainment systems, ever more-power-hungry barbecues, water features and pumps, hot tubs, patio heaters, and even outdoor air conditioning.

Finally, there is a notable, and ironic, development in the function of the garden itself. From being productive spaces and spaces of contemplation, entertainment, and leisure, the garden has increasingly become a space of storage and disposal—a resting place for the wasted products of consumption. Not only garden tools and appliances but also other unwanted or ambiguous objects are found here. Often initially seen as transitional spaces, where objects can be placed while their long-term usefulness is assessed and the options for disposal and disposition considered, many gardens have become recognizable marginal spaces of legitimized, domestic fly-tipping.

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See Also: Consumerism; Fly-Tipping; Overconsumption.

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Gasoline

The term *gasoline* is a generic name for a liquid mixture derived from petroleum. It is primarily used as a fuel in internal combustion engines. Before its first use in engines, the market for gasoline was almost nonexistent. In the 1800s, it was considered mostly waste or used as paint solvent, a treatment against lice and their eggs, and a cleaning fluid to remove grease stains from clothing. The first U.S. refineries processed crude oil primarily to recover the kerosene, and some dumped gasoline as waste directly into rivers or fields in the nearby area.

Health Hazards

As a hydrocarbon, gasoline is considered a hazardous substance and is regulated in the United States by the Occupational Safety and Health Administration. The material safety data sheet for unleaded gasoline shows more than 15 hazardous chemicals occurring in various amounts, including benzene (up to 5 percent by volume), toluene (up to 35 percent by volume), naphthalene (up to 1 percent by volume), trimethylbenzene (up to 7 percent by volume), methyl tert-butyl ether (up to 18 percent by volume, in some states), and about 10 others. Many of the nonaliphatic hydrocarbons naturally present in gasoline (especially aromatic ones like benzene), as well as many antiknock additives, are considered carcinogenic. Because of this, large-scale or constant leaks of gasoline pose a threat to the public's health and the environment in the event the gasoline reaches a public supply of drinking water. According to the Environmental Protection Agency (EPA), one gallon of gasoline can pollute 750,000 gallons of water.

Refining

In addition to the extraction of oil and its transportation to refineries, the first step to obtain gasoline is the refining process. This process releases a number of substances with extensive air-polluting potential into the atmosphere. A considerable odor normally

accompanies the presence of a refinery. Aside from air pollution impacts, there are also wastewater concerns; risks of spills, fires, and explosions; and health effects due to industrial noise. A persistent problem linked to hydrocarbons is corrosion of the transportation lines and storage devices. Corrosion occurs in various forms in the refining process, such as pitting corrosion from water droplets, fractures in metals due to exposure to hydrogen, and stress corrosion cracking from sulfide attack. To prevent corrosion, carbon steel is normally used for upward of 80 percent of refinery components, which is beneficial due to its low cost.

In the United States, there is strong pressure to prevent the development of new refineries, and no major refinery has been built in the country since Marathon's Garyville, Louisiana, facility in 1976. Since the 1980s, over 100 refineries have closed due to obsolescence or merger activity within the industry. Around the world, environmental and safety concerns have led to the construction of oil refineries some distance away from major urban areas. Nevertheless, the pace of urbanization makes this practice unsustainable. The possibility of disasters due to hydrocarbon spills in the vicinity of densely populated areas increases every year.

Spills and Cleanup

Most spills involving gasoline occur at the distribution phase. On June 10, 1999, a gasoline pipeline in Bellingham, Washington, owned by the Olympic Pipe Line Company ruptured, discharging approximately 236,000 gallons of gasoline into Hanna Creek. It then leaked into Whatcom Creek, a 3.5-mile-long coastal stream that runs through a city park, residential neighborhoods, and urban industrial areas before emptying into Bellingham Bay. As the gasoline was carried down the creek, the fumes were ignited, killing three people and affecting a variety of natural resources along the creek's path.

When a spill involving gasoline occurs, there are remediation-performance monitoring methods that can be applied to the contaminated site. Methods include phytoremediation, bioremediation, in situ chemical oxidation systems, or mechanical cleanup of the polluted materials. Phytoremediation is the use of vegetation to remediate contamination by the uptake (transpiration) of contaminated water by living plants. Foliage can be used to contain, remove, or degrade contaminants.

Bioremediation processes use microorganisms, fungi, green plants, or their enzymes to return the polluted environment to its original condition. It can be employed in areas that are inaccessible without excavation. It is especially used in hydrocarbon spills (mostly oil) or where chlorinated solvents may contaminate groundwater. Bioremediation attacks specific soil contaminants, such as degradation of chlorinated hydrocarbons by bacteria. An example of a more general approach is the cleanup of oil spills by the addition of nitrate and sulfate fertilizers to facilitate the decomposition of crude oil by endogenous or exogenous bacteria. Chemical analysis is required to determine when the levels of contaminants and their breakdown products have been reduced to below regulatory limits.

Bioremediation is typically much less expensive than excavation followed by disposal elsewhere, incineration, or other ex situ treatment strategies, reducing the need for "pump and treat," a common practice at sites where hydrocarbons have contaminated clean groundwater. Pump and treat involves pumping out contaminated groundwater with the use of a submersible or vacuum pump and allowing the extracted groundwater to be purified by slowly proceeding through a series of vessels that contain materials designed to absorb the contaminants from the groundwater. For gasoline-contaminated sites, this material is usually activated carbon in granular form. Chemical reagents such as flocculants followed by sand filters may also be used to decrease the contamination of groundwater. Air stripping is a method that can be effective for volatile pollutants such as benzene, toluene, ethylbenzene, and xylenes (BTEX compounds) normally found in gasoline spills.

In situ chemical oxidation (ISCO) is the injection into the subsurface of liquid or gas that causes oxidation and can result in the direct destruction of gasoline contamination. The chemical reaction produced, called oxidation, is a chemical reaction characterized by the loss of one or more electrons from an atom or molecule. When an atom or molecule combines with oxygen, it tends to give up electrons to the oxygen in forming a chemical bond. In contrast to other remedial technologies, contaminant

A puddle of waste gasoline, which must be managed as a hazardous waste because it is ignitable and toxic. Waste gasoline is gasoline that has been mixed with water or other products or is too old to be used. The U.S. Environmental Protection Agency (EPA) enforces specific rules for disposal, which include a limited time of storage, hiring a licensed transport hauler, and a detailed shipping manifest to be submitted to environmental authorities. The EPA warns that one gallon of waste gasoline can pollute 750,000 gallons of water.

reduction can be seen in short time frames (such as weeks or months). Although many of the chemical oxidants have been used in wastewater treatment for years, only recently have they been used to treat hydrocarbon-contaminated groundwater and soil in-situ. This process can also result in the indirect decrease of petroleum contamination by increasing the dissolved oxygen content in groundwater, which enhances biodegradation.

The oxidant (such as hydrogen peroxide) reacts with the contaminant causing decomposition of the contaminant and the production of relatively-innocuous substances such as carbon dioxide and water. Carbon in the form of organic carbon and manufactured hydrocarbons are common substances readily oxidized (reductants). For ISCO to effectively reduce contaminant concentrations, contact between the oxidant and the contaminant must be direct.

In case of a relatively contained and small spill, mechanical removal of contaminated soil is carried out by excavating visible contamination, screening the excavation site for hot spots with a photo ionization device, and then taking confirmation samples to show that the contaminated soil has been removed. Samples for gasoline spills should be analyzed for pollutants.

Waste Gasoline

An important source of pollution is waste gasoline. This is gasoline that has been mixed with water or other products or is too old to be used. In those cases, waste fuel has to be managed as a hazardous waste because it is both ignitable and toxic. Hazardous wastes must be managed on-site and disposed of by following specific EPA rules. Those rules include a secure custody chain "from cradle to grave," a limited time of storage depending

upon the amount of waste, hiring a licensed hauler to transport the waste gasoline off the site, and a detailed shipping manifest to be submitted to environmental authorities.

Whenever burned in engines, gasoline poses a number of risks for health. Lead pollution from automobile exhaust is expelled into the air and is easily inhaled. Tetraethyl lead (TEL) was widely used as an antiknock agent and to increase the fuel's octane rating until the 1970s. Concerns about health effects eventually led to the ban on TEL in automobile gasoline in many countries.

Lead is a toxic metal that accumulates and has subtle and insidious neurotoxic effects, such as low IQ and antisocial behavior, even at low exposure levels. It has particularly harmful effects on children. The EPA issued standards in 1973 that called for a gradual phase-down of lead to reduce the health risks from lead emissions from gasoline, culminating in the Clean Air Act Amendments of 1990 and EPA regulations banning lead in motor vehicle gasoline after 1995.

Beginning January 1, 1996, the U.S. Clean Air Act prohibited the sale of leaded fuel for use in on-road vehicles. Possession and use of leaded gasoline in a regular on-road vehicle carries a maximum $10,000 fine. However, fuel containing lead is authorized for off-road uses, including aircraft, racing cars, farm equipment, and marine engines.

Benzene, an aromatic hydrocarbon used as a gasoline additive to increase the octane rating and reduce knocking, is carcinogenic. Gasoline contained high proportions of benzene before the 1950s, when tetraethyl lead replaced it as the most widely used antiknock additive.

With the prohibition of leaded gasoline in the 1970s, benzene returned as a gasoline additive in some nations. In the United States, concern over its negative health effects and the possibility of benzene entering the groundwater have led to strict regulation of gasoline's benzene content, with limits typically around 1 percent. The EPA issued new regulations to lower the benzene content in gasoline to 0.62 percent by 2011.

Toluene, another carcinogenic, aromatic hydrocarbon can be used as an octane booster in gasoline fuels. Inhalation of toluene may irritate the upper respiratory tract. Overexposure can be associated with fatigue, confusion, headache, dizziness, and drowsiness. Peculiar skin sensations (such as pins and needles) or numbness may occur. Very high concentrations may cause unconsciousness and death.

Studies suggest that the amount of gasoline that evaporates from an automobile's fuel system when the vehicle is being used on a hot day may be 5–25 times greater than the amount of unburned gasoline that is permitted to escape in exhaust. The "running losses" may amount to 2–10 grams per mile, compared to 0.41 grams out the tailpipe. Ten grams of gasoline is about half a liquid ounce. Beginning in 1989, the EPA required gasoline to meet volatility standards to decrease evaporative emissions of gasoline in the summer months when ozone levels are typically at their highest.

According to the EPA, regulations require that each manufacturer or importer of gasoline, diesel fuel, or a fuel additive have its product registered prior to its introduction into commerce. In some cases, the EPA requires testing of these fuels and fuel additives for possible health effects. The EPA also requires that gasoline contain a certified detergent in order to reduce emissions.

In the early 1990s, the EPA began monitoring the winter oxygenated fuels program implemented by the states to help control emissions of carbon monoxide during the winter months and established the reformulated gasoline (RFG) program to reduce emissions of smog-forming and toxic pollutants. The EPA promulgated new regulations, setting standards for gasoline performance levels and for low-sulfur gasoline to reduce harmful air pollution and help ensure the effectiveness of advanced emission control technologies in vehicles.

A source of pollution is the fuel filter used in the fuel line that screens out dirt and rust particles from the fuel. These are normally made into cartridges containing a filter paper. Trace impurities in the gasoline and other incomplete combustion products contribute to the emission of volatile organic compounds (VOCs). In 1995, nine metropolitan areas in the United States were required to switch to reformulated gasolines (RFGs) for VOC controls. RFG requirements resulted in limits on benzene, sulfur, and aromatics to achieve reductions in VOCs, nitrogen oxides, and toxic emissions. In addition, oxygen content of at least 2 percent by

weight was required to improve cold-start emissions from older cars.

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See Also: Automobiles; Car Washing; Emissions; Engine Oil; Fuel; Tires.

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Georgia

Established in 1732, last of the original 13 colonies, Georgia was also one of the original Confederate states and the last state to be restored to the Union. The ninth most populous state, in 2007–08, Georgia had 14 of the nation's 100 fastest-growing counties. The capital, Atlanta, is the largest city and metropolitan area, and it is a major center in both the state and the southeastern United States as a hub of communications, industry, transport, tourism, and government. The agricultural and industrial economy of Georgia is diverse; many corporations (including Coca-Cola, Home Depot, and UPS) have their headquarters in Georgia, including 15 Fortune 500 companies and 26 Fortune 100 companies.

Georgia has one of the nation's highest electricity generation and consumption rates, the industrial sector being the chief energy consumer. While industry is a heavy consumer of electricity due to energy-intensive wood and paper product manufacturing, Georgia is also one of the nation's top producers of power from wood and wood waste.

The 16th Nationwide Survey of MSW Management in the United States found that, in 2005, Georgia had an estimated 11,549,889 tons of municipal solid waste (MSW) generation, placing it 13th in a survey of the 50 states and the capital district. Based on a population of 9,342,080, an estimated 1.24 tons of MSW were generated per person per year (ranking 26th). The state landfilled 7,195,075 tons (ranking 12th) in the state's 56 landfills, a figure that includes 1,738,964 imported tons. The state sent 81,535 tons (ranking 23rd) to its waste-to-energy (WTE) facility and was the only state to not report its recycled MSW tonnage.

In 2006, Georgia had 429,202,431 cubic yards of landfill remaining and was increasing its capacity; it was ranked seventh out of 44 respondent states for number of landfills. Whole tires, used oil, and lead-acid batteries were reported as banned from Georgia landfills, with yard waste banned from landfills built to Subtitle D specifications. Georgia is ranked seventh in the United States for number of landfills.

History of Waste Disposal

Georgian archaeology has engaged in detail with waste disposal on historical sites, even at the farmstead level. It is known that farmyards were swept frequently, especially on African American farms, and that this contributed to sheet midden forming around the yard's rear edges. Trash disposal is one of the key archaeological features of farm life, and Georgian archaeologists were able to apply the four patterns of disposal defined at Finch Farm, South Carolina, to Georgian farmsteads. These four patterns are (1) the Brunswick Pattern, refuse accumulating around the structures' rear doors, (2) accumulation of rear yard sheet midden, (3) the Piedmont Pattern, throwing trash down gulleys and ravines found near the farmsteads, and (4) the widespread practice of open burning.

The four patterns are thought to have followed each other to some extent. Sheet midden (late 18th and 19th centuries) shows a more hygienic approach than the Brunswick Pattern (18th century). The Piedmont Pattern (19th century) is seen as a response to erosion and the increasing use of disposable glass, which had to be discarded away from trampling hooves and feet. Open burning is thought to be contemporary with the Piedmont Pattern and reflects the growing use of paper packaging and changing attitudes toward household waste disposal.

As urban centers developed (in Georgia, every incorporated town is a city, regardless of size), informal and formal dumps were adopted. As the cities grew, they developed municipal garbage collection and disposal, some in the late 19th century and all by the mid-20th century. Two dumps in the Atlanta area dating from this period have been archaeologically investigated: Edgewood and Maddox Park.

Edgewood Dump, on the outskirts of Atlanta, is a ravine infilled with rubbish in the space of a few years up to ca. 1911, when a house was built on the same spot. Partial excavation produced an assemblage of 522 whole bottles that were used to study the time lag in bottle use (time elapsed between manufacture and disposal). Paradoxically, the greatest lag was in bottles produced for fresh beverages, probably because the bottles were recycled after their original contents had been used. Beer also had a long lag for which there was no apparent explanation. Long time lags in medicine and wine bottles were expected, as there was no necessity for prompt consumption.

As a whole assemblage, the Edgewood Dump bottles had a longer time lag deposition than three comparable dump sites, possibly because of the lower socioeconomic status of the Edgewood community. Analysis of ceramics and faunal remains from the site were also carried out.

Maddox Park was Atlanta's "Sanitary Dumping Ground" from 1884 to 1910, and the report is considered an outstanding study in the development of municipal garbage collection in Atlanta as well as in garbage collection and disposal technology. The site was eligible for National Register of Historic Places nomination, but no further work was required in this case, which involved a proposed rail line.

Hercules 009

The Hercules 009 Landfill is one of the best-known Superfund sites and is an example of one of the scheme's successes. The federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) allows the government to police and clean up toxic waste sites. As of 2010, Georgia had 15 Superfund sites, which are placed on the National Priority List (NPL); four sites have previously been cleaned up and delisted.

Hercules Incorporated chemical manufacturing site, near Brunswick, Glynn County, is a 16.5-acre facility and was granted a permit in 1975 to dispose of contaminated waste from manufacture of the agricultural pesticide toxaphene. Seven acres at the northern end of the site were turned into six 100–200-foot-wide by 400-foot-long cells, which have become known as the Hercules 009 Landfill. These cells were reportedly lined with a soil-bentonite clay mixture. Produced by Hercules since 1948, toxaphene was one of the most heavily used insecticides in the United States until 1982, when the Environmental Protection Agency (EPA) canceled its registration; by 1990, it was banned completely. The Hercules 009 Landfill was used between 1975 and 1980 to dispose of toxaphene-contaminated sludge, empty drums, glassware, rubble, and trash.

In 1980, state investigation showed that toxaphene in soil and water samples from drainage ditches around the site had reached unacceptable levels (15,000 ppm) and the landfill permit was revoked. The landfill was closed by 1983. In 1984, the EPA added Hercules 009 to the Superfund NPL. The threat of groundwater from the landfill flowing into private drinking-water wells was countered by connecting some properties to the Brunswick municipal supply in 1991. Toxaphene was detected in front yards of nearby residences in 1992; these homes were evacuated while the contaminated soil was excavated and replaced. A record of decision (ROD) for the site cleanup operation was put in place in 1993. The remedial work was designed and implemented by Hercules Incorporated.

The landfill was treated by remediation contractors using in situ methods. Contaminated soil from outside the landfill was also treated onsite and used to cap the landfill. The remediation included solidification/stabilization (S/S) treatment using Portland cement as a binding agent mixed into the contaminated waste to immobilize and physically or chemically alter hazardous constituents. The EPA upholds S/S treatment as the Best Demonstrated Available Technology (BDAT) for a range of hazardous wastes listed in the Resource Conservation and Recovery Act (RCRA). Breakthrough mixing techniques have been developed and applied at full-scale U.S. remediation projects, and these have made a large contribution to the

adaptability of S/S technology, which can be used in situ or ex situ.

At Hercules 009, 15 percent Portland cement by weight was added to the landfill contents using an excavator with attachments to mix dry cement into the in situ–contaminated deposits. Up to six 25-by-25-feet subcells could be treated at once with this method. Horizontal rotary mixers and deep-soil mixing augers can also be used for this purpose. The treated depth penetrated beyond the sludge zone in the bottom of the landfill and in most subcells into the regional groundwater table; 67,394 cubic meters (88,148 cubic yards) were reported as being treated. Post-treatment testing showed that a compressive strength exceeding the 50 psi specification was reached within three to five days, and Toxicity Characteristic Leaching Procedure (TCLP) testing showed no toxaphene present in the leachate. The site was regarded and revegetated following remediation, which could be considered "green remediation," as the improved construction properties of the treated matrix allowed reuse, and in situ treatment avoided 5,000 dump truck round-trips.

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See Also: Beverages; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Dating of Garbage Deposition; Pesticides.

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Germ Theory of Disease

The germ theory of disease evolved in the latter half of the 19th century. This fundamentally new understanding of infectious diseases became accepted with vital results for the health of humankind. The theory is anchored in the independent research of Louis Pasteur (1861) and Robert Koch (1862–63), although bacteria were discovered in 1675.

Louis Pasteur found microbes to be behind the fermentation of sugar into alcohol and the souring of milk and developed a heat treatment (pasteurization) that killed microorganisms in milk, which then no longer transmitted tuberculosis or typhoid. Pasteur also developed new vaccines against such infections as anthrax and rabies. His work on fermentation from the 1860s became familiar to Joseph Lister, who introduced antiseptic techniques in hospitals with the crucial positive result of decreasing the spread of infection and resultant mortality.

Another great success in bacteriology and human disease in the late 19th century was achieved by Robert Koch thanks to his implacable belief that germs cause diseases and to his almost superhuman tenacity. In two consecutive years (1882–83), he identified the bacteria that cause tuberculosis and cholera, respectively. Koch and his students opened the door for the golden age of microbiology. Four fundamental postulates about microorganisms were published in 1890; they are partially true from the perspective of later knowledge.

There were many famous scientists and social activists who did not accept germ theory, initially, or at all. Rudolf Virchow (1821–1902) denied its validity for most of his life. Florence Nightingale ridiculed the idea of germs until her death in 1910. However, in 1886, the theory entered the leading American pediatric textbook by Job Lewis Smith (1827–97) in which Koch's research on the tubercle bacillus was named the most brilliant discovery of the last decade.

Toward the end of the 19th century, the growing world of microbes included discoveries by

Louis Pasteur found that microorganisms in wine were responsible for spoilage and developed a unique heating technique to prevent the process. He applied his findings to raw milk, which stopped the transmission of tuberculosis and typhoid.

Dmitri Ivanowski (1892), and Martinus Beijerinck (1898), who revealed tiny infectious agents ("filtrable viruses") that were too small to be seen with the conventional microscope and could pass through bacteria-stopping filters. In 1928, Sir Alexander Fleming discovered penicillin.

Both the miasma and germ theories of disease causation stimulated an expansion of the policy of increasing personal, surgical, and public hygiene in Europe and the United States in the late 19th to early 20th centuries. Germ theory's preventive health innovation included protective inoculations.

Reassessment

Koch's postulates were reproduced decade after decade as a traditional belief that living microorganisms cause infection and contagious disease. However, in 1972, Stanley Prusiner identified a protein as an infectious agent. It was labeled a *prion*, a term derived from PRotein Infection ONly, for which he received the Nobel Prize. Recognition of transmissible disease mediated by a misfolded version of a normal cellular protein that is not associated with a microbe or nucleic acid is revolutionary. It modifies the germ theory of disease since it adds a new cause of disease.

Important Dates

- 1546—Girolamo Fracastoro (1478–1553) proposed that *seminaria contagiosa* could infect people three ways: by direct contact, through contaminated food or clothing, or through the air.
- 1675—Antonie van Leeuwenhoek (1632–1723), the father of microbiology, saw bacteria under his microscope. Van Leeuwenhoek did not author any books, although he did write many letters.
- 1846—Ignaz Semmelweis (1818–65) concluded some unknown "cadaverous material" caused childbed fever.
- 1861—"Experiments and New Views on the Nature of Fermentations," *Comptes Rendus,* v.52, in French) by Louis Pasteur (1822–95).
- 1882–83—Robert Koch (1843–1910) identified the bacteria that cause tuberculosis and cholera.
- 1867—"Antiseptic Principle of the Practice of Surgery," *British Medical Journal*, v.2299) by Joseph Lister (1827–1912).
- 1868—*Studies on Tuberculosis* (Paris, in French) by Jean-Antoine Villemin (1827–92).
- 1886—*A Treatise of the Disease of Infancy and Childhood*, 6th ed. (1827–97).
- 1928—Sir Alexander Fleming (1881–1955) discovered penicillin.

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See Also: Bubonic Plague; Hospitals; Medical Waste; Miasma Theory of Disease; Microorganisms; Public Health.

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Germany

Germany is one of the largest industrial powers on Earth; by 2010 it was the most populous member state of the European Union, with over 80 million people. As with other industrialized societies, Germany experienced a first "modern waste crisis" at the end of the 19th century in its cities. Because of exploding population figures and new consumption patterns in urban areas, the wasting practices of town dwellers began to substantially change over time. Toward the end of the 19th century and in a further effort of urban sanitation, larger cities such as Berlin, Munich, Frankfurt, and Hamburg installed municipal waste collection services and, with it, the compulsory domestic trash bin. The municipal disposal services, for which Prussian cities had imposed a tax since 1893, gradually put an end to the traditional backyard fosses in which leftovers were ditched. It also eliminated informal evacuation by local traders or farmers, who had retrieved the urban waste as manure.

Early 20th Century

During the first half of the 20th century, waste remained an urban hygienic problem. The waste's content consisted mainly of ashes, sweepings, and leftovers, with heavy seasonal and regional variations because of particular eating and heating patterns. Local regulations, combined with a transnational knowledge transfer among European cities, dominated waste treatment, while collecting and disposal technologies differed from city to city. Albeit such disparities, the simple dumping of waste in the urban periphery was omnipresent. Waste was used for landscaping, to create hills, gain land, or for soil amelioration. A special form of this was "waste flushing" (*Müllspülung*), practiced in the 1930s in the outskirts of Berlin. Evacuated by barks, the waste was applied on surrounding wetlands with the help of water and pumps.

In 1896, Hamburg, which had just undergone a cholera epidemic, was the first German city to implement (British) incineration technology. In general, German cities were eager to introduce the hermetic collection system, which meant that bins were equipped with lids and fitted the notches of the collection vehicles so that nearly no dust (identified as the main peril to hygiene) would escape.

In the pre–World War I era, it was assumed that an urban dweller produced about one liter of waste (or half a kilogram) per day. The waste was collected two or three times a week. Some rare cities such as Potsdam and Charlottenburg, experimented with a separate collection, as it was known in U.S. cities: edible waste and scrap (such as leather, paper, textiles, or rags) were evacuated separately in order to feed swine or to sell the scrap to scavengers. In Munich, the urbanites' waste traversed a separation facility, where scrap materials were sorted out manually. Scrap materials were rarely dumped but instead were reused or recuperated by ragmen since they had an economic value in the scavengers' trade.

World Wars

World War I, the crisis of the 1920s, Nazi politics, and World War II reinforced such cultures of thrift and turned the recovery of secondary materials into an issue of patriotism and national politics. Beginning in1914, some cities recovered leftovers for hog feeding, often supported by women's organizations. In 1916, any city with more than 40,000 people was officially obliged to separately collect edible waste, which would compensate for the deficit in foodstuffs. In addition, because of the shrinking calorific value of waste, incineration plants were shut down.

The national socialist regime saw the systematic collection of scrap as a way to meet requirements of economic self-sufficiency and its policy of rearmament. From the mid-1930s onward, the regime thus restructured the system of scrap collection in an overly bureaucratic way.

Moreover, a large number of scrap chandlers were forced out of the business because of their Jewish background. The new policy allocated certain districts to each scrap collector and stipulated a collection from private households on certain days. Dwellers were increasingly disciplined, as material became scarcer during the later years of the war.

For a number of years, the national socialist party had already propagandized the collection of scrap as a national duty and it had carried out collections through its organizations, such as the Hitler Youth. After 1939, however, the police were legally allowed to inspect the obligatory collection of specifically leftover foodstuffs and fine contempt. With regard to recycled material, the system was not entirely successful. Specifically, for the collected scrap paper, buyers could often not be found. Only scrap metal and rags always found customers.

Cold War Era

The communist German Democratic Republic (GDR) in many regards enforced a very similar policy as the national socialist regime. The collection of scrap material was seen as a national duty because of material scarcity. The mass organizations conducted public collections of scrap, and people were disciplined through a semipublic collection system within the apartment building community. The system also differed in many ways. The separate collection of different waste fractions for recycling was not a legally imposed obligation for households.

Instead, the system worked with economic incentives, such as exchange of scrap for new products or money. Most importantly, collection and recycling were gradually socialized until the early 1970s. In practice, this meant that both collection and recycling of scrap from industry and households were organized by governmental institutions according to the five-year plan. In a sense, the production of waste thus needed to be planned in advance, not unlike it is done in the 21st century by microeconomic materials management that has integrated waste as both a cost and a potential material resource. The statistics of the plan, which need to be treated with care, indicate that until the late 1970s, the GDR collected a higher rate of (household) scrap per capita than West Germany. This early implementation of a large-scale recycling system is one of the reasons why, after the fall of the Berlin Wall, many people regretted its fast disappearance.

The GDR thus had a somewhat exemplary role with regard to recycling, which West Germany, however, never copied and only studied briefly in the 1990s. In contrast, the GDR was particularly known in the West for its slack but nevertheless proclaimed environmental policy since the early 1970s. This included the import of industrial and household waste from West Germany, particularly from West Berlin, as well as from the rest of western Europe. The operation of the landfill Schönberg/Ihlenberg became known with this respect after the *Wende*, for imported toxic wastes had been disposed of for years without any kind of sealing.

In West Germany, the recuperation of waste materials still had its place in the mid-1950s, and even composting experienced some governmental funding. Dumping, however, dominated waste disposal, since both financial support and any public awareness on disposal methods were lacking. In the 1960s, about one-fifth of municipal waste was incinerated, only a few percent was composted, and the rest was dumped in unregulated landfills. At this time, West Germany had fully turned into a mass consumer society, and its consumers produced new waste fractions such as junk cars, bulky refuse, plastics, and packaging (the one-way glass bottle,

soon followed by the plastic bottle, were introduced in the 1960s).

More packaging, an increased paper consumption, and the deprivation of private hearths (which once had absorbed a substantial allotment of household waste) led to an alarming rise in municipal waste volumes and to the notion of an impending "waste avalanche" (*Müllawine*). The subsequent need for higher disposal capacities, a scarcity of tips, and the first legislation on water protection resulted in a growing awareness of the waste problem that soon would be reframed as an environmental problem.

In the 1960s, incineration had a resurgence despite technical and gas emission problems due to plastic waste. In the following decade, landfills were steadily regulated. In 1972, West Germany issued its first Waste Management Act, followed three years later by a comprehensive program to restructure the waste business. Since then, there has been a growing effort in West Germany's national politics toward recycling, influenced by citizens' initiatives that called for a separate collection of glass and paper.

In the 1980s, private disposal contractors increasingly entered the waste market via the field of salvage materials. In 1986, a law on the avoidance and removal of wastes came into force as an amendment to the 1972 waste law. It tried to institutionalize a new hierarchy in the consumption-wasting cycle, namely, to avoid waste in first place, recycle it in second place, and dispose of it only in third place.

1990s and Beyond

In 1991, the packaging ordinance was issued, which has been continuously revised. It aimed at using less packaging and at recycling. In 1996, the German law *Kreislauf- und Abfallwirtschaftsgesetz* was implemented. This law can be considered a milestone for Germany's garbage policy because it merged partly conflicting laws. In practice, the 1996 Waste Act furthered the systematic dealing with waste produced on a massive scale in consumer society, mainly by regulating both its recycling and disposal.

Furthermore, since officials and companies had only slackly considered prior laws, a range of measurements for controlling the disposal system were implemented. Since 1996, the law was at various points adapted to and supplemented by legislation of the European Union. In Germany, major adaptations concerned the regulation of waste disposal in landfills, the implementation of the polluter pays principle with respect to electronic scrap, the export/import of waste and the regulation of waste disposal from mining.

When compared to other European states, Germany's waste system was not more advanced or more hygienic or "sustainable" than, for example, the British system before the 1970s. Only through legislation since then and the citizens' rising environmental awareness did (West) Germany achieve high recycling numbers. In this respect, the GDR can be considered a forerunner that implemented a system of recycling on a national scale. In the 21st century, Germany, together with countries such as Belgium, Sweden, and Austria, leads in respect to the waste amounts that are either recycled or composted.

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See Also: Culture, Values, and Garbage; Recycling; Social Sensibility.

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Gillette, King C.

Widely praised or blamed as the entrepreneur who inaugurated throwaway products, as a utopian socialist reformer, King Camp Gillette (1855–1932) spent his life excoriating capitalism's inequalities and the inefficiencies of competition. Published a decade before the patent for disposable razor blades, Gillette's 1894 book *The Human Drift* dreamed up a vast hydropowered megalopolis that would consolidate U.S. urban populations and industrial production. His experiences running the Gillette Safety Razor Company informed later monographs advocating the establishment of a single, publicly owned corporation that would produce and distribute the entirety of humanity's material needs, putting an end to war and social inequality. Gillette's business practices and socialist advocacy were both marked by a materialist pragmatism riveted on exploiting possibilities of efficiency and waste inherent in commodity chains and industrial systems.

Gillette was born in Fond du Lac, Wisconsin, and raised in Chicago, Illinois. His father worked as a patent agent after the fire of 1871 destroyed his hardware store, and young Gillette became a traveling salesman. His mother published a celebrated cookbook that perhaps inspired Gillette's lifelong preoccupation with writing. Despite financial success from his razor empire, Gillette was nearly bankrupt at the time of his death in the midst of the Great Depression.

Disposable Products

In 1895, Gillette envisioned his namesake invention while shaving with a straightedge razor. It had grown too dull to be stropped and needed honing at a barbershop. He picked up the concept of repeat-purchase disposable products in the 1890s as a salesman of William Painter' s patented Crown Cork bottle-capping system. Working with MIT graduate William Emery Nickerson, Gillette spent a decade developing thin, stamped steel blades before patenting his safety razor kit in November 1904. The product embodied ideals of genteel masculinity, cleanliness, convenience, and independence (from barbershops) while getting consumers used to planned obsolescence (manufactured objects designed to wear out and throw away). Although the blade opened the doors for all manner of disposable products, it was not the first. In 1810, Nicolas Appert innovated canning methods for the Napoleonic army's long marches that inspired Peter Durand's tin can the same year; following the success of Painter's 1892 bottle caps, Johnson & Johnson's menstrual pads were first marketed in 1896.

Now celebrated as a mythical entrepreneur, Gillette's "freebie marketing" or "razor and blades" business model of inexpensively mass-produced disposable parts earned him a fortune. With global distribution networks and production facilities in France, Germany, and England, Gillette's face, integrated into packaging design, became internationally known. A World War I government contract for 3.5 million razors and 32 million blades issued as "khaki sets" introduced a generation of men to Gillette's product. Little piles of rusty blades can still be found beneath houses built between the world wars that included small slots in bathroom walls for the safe disposal of spent razors. However, the reuse of spent razors through steel recycling does not figure into the invention's history.

Efficiency

While the success of his invention depended on waste and disposability, as a utopian socialist reformer, Gillette was obsessed with efficiency. *The Human Drift* advocated the centralization of U.S. cities and industrial production in a single, master-planned urban core called Metropolis to be located between Lake Erie and Lake Ontario and powered by Niagara Falls. Centralization would eliminate waste involved in continent-wide distribution networks while streamlining the production of life's necessities: food, clothing, and shelter. Gillette's Metropolis consisted of a honeycomb pattern of circular 25-story apartment complexes covered by glass domes. The gridded layout and prevalence of greenhouses anticipated both Ebenezer Howard's Garden Cities (1898) and Le Corbusier's Ville Radieuse (1924). Subterranean layers provided for sewerage, transportation, and food distribution. Metropolis would be the hub of a "United Company" (later called "the People's Corporation") that would outcompete capitalism through superior efficiency. Gillette conceived of the incorporated city as an enormous machine respon-

sible for producing and distributing not only life's necessities but also individuals.

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See Also: Consumerism; Disposable Diapers; Disposable Plates and Plastic Implements; Steel.

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Gluttony

The word *gluttony* has especially Eurocentric origins; the Latin *gula*, meaning "throat" or "eating to excess"; *gluttire*, meaning "to swallow" or "gulp down"; and the 12th-century Middle English glotonie or glutonie, which refer most directly to the practice of eating or drinking in excess and in such a manner as to lose control of one's mental and physical faculties, or in fact to do great harm to the body. To eat or drink simply for the pleasure of the experience, or to withhold food from those who are in dire need of it, is also considered gluttonous. The term is inextricably related to social and political relations, religion, and spiritual practices—especially those of Christianity. Views on gluttony also reflect ever-changing ideas about discipline, the body, and the ethics of pleasure.

Ancient Greece and Rome

In the ancient Western world, Greeks and Romans embraced polytheistic mythologies and pantheons of gods that embodied complex matrices of social relations, rituals, and stories of origin. The Roman Empire was especially invested in ritual events that fostered a sense of duty and loyalty to the state and the emperor, who was in many ways a human extension of the deities. Religious festivals honoring the gods were often extravagant, public events that provided an occasion for the norms of society to be temporarily suspended, and participants were encouraged to indulge in the excesses of food, drink, dance, and all manner of conviviality. These traditional belief systems and pagan practices stood in sharp contrast to the emergent tenets of Christianity.

Early Christians

Romans generally combined elements of other belief systems—most notably that of the Greeks—into their religious practice. However, early Christian theologians openly condemned and directly refuted the festive celebrations integral to Roman religious expression. Monks, communities of men devoted to the ascetic practices of various Christian religious orders, vowed to live somewhat apart from the secular world and its trappings and relinquished any claim to worldly goods. In their earliest recorded writings, Christian monastic leaders advocated more temperate, contemplative acts of devotion, modeled after the example of the martyred Jesus Christ, whom they recognized as the only son of a singular and omnipotent God. The vices of gluttony permeated the writings of Christian monks as early as the 4th century.

During the 3rd century, the Roman government aggressively persecuted Christian extremists on the grounds that their teachings challenged the authority of the state and disrupted society. Christian worship rituals such as communion, which called for the symbolic consumption of the body and blood of Christ, were largely misunderstood and viewed with great skepticism. The average Roman also may have felt that Christian forms of devotion angered the ancient Gods and had the potential to threaten the balance of nature. Their fears sporadically materialized in the form of threats and violence against Christian practitioners; as a result, significant numbers of Christians fled Rome, seeking safety in the far reaches of the empire. Those who settled in Egypt near the Nile Delta subsisted on little sleep or food, solitary work, prayer, and meditation. Their primary objective was to follow a strict interpretation of Christ's teachings without seeking public recognition or validation of their efforts.

Writing mostly to direct their fellow brethren on the path of spiritual enlightenment through personal acts of sacrifice and prayer, monastic

theologians issued lengthy treatises on ascetic practices to counter the indulgences of the flesh. A number of scholars trace formative uses of the term *gluttony* to Evagrious of Pontus, known as one of the "Desert Fathers" or "Desert Monks" of Egypt. At the time of Evagrious's writings, Egypt was an occupied territory of the Roman Empire and its main supplier of grain. The scribe dedicated the first of eight chapters in his brief treatise: "The Eight Spirits of Wickedness," to gluttony, which he characterizes as an "evil thought" that must be contemplated and combated. In his later treatise: "On the Vices Opposed to the Virtues," addressed to the monk Eulogios, Evagrious encourages his brother to combat the evil of gluttony with its antithetical virtue, abstinence.

John of Cassius further expanded the Desert Fathers' writings on gluttony in the voluminous work known as *De institutis coenobiorum* (The Institutions). In books 5–12, John issues rules on morality to help those in monastic life navigate the ethical terrain of the eight principal faults, which he lists as gluttony, fornication, avarice, anger, dejection, weariness of heart, vainglory, and pride. In Book V: Of The Spirit of Gluttony, John counsels his brethren to reference Egyptian customs and traditions as models of discipline and self-control as they prepare to do battle with the "pleasures of the palate."

He suggests that gluttonous desires can be overcome through a methodically enacted combination of fasting, participating in vigils, reading, and mentally disciplining oneself to think of food as a bodily necessity and not a pleasurable concession. He offers practical and spiritual guidance, noting that a one-size-fits-all approach does not adequately accommodate physical differences, such as health and age, which can impact individuals' capacities for restraint. Likewise, he advises those seeking to guard themselves against gluttonous impulses to be mindful of not only how much food they consume but also to guard against eating luxurious or indulgent meals, as both in his opinion have the ability to "dull the keenness of the mind."

Deadly Sin

During the 6th century, Pope Gregory the Great included gluttony among the Seven Deadly Sins, which he ranks in order of increasing severity and identifies as the crux of all other sins: pride, envy, gluttony, lust, anger, greed, and sloth. While food and drink in and of themselves are neither good nor bad, the act of indulging in them is, in Gregory's estimation, the sinful element of the vice. Citing biblical examples of resistance to gluttony (Adam resists the devil's temptation to eat of the tree of knowledge; Christ does not yield to the devil's temptation when he is fasting in the wilderness), Gregory closely aligns the sin of gluttony with the sin of lust, noting Adam's eventual act of eating the forbidden fruit after being tempted by his wife, Eve. In his opinion, the sinful nature of gluttony is its predilection toward excess in all forms.

For Gregory, gluttony poses a threat to one's spiritual balance in a number of ways; no good can come of wanting any food—especially if it is extravagant, expensive, elaborately prepared, served in an unnecessarily generous proportion, sought after too much, or eaten out of wanton desire, rather than bodily need.

Later theologians proposed the Seven Heavenly Virtues as foils to counter these vices; in this formulation, temperance—the notion of restraint and delayed gratification—serves as a counterpoint to gluttony. When Gregory sent the monk Augustine to lead a Roman mission to Kent to convert the pagan Anglo-Saxons to Christianity, Augustine, who would later become the first archibishop of Canterbury, continued to consult the pope on matters of temperance as he advised the newly converted in spiritual matters.

The Seven Deadly Sins and Heavenly Virtues figure prominently in medieval philosophy, theology, art, literature, and everyday religious life. Thomas Aquinas equates the inordinate and irrational desire for food with spiritual depravity and takes great pains to distinguish between the innate biological or "natural" need to eat for sustenance and the desire to eat for pleasure, condemning the latter. Throughout the Middle Ages, religious canon laws designated certain days for ritual fasting—reverent occasions of personal sacrifice during which all Roman Catholics were to abstain from sex and meat ingestion. These "lean days" initially included all Fridays, the 40 days of Lent, the days before feast days (known as vigils), and other religious observances, which equated to more than half of the days of the year.

Gluttony

From the 12th through the 14th centuries, the notion of enjoying one's food too much was considered especially gluttonous. As a result, poorer people steeled themselves against the pleasures of the plate, whereas affluent folk unapologetically indulged in considerably more lavish meals. During this era, the glutton became an archetype of sorts, alternately personified by a pig or a corpulent man stuffing himself to the point of delirium and incontinence.

The Pardoner introduces readers to all manner of gluttonous consumption in the prologue to Chaucer's *Canterbury Tales*; a three-headed monster terrorizes the gluttons relegated to the muddy grounds that comprise the third circle of hell in Dante's *Inferno*. Conversely, the chivalrous knight and the virtuous woman emerged as models of temperance in literary and visual arts. Never greedy or drunk, the knight embodied all that is fair and just. In a similar fashion, the image of a woman pouring water from a pitcher became a popular illustration of the virtue of temperance.

In the 21st century, gluttony continues to yield insights into beliefs and attitudes about health, body image, and other cultural markers. Unlike the medieval glutton, a modern-day obese person may simply eat too much of the wrong foods and lack exercise.

Renaissance

A number of scholars have compellingly argued that attitudes toward gluttony began to undergo a significant transformation as a result of the shift in thinking inspired by the humanist movement during the Italian Renaissance, which began in Florence and emanated throughout Europe. Humanist thinkers took a renewed interest in the pagan classics and rituals of ancient Greek and Rome as models for how to live an ethical and fulfilling life. Renaissance art became more lifelike and engaged pleasurable themes and aesthetic practices; food was considered among these.

As the Renaissance spread, so did revolutionary changes to cuisines throughout Europe. When the adolescent Italian princess Catherine de Médicis came to Paris as the wife of King Henry II, she brought with her an entourage of Florentine cooks, expertly trained in the fine arts of Renaissance cooking. A number of French soups, sauces, and other culinary delicacies are attributed to the Italians. Catherine also brought with her to the French table a manner of refined aesthetic sensibilities, which served to enhance the dining experience. Under her hospitality, "ladies," who except for special occasions previously had dined in private, were admitted to the royal court on a regular basis. Décor and table settings were meticulously fashioned and selected by artists, and beverages were served in fine Venetian crystal stemware. Meals were served and eaten from artfully glazed dishes especially crafted for the occasion. During the medieval era, such an elaborate manner of dining would have been considered gluttonous.

Modern Conceptions

In a similar fashion, the technological innovations of the Industrial Revolution and 18th-century rationalism are credited for refocusing attention from

the heavenly realm to that of the more immediate materialism of the lived experience. Throughout history, class differences, not religious edicts, often determined who ate what.

Landless agricultural workers in the Old World often raised crops for export or for the upper classes; poor laborers usually had limited control of and access to provisions for personal consumption. Poor Europeans often relied upon the benevolence of some of their more affluent countrymen to put food on their tables.

However, it was not until 1962 that progressive bishops acting on behalf of their local constituencies earned the right to modify rules of fast and abstention for Catholics in their dioceses. A combination of Vatican II Council reforms and the 1966 Apostolic Constitution Paenitemini of Pope Paul VI on fast and abstinence further relaxed the strict Roman Catholic fasting and abstinence requirements according to local social and political conditions.

In the 21st century, gluttony continues to yield fruitful insights into beliefs and attitudes about health, body image, and other cultural markers of identity, such as race, class status, gender, and nationality. Those who are obese do not necessarily fit the image of the medieval glutton; they may not necessarily be obsessed with food but may simply eat too much of the wrong kinds of foods and not get enough exercise.

Likewise, those with compulsive eating disorders may obsess about food not because their souls are bereft but because of deep-seated emotional and psychological turmoil. In some cultures, the corpulent body is both a sign of wealth and a marker of social obligation to those in need. Fascist dictators, drug lords, and corporate "fat cats" perhaps embody the image of the modern glutton—those who have more than what they need have acquired it at the expense of those who do not have enough, and appear to be wasteful in their consumption habits.

Not unlike ancient engagements with the concept, gluttony remains a source of fodder for philosophical, religious, and artistic musings.

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See Also: Consumption Patterns; Culture, Values, and Garbage; Food Consumption; Garbage, Minimalism, and Religion.

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Goodwill Industries

Goodwill Industries is a network of 180 affiliated organizations in the United States, Canada, and other nations, organized under Goodwill Industries International, Inc. Its mission is to provide employment opportunities to those who have disabilities, have a lack of education or job experience, or face other challenges. Throughout its history, Goodwill has defined its social role as far greater than the trade in used goods. However, as one of the largest and oldest nonprofit reuse organizations in the country, it stands at the vanguard of this method of waste reclamation. Nearly two-thirds of Goodwill's revenue comes from the collection and sale of donated clothing, household items, and furniture in its 2,400 thrift stores. In 2009, it took in close to one billion pounds of material that might have gone to disposal, using proceeds to serve close to 2 million individuals with employment and training, and spending 83 percent of its $3.7 billion revenue directly on programs.

Beginnings and Goals

Goodwill was founded in 1902 in Boston, Massachusetts, by the Methodist clergyman Edgar Helms. Helms had come to Boston in the late

1890s to minister to Polish, Italian, and German immigrants, many of them converts from Catholicism. He settled at Boston's South End Memorial Chapel, which had been established in 1859 by Henry Morgan, a renegade Methodist missionary. In 1900, Helms began to go door-to-door to collect unwanted clothing and household goods from wealthy Bostonians. According to official histories, parishioners were too proud to accept the items as handouts, preferring instead to refurbish and sell them. This formed the core of the Goodwill mission: to aid the poor via the redemptive quality of work, offering a hand up, not a handout. This model of welfare provision had strong roots in Protestant Christian doctrine, which emphasized vocation as central to the individual's relation to God. It contrasted with Catholic models of charity premised on giving alms. In this regard, Goodwill, along with other Protestant charities originating in this period, brought religion, welfare, commerce, and recycling of materials together in a working institutional model.

Spread and Secularization

In the following decades, hundreds of affiliated Goodwills were established across the United States under the loose administration of the Goodwill national office. After World War I, as disabled servicemen returned home, the organization began outreach to the physically handicapped. Goodwill worked closely with the National Recovery Association throughout the Great Depression and supported federal initiatives during World War II to gather small quantities of scrap to support the nation's war economy. Goodwill began a long process of secularization in the 1940s, both as a result of factionalism within Methodism and in response to federal funding requirements. It prospered in the 1950s and 1960s as booms in material production channeled increasingly short-lived goods toward donation.

Recycling

Goodwill's relationship to recycling since the 1970s has been complex. Prior to 1970, Goodwills had at times collected both reuseable and recyclable commodities, competing with the for-profit rag and paper scrap industries. With the emergence of urban recycling as an activity whose goals included saving the Earth, along with job creation and urban order, Goodwill began to redefine some—though not most—of its mission to include environmental considerations. Throughout the 1970s, Goodwills in some states established recycling drop-off centers for glass, metal, and plastic containers. These programs were small-scale and short-lived as markets for recycled commodities plummeted through the 1980s. By the latter part of that decade, municipal curbside recycling programs were beginning to proliferate, as were container deposit laws in some states, making Goodwill's involvement in recycling collections redundant.

Reuse

Goodwill pioneered institutionally organized reuse as an alternative to disposal. In the early 20th century, woodworking and sewing had been core skills for vocational program participants and were an important step in revalorizing discards. Some Goodwill stores continued to train clients in furniture and equipment repair through the early 1990s. Donation guidelines in the 21st century explicitly require all items to be clean and in complete working order. The demise of clothing and product repair as a trade, in tandem with the growth of irreparable furniture and other household goods, was in keeping with overall trends of low-quality mass production and planned obsolescence. Such trends rendered the repair aspect of Goodwill work obsolete. At the same time, Goodwill began taking in increasing quantities of used goods each year and began to stand as a model for community-based social enterprises focused on reuse.

The organization has embraced the information technology revolution in both virtual and practical ways. In 1999, it launched an online auction site, with revenue growing from $63,000 that year to over $10 million in 2009. In 2004, a Goodwill in Austin, Texas, established "Reconnect" in partnership with Dell Computers to collect used residential electronics. By 2010, some 1,900 shop locations had joined the partnership, with an estimated 96 million pounds of e-waste recycled since the program's founding. Goodwill's online impact calculator estimates diversion of close to 1 billion pounds of usable goods from landfills in 2010 alone. On

April 22, 2010, the 40th anniversary of Earth Day, Goodwill president and CEO Jim Gibbons noted the organization's long history as an environmental pioneer and its role in diverting materials from disposal, continuing the organization's secular role uniting social services, retail commerce, and materials recovery in response to evolving societal needs and economic conditions.

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See Also: Consumption Patterns; History of Consumption and Waste, U.S., 1900–1950; History of Consumption and Waste, U.S., 1950–Present; Salvation Army.

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Greece

From its roots as a classical civilization, modern Greece has developed into one of the more developed economies in the Mediterranean. Garbage in Greece has been a central subject of debate between various officials, members of parliament, European Union (EU) representatives, citizens, scientists, and environmentalists. Various difficulties in the treatment and disposal system—in combination with the rising consumption of mass commodities, especially after the 1960s—the development of the Greek industry, the increase of the general population, and the pollution of the Mediterranean basin are the main concerns of the agents involved. While the debate has mainly been focused on garbage as consequence of the development of the country and only technological and organizational solutions have been proposed, there is a need for an understanding of garbage as a cultural, political, and economic phenomenon. A major problem has been the divergent views between environmentalists, communities, and state officials. The Greek informal garbage economy, for example, has been largely neglected as a source of collection, management, and recycling of waste.

In the 21st century, Greece enjoyed an average annual growth of almost 4 percent before a debt crisis in 2010 led to austerity measures and social unrest. Over 10 million people live in Greece, about one-third in the Athens urban area. As a member of the European Union, Greece has benefited from the influx of European cohesion funds and subsidies. A significant part of EU cohesion funds and public investment, as well as major public works for the 2004 Olympic Games, were dedicated to Greece's infrastructure network. Environmental projects have been initiated, including various efforts to invest in alternative energy, as both the government and businesses have to take certain measures to meet the country's obligations to the EU. In particular, recycling, solid and hazardous waste treatment, and alternative energy sources in Greece fall short of EU averages.

Hazardous Waste

A new legislative framework for hazardous waste treatment was adopted in 2005. As such, a set of specific, systematic measures for dealing with these waste streams still remained to be implemented as of 2010. In Greece, there are very few hazardous waste treatment and final disposal sites, which are not sufficient for dealing with existing demand. According to the dominant political views, there is a strong need for new technologies and transnational collaborations.

As is the case with hazardous, industrial, or hospital waste management, there is also organizational demand and significant space for improvement in the field of animal by-products waste treatment and management. Finally, as the agro-food sector is one of the major industrial sectors in the country, organizational systems are needed for the treatment of

food-related waste streams for the production of usable energy.

Waste Management

Greece is part of the developed European Union, but the amount of garbage produced is relatively low in relation to other European countries, especially because the Greek industrial sector is one of the smallest in Europe. Moreover, the average per capita income of Greeks is much lower in comparison to other European countries, and average consumption of mass commodities is lower as a result.

A major factor in the increase of garbage production has been population. The population in Greece, according to the 2001 census, is 11,275,312, and each inhabitant generates 411.5 kg of municipal waste per year (1.12 kg per day). Despite the fact that the birthrate is low, urbanization and immigration have contributed to an increase in the population density, mostly in the urban centers of Athens and Thessalonica. Almost half of the country's population dwells in these two cities.

Waste management in Greece has been upgraded since the 1990s, mostly in urban areas and in some large parts of rural areas. More recently, significant improvements have been accomplished in terms of facility development, collection, and recycling. However, the management of municipal solid waste (MSW) in Greece needs to be further improved in order to achieve the quantitative targets posed in the European Union Directives, with the landfill directive especially requiring a restructuring of many components of the waste management system, as Greece relies on landfilling for over 90 percent of its waste.

Various regional waste management plans foresee the construction of mechanical biological treatment plants, but many of the proposed projects had not entered the actual planning phase as of 2010. The possibility of revising these waste management plants to include other options, such as thermal treatment or source separation, has been taken under consideration. In the early 21st century, there are no facilities to process source-separated organic waste. As far as composting is concerned, no source separation schemes are in place for the organic fraction of MSW, therefore, there are no composting facilities producing quality compost. The very low charges for disposal do not act as an incentive for the implementation of other options, such as recycling and composting. The Greek Ministry for the Environment, Physical Planning and Public Works reports that the annual generation of solid waste in Greece is exceeding 4 million tons per year. The overall production of MSW in Greece is estimated around 4,600,000 tons per year. New sanitary landfills and treatment plants, as well as composting facilities and waste transfer stations, had been constructed as of 2010, but there are many more to be completed. For example, there is significant potential in the creation of landfill gas plants. Incineration is not broadly accepted and is illegal. Greece is one of the few countries in Europe in which incineration plants are not yet operating. At the same time, complete recycling is not applied because of infrastructure and logistics insufficiencies.

The most serious solid waste pollution problem is in the greater area of Athens, with a population close to four million inhabitants. In 2003, the Greek government decided to implement a development plan that includes the building of new sanitary, legal waste burial sites and waste processing centers in Attica. Similar projects are planned for Thessalonica, the major cities on the island of Crete, and many other cities throughout Greece. In addition, the Ministry of Environment has put forward legislation regarding recycling packaging materials and more specifically glass, plastic, metal, and paper and promoting new waste management methods, such as converting decomposing refuse into biogas to produce electricity. This legislation has supported two major projects in the area of Attica: the construction of a new recycling facility and the development of a biogas station. Establishing more recycling facilities and landfills is among the main priorities of the state.

Pollution and Environmental Protection

A problematic view of environmentalists and conservationists as well as policy makers is related to an understanding of nature as separate from society. An example of such policies comes from the conservationists and state organizations that tried to initiate a project in Lake Prespa in northern Greece in order to protect a rare species of pelican. The project initiated the removal of a few small settlements of fishermen in the area, including their waste disposal sites, so no human intervention would take

place in the "wild" protected area. The results of this policy were devastating when the settlements were moved, as the garbage disposed by the fishermen fed the birds. Garbage is not necessarily viewed as polluting by all social groups but rather can be a source of income. Greek Roma travel regularly around the countryside in order to collect garbage that has not been removed by municipal authorities. Old cars, household devices, iron, steel, and plastic are collected on a regular basis and resold to various companies to be recycled. Another divergent view of garbage has been established between local communities and state officials. Local communities have opposed large environmental projects, including the wind turbine industrial plan in parts of Greece, mainly because there is a significant concern over the scale and maintenance of such projects. As a result, European Union and environmentalist views of preserving the environment and reducing pollution contradict the views of various Greek communities that realize these efforts as production of pollution and garbage in their own communities. Past failed projects and poor or nonexistent maintenance of various environmental efforts that were caught up in state politics legitimize such views.

Therefore, many environmentalists and state officials consider the environment and garbage as separate from society. The role of Greek Roma, for example, or other social groups who participate actively in the informal garbage economy is widely neglected. As a consequence, environmentalists and policy makers have been proposing technological solutions in order to deal with the treatment and disposal of garbage. However, such plans have resulted in conflicting views with local societies that are either obliged to live with the disposal of garbage close to their communities or face the failure of environmental policies.

Finally, a view of garbage as a social, cultural, and political process might be able to bring more insights into its production, consumption, and disposal. A focus solely on the organizational and technological aspects of waste treatment has not been as productive in Greece; on the contrary, it has resulted in various social conflicts, divergent views, and misconceptions.

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See Also: Environmentalism; European Union; Politics of Waste; Power Plants; Recycling; Waste Treatment Plants.

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Greenpeace

One of the most visible environmental activist organizations in the world, Greenpeace has engaged in several campaigns against nuclear arms, toxic waste, water pollution, and global climate change. It has advocated zero waste practices in developing nations across the world. Its methods are nonviolent, but confrontations with several nations (among them Japan and France) and industrial interests have aroused both controversy and acclaim over the organization's history.

Greenpeace was formed in 1971 when some members of the Quaker faith in Vancouver, Canada, decided that they wanted to protest the underground testing of nuclear bombs taking place on the tiny island of Amchitka off the west coast of Alaska. One of the tenets of the Quaker faith is to "bear witness," or to observe situations that one feels are morally wrong. The small group of activists, concerned about the consequences of nuclear tests, sailed off in a boat named the *Phyllis Cormack*, but they did not make it to the Amchitka site before the nuclear test. Far from being a failed endeavor, however, the attempt to witness the nuclear test garnered so much media, public, and political attention that the activists realized that the attention to the issue of nuclear testing was, in itself, a success.

At a meeting soon after the *Phyllis Cormack*'s sailing, someone left the room saying, "peace" and someone else replied, "make it a green peace,"

and the international environmental organization Greenpeace was born. In the 21st century, Greenpeace continues to maintain as one of its core values "bearing witness to environmental destruction in a peaceful, nonviolent manner." It has grown around the world, according to the Greenpeace international Website: there are Greenpeace offices in 41 countries, almost three million members, and a long list of victories. For example, the attention that the first Greenpeace sailing garnered, along with the subsequent work, was successful in pressuring the United States to abandon its Amchitka nuclear testing site in 1972.

Exposing Issues of Waste

Greenpeace's real strength has been in exposing consumption and waste-related issues that would otherwise be hidden from view. For example, Greenpeace's campaign against the killing of whales (a practice that often takes place in remote ocean waters) is perhaps its best-known campaign and remains a central focus for the organization. As whaling ships have aimed their harpoons at the whales, Greenpeace activists have positioned their small inflatable boats between the whales and the harpoons. In 1982, Greenpeace was instrumental in pressuring the International Whaling Commission (IWC) to adopt a whaling moratorium, but Greenpeace continues to fight to stop whaling, as one of the most prolific whaling countries, Japan, continues to both kill whales and lobby to have the IWC's moratorium rescinded.

Another well-known Greenpeace campaign has addressed a devastating practice that has taken place throughout modern history: the use of the world's oceans as a waste dump. This practice has included the dumping of radioactive nuclear waste into the remote—and seemingly endless—expanses of the world's oceans. Greenpeace has drawn attention to such dumping by having activists place their inflatable boats in the path of the barrels of waste that sailors try to dump overboard. As these actions have drawn attention, the media, members of the public, and politicians have begun to pay attention. In 1983, the parties to the London Dumping Convention called for a moratorium on radioactive waste dumping at sea. According to Greenpeace, this marked the first year since the end of World War II that no radioactive waste was dumped at sea. Subsequently, in 1993, the London Dumping Convention created a permanent worldwide ban on the dumping at sea of radioactive and industrial waste.

One of the most notorious chapters in Greenpeace's history also relates to the campaign against ocean dumping of toxic and radioactive wastes. During the 1980s, the organization used its *Rainbow Warrior* ship in the Pacific Ocean to assist in the evacuation of 300 Rongelap Atoll residents from their community that had been contaminated by U.S. nuclear tests during the Cold War. Subsequently, the vessel was to help lead protests against French nuclear testing in 1985, but it was sunk in Auckland Harbor, killing Dutch photographer Fernando Pereira. An investigation by New Zealand police revealed the boat had been bombed on orders of the French government, ultimately resulting in both financial compensation and unprecedented international publicity for Greenpeace.

These Greenpeace campaigns against nuclear testing, whaling, and ocean dumping represent a small selection of the consumption and waste-related work that Greenpeace performs as part of its six core campaigns of climate change, forests, oceans, agriculture, toxic chemicals, and ending nuclear power. Greenpeace continues to use the tactics of nonviolent action to draw attention to the issues, but its work also includes political lobbying, public outreach, and scientific testing.

Greenpeace's development of campaigns within and across national boundaries represents an important historical precedent for the work of environmental nongovernmental organizations worldwide. Its campaigns to establish zero waste programs in nations ranging from Argentina to Lebanon are important shapers of 21st-century waste policies.

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See Also: Consumerism; Ocean Disposal; Overconsumption; Radioactive Waste Disposal; Zero Waste.

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Grocery Stores

For many people, grocery stores serve as the primary—if not the sole—outlet by which they acquire food. Grocery stores create the illusion that food is easily and readily available. Grocery stores sell a variety of household goods, including both fresh and packaged foods. Climate-controlled grocery stores complete with refrigeration and freezer units are often disconnected from the conditions under which food was grown, harvested, processed, packaged, and shipped. In some instances, the quality of foods is measured not in terms of taste or freshness, but rather by the extent that they can endure being shipped hundreds or thousands of miles.

Small grocers evolved from food peddlers in many cities in the early 20th century. In several U.S. cities, stores developing within local immigrant populations were commonplace by the 1930s, and small chains were evident as early as World War I. As the United States suburbanized after World War II, large grocery stores became staples in shopping malls, allowing consumers to drive and park, taking care of their shopping needs once a week, rather than purchasing small amounts of food daily. This development substantially increased the convenience and flexibility of housewives to provide food for their families, as both the volume and variety of goods in supermarkets grew in the postwar era. Large grocery stores have been described by some commentators as contributing to the undermining of local food systems, particularly small grocers who are unable to compete with large grocers. Larger grocers have the advantage of being able to buy large quantities of food and hence receive large-volume discount prices. The savings are passed on to consumers, who usually choose the larger store in greater frequency to the smaller store. This decrease in price also means that consumers are able to spend less of their income on meeting their caloric needs, hence freeing up more income for either necessities or other consumables.

Food Deserts and Locations

As an alternative to this narrative of large grocers dominating the market and pushing smaller stores out of business, some commentators have touted large grocery stores as the solution to food deserts. Although there are tens of thousands of grocery stores in the United States alone, many people and communities may find themselves without ready access because grocery stores—particularly larger grocery stores—are not evenly distributed in relation to the population. Food deserts are those areas where residents have limited to no access to fresh produce. These food deserts are mapped onto landscapes so as to make claims about relative food accessibility, and hence food security, in both rural and urban regions. By focusing solely on the presence or absence of large grocery stores, these studies discount the importance of local and regional sources of food, which can also provide high-quality foods in terms of nutrient-to-calorie ratio.

Local and regional sources of food include farmers markets, community-supported agriculture operations, box schemes, community gardens, neighborhood gardens, school gardens, household gardens, farm stands, local butchers, and smaller grocers. Informal networks of sharing and exchange are often not considered in analysis of food deserts. These studies of food deserts have contributed to a corpus of knowledge to argue for the development of new, large grocery stores as the solution to food deserts and inequities in the food system in terms of nutrition and food availability. This has led to a legislative push to enact economic incentives to increase the number of large grocery stores being built. As an example, Maryland passed a law to allow grocery stores to be built tax-free in given locations.

The location of grocery stores is of particular importance to those who do not have access to personal transportation and instead have to rely upon public transportation infrastructure or social

networks for transportation needs. People without reliable access to transportation must rely on whatever food stores are available in their neighborhoods; for those in poorer neighborhoods, these are often convenience stores, which stock little—if any—fresh foods. In some cases, the relative absence of larger grocery stores is due to historical socioeconomic shifts in neighborhoods and the construction of large grocery stores in suburban areas has also led many smaller grocers in urban settings to go out of business.

Nutritional Quality and Price

It is not simply the mere absence or presence of grocery stores that determines nutritional outcomes and options for a population. The foods found on their shelves, as well as the price, also determine the food options available to consumers. The presence or absence of a greater variety and selection in terms of fresh, nonprocessed foods in comparison to what Anthony Winson refers to as "pseudo-foods," or heavily processed foods, also impacts the overall availability of high-quality foods in terms of nutrition, taste, and preference. As has been shown by Winson, the quality of grocery stores, in terms of their selection of low-nutrient, high-calorie foods compared with nutrient-dense foods, varies even in the same city. As Winson has demonstrated in Canada, it is generally the poorer regions of a given area that have a greater concentration of pseudo-foods in their grocery stores.

The goods present in grocery stores rely upon corporate infrastructure, including shipping and handling of fresh and processed foods over long distances. In some instances, this transportation, particularly to more remote areas, can compromise the overall quality of fresh foods. In addition, higher food miles (the average distance that food is transported) increase the price of foods for more remote areas.

As an example, foods in urban Alaska are generally 15–30 percent higher in price than in the continental United States, and food prices in rural Alaska can be 200–300 percent higher than they are in the continental United States. Since the presence of food is reliant upon transportation infrastructure and fossil fuel consumption, the price of foods fluctuates with the price of oil.

Effects on Health and Culture

The arrival of grocery stores in a region can dramatically impact the health of people. Often, the arrival of grocery stores marks a key transitional stage for rural communities. The shift from a subsistence-based economy to one revolving around the purchase and consumption of foods from grocery stores can, over time, contribute to marked changes in the health of differently situated populations. In some instances, the utilization of grocery stores has led to a movement away from traditional subsistence activities, which require extensive labor to acquire food resources. The utilization of grocery stores as a part of integration into the cash economy meant that some populations spent less time in food procurement and, with this, a decrease in caloric expenditure. This decreased involvement in subsistence activities has led to shifting cultural understandings over generations, which contributes to a loss of previously shared, traditional, ecological knowledge concerning subsistence resources. At the same time, grocery stores have, in some instances, been able to serve local communities by selling traditional foods. Regulation as well as centralization of food distribution has kept many grocery stores from realizing their full potential to sell such foods. As centralized units of food distribution, grocery stores, while adapting to meet the regional demands for foods, often do not carry locally grown, lesser-known foods. However, as consumer demand calls for specialty products and labeling such as third-party certifications for Fair Trade or organic, grocery stores not only carry these items but also dedicate and arrange specific spaces or sections for these foods.

Marketing

Grocery stores and the products in them are not just passive spaces and objects of mere consumption but are rather spaces and objects that engage consumers. Grocery store managers and food industry executives help fashion consumer perception through the deployment of advertising, specials, and product availability, and these products are also themselves fashioned by consumer perceptions and preferences. This has not been lost on grocery store managers, marketing firms, and corporate executives who attempt to engage the consumer in a variety of ways. Perhaps the most prevalent of these mechanisms

and the least intrusive is the utilization of rewards or loyalty cards, which have been adopted by every major grocery store and provide valuable information to grocery store managers and chains. These individual records of purchases are utilized to perform sophisticated analyses of consumer shopping preferences and patterns. This is done in hope of adjusting marketing strategies and store selection in order to increase profits. At the same time, there is a positive feedback loop wherein grocery stores attain a greater share of the market and enter into the process of assessing and predicting consumer preferences and shopping patterns.

Hence, grocery stores are not passive spaces where consumers make selections based on what is available, but rather they are active in selecting what products the grocery stores sell. Grocery store managers and executives deliberately try to create a pleasant shopping experience in higher-end retail settings with lighting, music, free samples, and in-store dining options all designed with the intent of extending the length of time shoppers will spend in the store. In some cases, specialty grocery stores, such as natural food stores, go well beyond this by offering cooking classes, holistic health speakers, or in-store mini-massage therapy and bodywork sessions.

There is not, however, infinite choice as the range of potential products is rather narrow, with many products being very similar, with only slight variations of one another. In addition, grocery store chains buy large quantities of foods, hence products that may be highly desirable to a small percentage of shoppers might not necessarily be available. At the same time, grocery stores have developed their own brands, often undercutting the price of national brands for oft-consumed food products.

Some commentators have claimed that large grocery stores undermine local food systems, especially small grocers who are unable to compete. One of the biggest threats to the growth of grocery stores comes from the rise of supercenters and warehouse stores, where bulk purchasing allows retailers to lower prices on a variety of products traditionally purchased at grocery store outlets. The savings are passed on to consumers, who tend to choose the larger store more often than the smaller store.

Prices

The economies of scale drive down the price food processors pay to producers and ultimately lower the profit-margin on the farm. At the same time, this has resulted in a decrease in the real price of foods for consumers, although the prices are typically higher in smaller grocery stores. The "price wars" between grocery stores has also contributed to decreased food prices paid by consumers. While analysis of these general trends is possible, in-depth individual consumer preferences are generally regarded as proprietary business information and as such are usually only available to company insiders and not to outside researchers.

Uniformity and Consolidation

The corporations that own grocery stores and other aspects of the food system are increasingly able to exert greater control over the food supply of those who do not produce their own foods. This is particularly true in both Europe and the United States, where a handful of corporations are responsible for a greater percentage of total food sales each year. In order to produce a uniform product, stores and processors dictate the types of plants and animals to be raised and the conditions under which they are grown. This emphasis on uniformity leads to increased vulnerabilities within agricultural systems, which can lead to increased on-farm consumption of chemicals and other farm inputs with their resulting waste issues.

A food system that rewards uniformity, scale, consolidation, and ready availability of globally produced goods calls into question the future of grocery stores. One of the largest threats to traditional grocery stores comes from the rise of supercenters and warehouse stores, whose prices are markedly lower than those of traditional grocery stores for dairy and a variety of other products. Grocery stores led a shift in the way food has been distributed but they are not permanent fixtures. Increasing consolidation by retailers has led to an increase in the variety of goods sold by each store; this, coupled with Internet-based sales of food, has the potential to dramatically alter the distribution of food in the future. In addition, the alternative food movement, including alternative distribution mechanisms, is challenging grocery stores, albeit to a limited extent economically. The more serious challenge to the current paradigm of food distribution via grocery stores is that these alternative food movements may present an ideological shift in the future wherein consumers continue to demand not only safe and nutritious foods but also locally and community-grown foods.

Large grocery operations such as those found in Walmart stores can pressure suppliers into affecting the cost and quality of their food. This has often led to a "race to the bottom" decline in the quality of foods on shelves. In 2010, Walmart announced a sustainability initiative that included favoring small, local farms and reducing the environmental impact of farming. Time will tell if this initiative reverses or slows environmental damage associated with large grocery stores, but at the very least, it represents heightened awareness of unsustainable food production and distribution practices.

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See Also: Carbon Dioxide; Certified Products (Fair Trade or Organic); Dairy Products; Farms; Food Consumption; Organic Waste; Slow Food; Sustainable Development.

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Hanford Nuclear Reservation

The Hanford Nuclear Reservation (Hanford), the largest nuclear waste site in the Western Hemisphere, is located in the state of Washington. Maintained by the U.S. Department of Energy (DOE) since having been taken over as part of the Manhattan Project, by the time production stopped in the 1980s, Hanford had made most of the plutonium produced in the United States.

Hanford reactors produced plutonium for the United States' defense program for more than 40 years (1944–87). In addition to the liquid and solid waste generated from the production of plutonium, the facilities and structures associated with Hanford's defense mission must also be deactivated, decommissioned, decontaminated, and demolished.

History

The area along the Columbia River has been home to several, typically nomadic Native American tribes, including the Nez Perce, Umatilla, Wanapum, and Yakama. In the mid-1800s, pioneers and settlers began to arrive, eventually forming the town of White Bluffs, home to approximately 900 people by the 1940s, and the small community of Hanford. In 1943, under eminent domain, residents of White Bluffs and Hanford were given 30 days and a small payment to evacuate for the purposes of "important war work." The war department needed a remote area with access to cold water and electricity (to be provided by the recently completed Grand Coulee hydroelectric dam) to develop atomic weapons.

After the residents of White Bluffs and Hanford had been evacuated, the war department began recruiting workers to build the nuclear reactors and processing facilities required to produce plutonium for atomic weapons. Ultimately, a 51,000-person workforce was formed, creating the fourth-largest city in Washington at the time, with few of the workers having knowledge of what was being built or what the completed facilities would do.

Three areas were formed: the "100 Area" for transforming uranium into plutonium, the "200 Area" for plutonium processing and waste storage, and the "300 Area" for manufacturing work and experiments. Workers began building the first three of what would ultimately be nine plutonium production nuclear reactors at Hanford, the first of their kind in the world. Within 13 months, work was completed on the B Reactor, the world's first nuclear reactor, as well as the T Plant, the world's first facility to extract plutonium from irradiated fuel rods. In

August 1945, plutonium from the B Reactor and the T Plant was used in the Fat Man bomb detonated over Nagasaki, Japan.

In 1959, construction began on the ninth Hanford reactor, the N Reactor, with the dual purpose of producing plutonium for atomic weapons and steam for generating electricity. N was the only dual-purpose reactor in the United States. For two years, from 1963 to 1965, all nine reactors were producing plutonium for the U.S. defense program. By the mid-1960s, some of the older reactors began to be shut down, with B, C, D, DR, F, and H Reactors being deactivated by 1970. The K-East Reactor ceased production in 1970, followed by the K-West Reactor in 1971. The N Reactor continued producing both plutonium and electricity until 1987, when the Department of Energy placed N in a standby status and it has not been reactivated.

Cleanup Initiatives

That which is considered solid waste is broad, ranging from broken reactor equipment to contaminated clothing. Solid wastes were buried in the ground in pits or trenches, with or without containment (steel drums or wooden boxes), and, depending on when the waste was buried, records about what was buried and where are highly variable.

In addition to millions of tons of solid waste, hundreds of billions of gallons of liquid waste generated during the plutonium production days were intentionally disposed of by pouring them directly onto the ground or into trenches or holding ponds. Unintentional spills of liquids also took place. As with the solid wastes, records of spills, including what, where, and volume, are highly variable.

A majority of the solid wastes, contaminated soil, and building debris will be taken to the Environmental Restoration Disposal Facility (ERDF) located on the Hanford Site and regulated by the Environmental Protection Agency. This includes some of the more hazardous chemical or radioactive solid wastes stored in the Canister Storage Building at Hanford. Solid transuranic (TRU) waste—debris that is contaminated with plutonium or other materials that may remain radioactive for hundreds of thousands of years—is packaged and shipped to the Waste Isolation Pilot Plant in New Mexico. Much of Hanford's liquid waste will ultimately be vitrified (transformed into a stable glass product) at a facility being constructed at Hanford.

Liquid waste that had been poured onto the ground or held in ponds or trenches has caused soil and groundwater contamination. Spreading at variable speeds (depending on chemical composition and rock and soil type), plumes require a variety of containment strategies. Remediation techniques include barriers and biostimulation, a new technology in which organic materials are pumped into the ground to be eaten by soil microorganisms, thereby altering the chemistry of the groundwater and rendering the contaminants harmless to the environment.

Conclusion

Government officials recognize that they still have a weak grasp of how much plutonium is contaminating the environment as a new analysis indicates that the amount of plutonium buried at Hanford is nearly three times what the federal government previously reported. This suggests the need for a more challenging cleanup initiative, perhaps requiring technologies that were not created as of 2010. While the DOE has been weighing to what degree remediation should occur, given the relative cost and extent of devastation, the preferred option is 99 percent remediation.

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See Also: Environmental Protection Agency (EPA); Nuclear Reactors; Radioactive Waste Disposal; Radioactive Waste Generation; Uranium.

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Hawaii

The U.S. state of Hawaii is a volcanic archipelago comprised of hundreds of islands spread over some 1,500 miles in the Pacific Ocean and it is the only state comprised entirely of islands. Along this great expanse, only the southeasternmost islands, generally termed the main islands, of Niihau, Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii are settled or typically considered in discussions about Hawaii.

This set of main islands lies over 2,000 miles from the nearest continent, making the state the remotest part of the world that humans have settled. In fact, the city of Honolulu on the island of Oahu is considered the remotest urban area in the world. Home to roughly 1.3 million people (most of whom live in Honolulu on the island of Oahu), plus millions of tourists who visit the islands every year, the state faces challenges in terms of both consumption and waste because of its isolation.

Production History

Historically, Hawaii had an economy based on agricultural export; however, as pineapple and sugar became cheaper to produce elsewhere in the world, agriculture in the islands declined markedly. As a result, the islands import approximately 85 percent of their food in the 21st century, making the islands dependent upon the global market to supply their food. Likewise, the lack of nearly all natural resources in the islands means that nearly all materials needed for construction, transportation, and personal consumption are produced elsewhere and imported. Because of this dependence on imported goods, Hawaii's food security is quite vulnerable to shipping delays or natural disasters that affect the infrastructure, such as tsunamis and hurricanes.

Waste Incineration and Export

The large volume of goods imported to Hawaii produces a significant waste stream that poses serious challenges to the state. Specific aspects of waste collection in the state differ by island and county but share a number of similarities across the state. For instance, nearly all household and commercial waste is deposited in either landfills or incinerated for energy. As many of the landfills have reached capacity or will reach capacity in the next several years, there has been increased pressure to expand the landfills. However, given the strong public opposition to expanding the landfills, due to both the fragile nature of the island ecosystems and the proximity of the landfills to areas of rural poverty, local governments have been pursuing alternatives.

One alternative is expanding the garbage-to-energy plant on the island of Oahu, which incinerates trash to create steam for a turbine. As of 2010, the garbage-to-energy plant (H-Power) is capable of producing 46 MW of power through consuming up to 2,160 tons of garbage per day. This volume of garbage reduces the volume of municipal solid waste that goes to the landfill by 90 percent. Because of this decrease in solid waste, the garbage-to-energy plant is seeking to add a third boiler, thereby increasing annual capacity from 600,000 to 725,000 tons of garbage incinerated per year. The islands of Maui and Hawaii are exploring garbage-to-energy plants as their landfills are reaching capacity.

Hawaii's economy used to depend on agricultural export, primarily pineapples and sugar. However, global price declines for these commodities have considerably suppressed agricultural production on the islands, which now import 85 percent of their food.

A second alternative is to export waste out of Hawaii to the continental United States. Similar to other municipalities across the United States, Hawaii has explored the potential to export a portion of its municipal waste to a landfill in Columbia Gorge, Washington. In fact, trash on the island of Oahu was collected and baled for shipment beginning October 2009. However, after failing to receive the necessary permits needed to transport and dump the waste, the program was suspended in September 2010, with no waste having left the island. All of the baled waste is now being processed for either the garbage-to-energy plant or the landfill.

Recycling

Aside from addressing the waste removal process, Hawaii has been exploring other avenues to reduce the waste stream. For example, island-wide recycling programs have started on several islands, including Oahu. Recycling programs use single stream collection, accepting newspaper, aluminum, glass, several forms of plastic, and cardboard. While steel and tin are noticeably absent from the recycling collection system, these items are removed further down the waste stream on islands such as Oahu, where the trash is sorted prior to incineration.

A second form of recycling that was implemented in 2005 was a bottle deposit for aluminum, bi-metal, glass, and plastic (PET and HDPE only) containers up to 68 ounces, with milk and several alcoholic beverage containers exempted. The $0.06 deposit is attached to beverages at time of purchase, with a $0.05 return rate (the extra $0.01 is a nonrefundable container fee paid to the Deposit Beverage Container fund to help pay redemption centers' handling fees). According to current estimates, more than 75 percent of beverage containers covered by the deposit are returned.

A third form of recycling that greatly reduces input to the waste stream is green waste collection. Green waste refers to plant material that can be mulched or composted. Given the tropical climate and rapid plant growth, removing green waste greatly reduces inputs to landfills.

Other Legislation

Besides recycling programs, new laws have recently been codified that will remove important components from ever entering the waste stream. In particular, Maui has enacted a law, similar to Washington, D.C., that bans the use of plastic bags by most types of stores. Likewise, there is increased interest in eliminating plastic bags from the other islands due to their nonbiodegradable nature and marked impact on the marine ecosystem (for example, entanglements with animals) surrounding the islands.

Conclusion

The insular nature of Hawaii, its dependence on imported goods, and its unique ecosystems ultimately yield few options for addressing waste removal and disposal. While garbage-to-energy offers a way to reduce landfill inputs and lessen the state's dependence upon imported energy, it alone is not a solution. The plant still produces toxic material, some air pollution, and continues to add waste to the near-capacity landfill. Likewise, recycling programs have reduced inputs to the waste stream but have not been as fully implemented as could be possible. Thus, other options likely will need to be explored in the 21st century. Such options could include additional deposit laws on other consumer items, expansion of the existing bottle law, banning certain products that cannot be disposed of properly, and duties or fees on nonrenewable packaging.

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See Also: Beverages; Composting; Food Consumption; Incinerators; Landfills, Modern; Recycling; United States.

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Hazardous Materials Transportation Act

The Hazardous Materials Transportation Act (HMTA) was signed into law in 1975 in order to better regulate the safe transport of dangerous materials and to harmonize conflicting state and local laws regarding the transportation of hazardous materials (also known as hazmats). The law represents the continued attempt by the Department of Transportation and other regulating bodies to respect the freedom of interstate commerce while guaranteeing public safety. The HMTA is routinely at the center of high-level legal battles and has been criticized both as too nebulous to allow proper enforcement and too stringent for municipalities and businesses to properly follow.

History, Goals, and Guidelines

The HMTA was born out of public concern arising from the large number of highway accidents involving hazardous cargo in the 1960s and from raised awareness of the role of toxic substances in daily life inspired by growing environmental movements. Early environmental battles were often waged by those concerned with the location of facilities using potentially dangerous chemicals, but it soon became clear that these substances also posed a serious danger while in transit. Particularly given the more dispersed nature of commerce and industry and the expansion of the national highway system during the 1950s and 1960s, cross-state regulation became crucial to preventing accidents. The HMTA necessitated enhanced safety precautions as well as special permits for the transport of hazmat materials. The law was an attempt to tighten safety, prevent illegal disposal, and standardize varying state and local laws by applying minimum safety thresholds that could be expanded upon locally.

The HMTA designates specific materials such as oil, nuclear, and chemical substances as "hazardous" and provides guidelines for transport. There are specific requirements for the packaging, handling, and delivery of the hazardous materials, as well as training requirements for those licensed to transport such materials. The act also specifies worker safety, such as protective suits and respiratory devices that must be used by those handling hazardous materials. These rules apply to all forms of shipment and are also general guidelines that may be augmented by local policies, for instance, by regulating times of delivery, adding special precautions in populous areas, or limiting the use of specific roads and highways.

Controversy

From the first years of the HMTA, legal battles often involved local regulations that were challenged on the basis of infringing interstate commerce because they sought limitations on transport through their jurisdictions. Often, the issue at hand was the use of urban roads that were particularly vulnerable to an accident because of high density and narrow maneuvering space. Some localities received protection by the courts because of their high-risk potential, but others were denied because they prescribed unnecessary diversions based on local interests. In general, these efforts have required regions to compete against one another in order to avoid potentially dangerous uses of highways and other transportation centers.

The HMTA has been criticized as insensitive to local realities given the broadness of the Department of Transportation's administration of the law, thus excluding those with local knowledge from decision making. Some also find fault with the approach of setting only minimum requirements, because stricter laws are only enacted from lower levels of government where there can often be a lack of political will to encumber business and pass new legislation that goes beyond federal law. Accordingly, there is a disincentive for cities or states to make the law stricter because it depicts regulators as deliberately raising the cost of doing business. However, local politicians are also sensitive to the needs of their constituents, and in areas with increased environmental activism or high risk potential, considerably stricter local ordinances have been successfully passed.

Amendment

The HMTA was amended in 1990 in order to clarify discrepancies in the previous law and to enact stricter penalties for noncompliance. Key areas of public interest were industrial pollution, the management of oil spills, and the transportation of radioactive waste. Incidents such as the *Exxon Valdez* spill in 1989 highlighted the need to enact more specific legislation for special activities such as coastal oil extraction and transport. Although the 1990 amendment specifically addressed the transportation of oil, it also set liability limits, which were vaguely defined and contingent upon the financial resources of the owner. This loophole became an issue for the compensation of Gulf Coast residents as well as the costs of cleaning the Deepwater Horizon spill in 2010. Finally, the revised HMTA is still administered by a number of federal agencies, such as the Department of Transportation, the Department of Energy, the Nuclear Regulatory Commission, and the Occupational Safety and Health Administration, leading to bureaucratic conflict and inconsistencies in enforcement. Some consider this fragmentation as a potential threat to the integrity of the act, because responsibility is split even at the highest levels and there is the possibility that proper regulation may be encumbered by lack of communication or coordination.

Since September 11, 2001, HMTA has again been the subject of debate because of renewed interest in hazmat transportation as the potential target of terrorism. Municipalities and states began to include the protection of key transportation sites in new emergency plans that prepared for both accidental chemical disasters and the intentional targeting of nuclear or chemical facilities meant to disrupt transportation or cause injuries. Although no substantial changes were made to the law, the risk of transporting potentially dangerous materials through highly populated areas continues to be a subject of safety debates in the fields of disaster planning, terrorism prevention, and the building and maintenance of transportation hubs.

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See Also: Environmental Protection Agency (EPA); Radioactive Waste Disposal; Toxic Wastes.

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High-Level Waste Disposal

Nuclear energy is a paradox. It is both a high-tech industry and extraction based, with the strengths and weaknesses of both. It is one of the most debated, analyzed, and policy-driven issues in the 21st century, but it is also one of the most vaguely defined. It is considered by some to be the cleanest energy source in the world and by others to be the dirtiest. It is both a weapon that can potentially destroy mankind and a source of potentially perpetual industry.

For the first part of its history, the threat of nuclear war and, later, nonproliferation overshadowed nuclear waste disposal. Since some radioactive wastes have half-lives of one million years or longer, most waste was placed in above-ground storage in the hope that a disposal solution would be found within the next 100 years. Some of the first high-level nuclear waste was 60 years old as of 2010, and many nuclear power plants, like many older manufacturing facilities around the world, are reaching the end of their operating lives. Some countries are dealing with leftover radioactive waste from decommissioned cold war–era nuclear missiles. While nuclear technology has advanced, nuclear waste disposal still remains a waiting game of keeping it as far from humans as possible until it is not toxic. When many countries built nuclear reactors, they expected that their nuclear fuel would be reprocessed and stored in a foreign country. As the world becomes increasingly crowded, it becomes more difficult to find places to handle and

store potentially harmful waste. In the 21st century, several new ways of disposing of high-level nuclear waste are being developed, and many countries have begun to reprocess or recycle nuclear waste. The biggest challenge is not only technical but also political and societal because of competing beliefs, goals, and impacts. Nuclear waste and the subsequent issues of storage are as diverse as the policy debates on the issue. To fully comprehend the implications of the latter, one must first have a basic understanding of the former. Nuclear waste can be delineated into three categories: extraction waste, low-level waste, and high-level waste.

Extraction Waste or Milling Waste

Extraction waste, or milling waste, is a by-product of uranium mining. Waste of this sort comes from the extraction of the uranium ore from the Earth and the subsequent process of concentrating it into yellowcake uranium. National or regional regulatory agencies like the U.S. Nuclear Regulatory Commission (NRC), France's Agence nationale pour la gestion des dechets radioactif, or the International Commission on Radiation Protection often regulate both the processes of extraction (to what degree depends on the process used) and waste management. Uranium mining can be broken down into two categories. The first, conventional mining, is the process of removing uranium from the Earth via underground shafts or open pits. The second category is in situ recovery, also known as solution mining, which chemically alters the uranium by pumping a solution, usually made up of water mixed with hydrogen peroxide or oxygen, called lixiviant, through a series of wells. This process causes the ore to dissolve into the solution, which is then pumped to a series of recovery wells at the surface.

Like most types of mineral and resource mining, extracting uranium produces four types of waste: waste rock, tailings from the ore processing, industrial waste, and wastewater. Throughout the mining process, the most common of these four categories of waste is waste rock and tailings. Waste rock is simply defined as rock with no commercial value that must be extracted from the mine in order to get access to the uranium ore. Above-ground mines, commonly known as strip mines, produce significantly higher amounts of waste rock than the below-ground mines. The second most common waste product from the mining process is tailings. Where waste rock stems from the mining process itself, tailings are a product of the process of separating metals from ores. For most of the waste products associated with the mining process, the goal is to dispose of them in a manner that would require no upkeep.

High-Level Nuclear Waste

High-level nuclear waste is defined as the extremely radioactive by-products of either the fission process found in nuclear power plants, weapons, or fuel reprocessing. High-level waste makes up over 95 percent of the total radioactivity produced in the process of nuclear electricity generation. A typical nuclear power plant produces about 27 tons of nuclear waste every year. Some examples of high-level nuclear waste include spent nuclear fuel, the highly radioactive solid or liquid materials that are products of nuclear reprocessing, and any other materials that have become highly radioactive through their proximity to the reactor that need to be stored in isolation. In most countries, spent nuclear fuel (SNF) is the most common type of high-level nuclear waste. SNF can be defined as used fuel from a nuclear reactor whose fission process (the process in which a uranium atom is split, releasing a small number of neutrons that then collide with other uranium atoms, thus causing a chain reaction) has slowed to the point where it is no longer efficiently producing electricity. Moreover, uranium is not the only radioactive element that must be dealt with. The fission process releases other radioactive elements, including strontium 90 and cesium 137, which also require storage. This release of elements intensifies the radioactivity of the fuel rods (metal rods with ceramic pellets containing uranium inside).

Governments around the world use similar waste management and disposal approaches, which are often dependent on the age of legacy nuclear power plants, the amount of nuclear energy they generate, and the proximity of neighboring countries that use nuclear energy. France, for example, produces 75 percent of its electricity from nuclear reactors, the highest percentage of any country. France has had one of the most advanced high-level management

approaches, since the country began using nuclear power in the early 1970s in response to the first oil crisis. It reprocesses and recycles spent reactor fuel and even recycles fuel from other countries, which is returned to the country of its origin. While a few countries, such as France and Japan, provide reprocessing for other countries, many more provide underground disposal sites. Although it has no nuclear sites itself, the Association for Regional and International Underground Storage is located in Australia and provides storage for Belgium, Bulgaria, Hungary, Japan, and Switzerland. The Central Organisation for Radioactive Waste (COVRA) in the European Union (EU) is working on a European-wide waste disposal system with single disposal sites that can be used by several EU countries. Russia operates as an unofficial international repository system, with South Africa, Argentina, and China considering taking on the same international role. Other countries, such as Finland, prohibit the import or export of radioactive waste.

High-level waste that is not reprocessed is stored in two very different ways by nuclear power plants. The first and most common way is in water-cooled pools. These pools are large basins in which the spent fuel rods are placed beneath roughly 20 feet of water. At that depth, the water is able to act as an insulator, thus protecting the surrounding areas. The typical water-cooled storage facility can hold roughly five times the amount of fuel that the core can. The second type of high-level waste storage facility is commonly called dry cask storage. It was originally developed out of necessity. During the 1970s and 1980s, the general consensus among experts was that cooling pools could not keep up with the amount of waste being produced. As an alternative, dry cask storage typically stores spent fuel in steel cylinders that are either welded or bolted closed and are then surrounded by additional concrete, steel, or other material to act as a radiation barrier. The challenge is to find storage materials that retain their integrity for several thousand years. Ceramic is currently the most advanced method, while nanostructured materials are the future. Because spent fuel, and other high-level waste, comes out of the reactor at extremely high heat, it needs to be placed in a storage pool for between one and three years for cooling purposes before it has the option of being placed in a dry storage facility. Dry cask storage also affords the user some fairly significant benefits. For instance, many of the cylinder designs can be used for both storage and transportation. Moreover, this style of storage facility can be—and has been—designed to allow for either vertical or horizontal storage, thus maximizing any given space.

Several countries, most notably the United States, Canada, China, Germany, and Sweden, have begun researching and siting underground facilities or long-term geological depositories. In the United States, disposal of high-level nuclear waste is done at nuclear power plants because there was no permanent disposal facility within the United States as of 2010. This means that every power plant that is operating within the United States has its own storage facilities. However, the 1982 Nuclear Waste Policy Act states that all high-level nuclear waste should be disposed of deep underground in a geologic repository. The Nuclear Regulatory Commission (NRC) has stated that it will only grant the proper permits and licenses to operate such a facility if it can be proven that (1) the installation can be safely constructed and (2) it can be operated without any significant risks. As of 2010, the only site proposed was Yucca Mountain in Nevada, which would hold roughly 77,000 tons of high-level waste. It would fall under the jurisdiction of the NRC, Department of Energy (DOE), and Environmental Protection Agency (EPA). Preliminary work began on the site in 1991.

In 2002, the DOE, after completing about 10 years' worth of tests, determined that Yucca Mountain would be a suitable location for a storage facility. President George W. Bush and Congress accepted the DOE's findings and allowed it to submit a license application for construction, which it did in June 2008. Later in the same year, the NRC issued notice of a hearing on the Yucca Mountain site, which was to be adjudicated by the Atomic Safety and Licensing Board Panel. In total, about 319 contentions were filed against the proposed facility by 12 different groups.

Low-Level Nuclear Waste

While many people are aware of the potential impacts of high-level nuclear waste, low-level

nuclear waste suffers from the same challenges as high-level nuclear waste. Where high-level nuclear waste is defined as the waste material produced from the fission process, low-level waste consists of items that become contaminated with radioactive material or have become radioactive through their proximity to radiation. Examples of low-level waste include anything from shoe and clothing covers to medical tubes and filters. All generators of low-level nuclear waste must possess a specific or general license that allows them to have and use radioactive materials. Moreover, low-level waste comes from a variety of places, including medicinal use; decommissioning, research, and development activities; and industry.

Low-level waste can be broken down into three categories that range in severity from background radiation levels that can be found in nature to highly radioactive: A, B, and C. Dividing waste into the three classifications is a complicated process that consists of measuring the concentrations of a number of radionuclides. If the concentration of a specific radionuclide is below 0.1 times the specified concentration in a cubic meter of waste, it is considered to be low-level waste class A. If the concentration exceeds 0.1 but does not exceed the specified concentration for a cubic meter, it is considered to be class C. Class B lies somewhere in between. If the concentration exceeds the set limit, it is then bumped into the high-level waste category. Some other aspects taken into consideration when classifying low-level waste include the total of all nuclides with less than a five-year half-life and whether the waste in question has a combination of radionuclides. Class A waste makes up roughly 96 percent of the total volume of low-level waste.

Storage for low-level waste varies based on the level of radioactivity found in the item. Items with concentration levels that are too high to allow them to be thrown away in the trash are shipped via Department of Transportation–approved containers to commercially operated disposal facilities. These facilities are licensed through the NRC or, based on the Atomic Energy Act of 1954 mandate, an Agreement State, as the act allows the NRC to delegate some of its regulatory authority to the state. An Agreement State is one that has petitioned the NRC to have the ability to regulate nuclear by-product, source material, and certain quantities of special materials as well as to issue licenses to those using or storing radioactive material. To become an Agreement State, the state in question must first prove to the NRC that it has a regulatory program that is comparable to that of the NRC and, second, the governor of the state must officially sign on to the program through a formal agreement with the commission's chairman. In all, 37 states have committed to being Agreement States, the first, Kentucky, signed on March 26, 1962.

The most common way to store high-level nuclear waste is in water-cooled pools such as this one, which cover the rods with about 20 feet of water. The water insulates the waste and protects the surrounding area.

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See Also: Hanford Nuclear Reservation; Hazardous Materials Transportation Act; Medical Waste; Nuclear Reactors; Uranium.

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History of Consumption and Waste, Ancient World

The first evidence of object production by humans begins around 2.5 million years ago, when the earliest humans collected stones for making crude chopping tools. Stone tools are made by striking a blow that fragments the stone, leaving a sharp edge on the main piece of stone and resulting in the discard of the associated chips that are the by-product of the flaking process. The manufacture of other early objects made of bone, wood, and other perishable materials would similarly have resulted in waste materials as an integral part of the production process.

Food Waste

The process of preparing and eating food also produces waste. Almost all foods have some inedible part, such as shells, peels, seeds, husks, and bones, which are discarded as part of preparation, serving, and consumption. The earliest humans would have continually been picking through their food items and discarding the unwanted portions, discarding them in patterned ways that can be recovered through archaeological excavation. The rate of discard of food items increased after the development of pottery and metal vessels, which also broke and were thrown away as part of food-related waste.

The process of discard diversified when populations grew and as residential sites became larger. Starting 10,000–12,000 years ago, human group sizes began to increase from 50–100-person mobile foraging groups to sedentary village societies with hundreds or thousands of inhabitants. Often, this transition to fixed-place living coincided with the development of agriculture, which required a whole new range of production and processing tools such as farming equipment, grinding stones, storage bins, and cooking pots. The process of settled village life also resulted in regular patterns of discard behavior as people determined the locations of appropriate refuse disposal.

Early Technologies

The technologies of the sedentary period comprised many composite tools such as plows, harnesses, and other agricultural equipment in which elements could be replaced to continually upgrade and maintain the utility of the object. This resulted in fragments of "partible waste" that represented the discarded or replaced elements of the composite object. Other types of objects, such as pottery, were usually discarded rather than repaired. The notion of selective repair resulted in the increase in categories of "waste" objects as individuals had to decide how and whether to fix items or simply discard them altogether.

New technologies such as metallurgy and pottery production produced large quantities of waste in addition to producing changes in the landscape through the extensive use of trees as fuel. In the Indian subcontinent as well as in many parts of western Africa, the production of iron resulted in large and distinct piles of slag as part of the human-made landscape. Waste from production of these new technologies and the discard of surplus objects piled up around settlements, resulting in a landscape in which waste was a constant component of everyday life.

Waste Management

The process of biological decay also resulted in the innovation of new techniques to proactively address the production of waste. Fermentation can be regarded as a process in which people deliberately managed natural decomposition processes to produce cheese, wine, beer, and other edible products. Other processes such as smoking, wrapping, and sealing off air are meant to forestall decay in fresh foods. The process of making value-added foods through additional work can be seen in analogous developments in the 21st century, such as the creation of croutons from stale bread or the invention of "baby" carrots through the shaving down of otherwise odd-shaped vegetables.

Archaeological sites have large amounts of detritus that show deliberate accumulation, even when the inhabitants had many options for removing waste from habitations. In the stone-tool period, sites regularly are found with thousands or even hundreds of thousands of waste flakes littering the living areas. Sites of the early food-producing period also regularly show the accumulation of large amounts of broken objects and implements. In the sedentary period, starting with the first villages and up until nearly the present day in urban contexts, archaeologically recovered food remains such as bones, pottery, eggshells, and inedible plant parts often are found in close proximity to dwellings.

Archaeological sites near seacoasts or rivers often are marked by dumps of food-related debris, including large amounts of shells of edible mollusks. These "shell mounds" constitute some of the earliest settlement types of every inhabited continent and in some cases represent hundreds of years of accumulations that afterward served as elevated areas for housing and other activities. One shell mound, at Indian Knoll, Kentucky, was so large that when excavated, it was found to contain over one thousand human burials.

Recycling

The recycling of waste objects for the manufacture of new goods also can be seen in ancient contexts. In the process of manufacturing that resulted in flakes, peelings, and trimmings, people evaluated the potential for those waste materials to be turned into useful objects. The development of the first composite tools, consisting of stone flakes hafted into a handle, may have been one of the first innovations that made use of otherwise discarded materials to make a tool that could be renewed through the insertion of fresh blades.

The term *waste* can be generative of new commodities when objects are recycled. The contents of archaeologically recovered metal hoards worldwide show that smiths deliberately set aside worn and broken objects for melting down to produce new ones. Ancient pottery sometimes also deliberately incorporated crushed broken pottery as a means of strengthening the clay of new vessels. In the 21st century, the use of undisguised waste materials as art can be seen in the use of "found" objects for collages and even for large architectural creations (such as the Watts Towers in Los Angeles, California).

Conspicuous Waste and Deliberate Discard

The ancient attitude toward waste included not only the discard of by-products and worn-out elements but also the deliberate discard of usable goods as a sign of social power and wealth. Conspicuous waste was an important aspect of feasting and other celebrations even in the earliest village societies starting 10,000–12,000 years ago. Ancient burial sites often are accompanied by deposits of smashed cups and bowls, which are usually interpreted as signs of a funeral feast in which objects that might otherwise be reused are instead consigned as commemorative deposit. More rarely, elite burials include multiple bodies representing the sacrifice of otherwise able-bodied individuals whose premature death might otherwise be considered "wasteful."

In some historically documented cultures, serving dishes were meant to be utilized only once, resulting in the potential for significant quantities of discard. While discarded items might have been regarded as ritually "polluted," an ethos of deliberate discard was part of many ancient festivities. Other practices that might be considered "wasteful" of productive capacity include warfare (which often disproportionately results in the deaths of young men whose strengths would also otherwise be needed for farming, fishing, and provisioning their households and communities) and sequestering into religious institutions (which often disproportionately results in females removed from the reproductive pool).

Thus, the notion of waste is not merely about trash or detritus but also encompasses humans' cognitive abilities to assess the relative value of different states of material or physical being. The assignment of the philosophical or economic category of "waste" is a variable one, with some occasions (such as daily meals) including a focus on parsimony, while other occasions (such as celebrations) marked as "successful" by the quantity of excess food and drink that is afterward divided among the participants or simply thrown away.

Urban Waste

The creation and disposal of waste accelerated by the time of the appearance of the first cities,

starting around 6,000 years ago. Ancient cities are some of the best places to understand trash behavior, as there are more people in cities and each individual has more types of objects to choose from, acquire, and use. Often times, this waste was piled up in residential areas and became part of the living landscape. Research at ancient Mayan cities shows consistent patterns of trash disposal around households, with some areas devoted to ordinary trash and other zones with chemical signatures of special-purpose waste, including signatures of heavy metals from the production of pigments. Monte Testaccio, in Rome, is a hill almost entirely made of discarded pottery vessels from the early centuries C.E.

In many cities, rubble from dismantled buildings was reused for the construction of platforms and building foundations. This practice was significantly different from the modern tendency to remove the debris of demolished buildings. The habit of knocking down older structures and using the elevated rubble as a foundation for new buildings resulted in the vertical accumulation of archaeological deposits, as seen most distinctly in the elevated cities known as "tells" in Mesopotamia.

In ancient cities, people recaptured solid and liquid waste as a marker of urban cleanliness. Archaeological investigations of the Harappan Bronze Age culture (ca. 2500 B.C.E.) of the western Indian subcontinent show that there was a collection of waste water from individual houses that led to larger-scale street drains. At the site of Taxila (ca. 6th–2nd centuries B.C.E.) in Pakistan, the excavator noted the presence of refuse bins for waste materials such as bones and broken pottery.

In other ancient cities, accumulated human waste was collected for agricultural and industrial purposes. The archaeologist Tony Wilkinson has suggested that the low-density artifact scatters seen around urban sites in Mesopotamia were the result of using domestic waste to enrich hinterland fields. In ancient Rome, the emperor Vespasian had urine collected, taxed by the state, and sold as a cleansing agent.

Around the world at the household level, the urban response to waste has included the use of wood trimmings and other dry organic waste for household fires (a precursor to more modern forms of waste energy capture such as modern cogeneration plants, which capture remnant heat energy that would otherwise be unused). Urban waste and its treatment thus represent a significant potential for both the individual and the collective approach to material culture.

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See Also: Archaeology of Garbage; Food Waste Behavior; Funerals/Corpses; Recycling in History; Sewers.

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History of Consumption and Waste, Medieval World

Over the medieval period (ca. 500–1500), the European population rose dramatically, people began to move into urban areas, and towns and regions were well connected via trade routes. This situation facilitated booming consumption and the concomitant problems of waste disposal.

Two types of sources are available for medieval consumption and waste disposal: written and archaeological. The documentary evidence is wide-

ranging, including manorial records of harvests and goods consumed, town and guild regulations, wills and property transfers, and cookbooks. The material remains of consumption—the leftover material from craft production, broken pots in pits, and worn-out clothing—are typical objects of archaeological investigations. In fact, waste is the main source for much understanding of daily life, since objects like spoons, cups, buckets, shovels, clothing, and shoes were often in service until they were no longer usable and were then thrown away. Typically, only high-end artistic—and thus expensive—objects and those used in funerary rites survive as non-waste.

The objects of consumption fall into several categories: building materials, everyday craft goods, luxury goods, and food. There were differences between rural and urban consumption, with urban residents tending to depend on specialized craftsmen and merchants to supply the majority of their goods, whereas rural people produced more—but not all—of their own goods.

Building Materials

Building techniques varied widely over the medieval period, with everything from turf houses to grand stone cathedrals. Materials used in construction included stone, marble, brick, wood, and window glass. Building projects in much of Europe intensified after 1000 C.E. as more and more people began moving into urban areas. Old building materials could be reused as foundation or fill for new buildings and streets or to create new land in harbor areas.

Everyday Craft Goods

Everyday craft goods included a variety of items needed for the average household, including pottery, iron cauldrons, leather shoes, fabric clothing, bone combs, and wooden furniture. In general, craftsmen tried to maximize the amount of raw material from a given source; for example, a slaughtered cow generated meat for the butcher, a hide to work into leather, tallow (fat) for candle and soap making, and bones and horns for combs and utensils. However, the production of household goods for sale also generated large quantities of waste, which is often the main evidence for the location of particular craft shops.

Luxury Goods

The higher classes, including secular rulers and churchmen, consumed luxury goods, including gold and silver objects, paintings, sculptures, and books, throughout the medieval period. Many of the medieval objects on display in 21st-century museums such as the Louvre and the British Museum fall into this category of luxury object. The consumption of private books increased dramatically in the later half of the Middle Ages as university education expanded (increasing the demand for textbooks) and private religious devotional books came into use.

Food

Food consumption, while variable over space, time, and social station, was not as sparse in the medieval world as might be assumed. Documents show that beef, pork, fish, bread, produce, and spices were all sold in town markets across Europe, and town governments often attempted to control the quality and prices of the food sold. The consumption quantities were not insignificant: *Le Ménagier de Paris*, a book written at the end of the 14th century, records that 3,080 sheep, 514 beef cattle, 306 calves, and 600 pigs were slaughtered in Paris butcher shops every week to feed the 200,000 residents, and the royal and noble households consumed more on top of that. Much of the food was grown locally, including produce from urban and extra-urban gardens and livestock raised on nearby fields, but not everything was short-traveled. Even in the Middle Ages, extensive trade networks existed for goods like spices and fish, which came from limited geographical areas. Spices were imported via exchange networks from southeast Asia and Africa. Many locations needed to import fish in order to meet the requirement of fasting from meat during the Christian Lenten holidays.

Guilds

In the second half of the medieval period, craftsmen organized into guilds by the type of material they worked with—there were guilds for stonemasons, carpenters, dyers, and bakers. Guilds maintained monopolies on craft production in a particular town, ensuring that outsiders did not enter the market. By setting standards and monitoring the production of their members, guilds controlled the quality of goods, prices, and membership in the trade.

Waste

All of this consumption, particularly in the growing urban areas after the 12th century, led to waste disposal challenges. Waste sources included craft by-products, household rubbish, food scraps, livestock dung, and human excrement. Waste disposal regulations appeared by the 13th century and became commonplace by the end of the 15th century.

Craft By-Products

Archaeological investigations often discover rubbish pits co-located with craft workshops. Considerable amounts of waste are often associated with craft processes. For example, in the shoemaking area of medieval Bergen, Norway, archaeologists have found approximately 27,000 individual pieces of leather scraps weighing 200 kg from the 12th century. The pottery industry also generated thousands of kilos of waste materials and broken pots at sites such as the pottery kilns from the 13th and 14th centuries outside the city walls of Brugge, Belgium.

Urban Waste

Town and central governments throughout Europe issued ordinances forbidding the disposal of waste in urban rivers or vacant property within the town walls. The earliest regulations appear in the mid-1200s in several places: guild regulations from Berwick, Scotland (ca. 1249), contain an ordinance against filth in the town; Bassano, Italy, had sanitation regulations by 1259; and Verona, Italy, had similar regulations by 1276. Records show that local authorities handed out citations and fines to those who violated waste disposal regulations. In spite of the illegality of urban waste disposal in unacceptable places like streets and rivers, there were numerous complaints about waste strewn in the towns. Butchers were particularly notorious for throwing offal into urban rivers and received special treatment in laws in England, France, and Italy. Commoners and elites alike regularly complained about the stench of the urban rivers in metropolitan cities such as London and Paris.

Waste Collection and Disposal

Barrels and waste bins appear in towns beginning in the 1200s in northern Europe. Residents placed barrels in the ground or at the corner of the house or in the courtyard. It would appear that householders took the barrel contents for final disposal off-site and the archaeological material that remains is from the final time the barrel was filled. By the 15th century, the most common acceptable waste disposal locations were community rubbish pits outside the town walls. For example, documents from Coventry, England, include mention of five acceptable waste pit locations outside the gates by 1427. In Stockholm, a 1482 proclamation required individuals to take all waste to a specifically marked area in the hills outside town.

To aid in waste collection, some towns hired street cleaners and weekly waste disposal carts by the end of the 1400s. Carters went through town once or twice a week and collected waste that had been piled up by residents the night before on the street in front of their doors. The local governments collected taxes from residents to pay for these services. The carter services often focused on urban livestock dung, which was either sold or given to farmers for use as fertilizer on their fields.

Latrines

Latrine pits were commonly used for human waste collection in European towns. Privately owned pits were often located within the residential area on back sections of plots or between houses. When possible, they were built to overhang ditches or rivers that would wash the excrement away. Latrine houses often had more than one seat and were shared among residents. Some urban governments maintained common latrines—London had at least 13 common latrines by the early 1400s. Many latrine pits were emptied and the contents disposed of off-site. Human excrement may have been mixed in with animal waste for disposal in some locations, although the documentary evidence is often unclear, with no distinction between human and animal waste. Cleaning these pits was a dangerous job, as medieval coroner's reports in London reported several deaths caused by falling into one.

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See Also: Archaeology of Garbage; History of Consumption and Waste, Renaissance; Human Waste.

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History of Consumption and Waste, Renaissance

From the vantage point of the 21st century, the Renaissance is a period that is remembered for art, literature, music, science, and exotic luxuries, which can be seen as hallmarks of the expansion of the human mind and spirit. The Renaissance, literally a "rebirth," signaled a stage in European history when man sought to understand not only the world but also the human condition, in new and vividly creative ways. By the middle of the 16th century, Leonardo da Vinci had created fanciful machines and intricate anatomical drawings, Martin Luther had challenged the authority of the Roman Catholic Church, and Christopher Columbus had proven that the world is round. International commerce expanded on an unprecedented scale, and the wealth of monarchs, clergy, and noblemen fueled widespread decadence and competitive patronage of the arts. Universities were established to foster education in literature, science, philosophy, and history. With advances in translation and printing, books became accessible for many.

But to consider just the riches of the Renaissance is to adopt a myopic view. Europe during the Renaissance was also a very restless and volatile part of the world. Political upheaval forced the redefinition of once-feudal states into centralized territorial states, commercial battles ensued over trade routes, and corruption and debt cast shadows across society. The church often exerted influence on the state in domestic and international arenas. The discovery of distant lands resulted in the exploitation of indigenous peoples and their resources, ultimately leading to colonization and slavery. Death was an ever-present reality that took the guise of war, famine, or disease, affecting both rich and poor with equal consequence. In Renaissance Europe, misery served as a counterweight to opulence. To understand this dichotomy and the socioeconomic forces behind it, one must consider the long-term effects of climatic changes originating in the previous period. For the majority of Europeans, patterns of consumption and waste during the Renaissance hinged directly on subtle, but lasting, shifts in the weather that had far-reaching consequences on land, at sea, and even in the religious imagery of the afterlife.

For a span of four centuries, from about 800 to 1200, Europeans enjoyed a time of mild and stable weather known as the Medieval Warm Period. These years witnessed great trends of exploration and activity: the Norse established settlements in distant lands of the North Atlantic, majestic cathedrals were erected in France and England, and resources were amassed to support the Crusades. Both poor and rich found sustenance in the annual harvest, and during the Medieval Warm Period, regular, predictable seasons meant that harvests were plentiful enough to feed people and livestock. Some were able to supplement their diet with fish or game, and hearty farm animals ensured that there would be plenty of manure to fertilize the next cycle of crops. This also meant that wool and leather were widely available commodities. Human and animal populations rose dramatically during the Medieval Warm Period, and villages sprang up on formerly open tracts of undeveloped land. Despite localized conflicts and the struggles of vassal relationships, life was generally good. Christianity provided a social order that was felt across Europe, and people sought to demonstrate their devotion and gratitude to God in their daily lives.

In the late 1200s, temperatures shifted and grew increasingly colder. Around 1300, a phenomenon

Country life in France from the 1517 book Manners, Custom and Dress During the Middle Ages and During the Renaissance Period. *Contrary to the popular notion of the Renaissance as an idyllic time of discovery, the period was also marred by strife and disease.*

known as the Little Ice Age began and held Europe firmly in its grip until the 19th century. Conditions during the 1300s were the most severe. Cold rains that lasted well into the summer months created flooding that limited crop yield and prevented harvested hay from drying. Inevitable rot and diminished returns eventually brought on illness and hunger. The wettest years sparked a widespread famine lasting from 1315 to 1321. Those people and animals that survived were so nutritionally deprived and physically weakened that bubonic plague easily wiped out whole towns and villages, culminating in the Black Death of 1348. Glaciers began to advance in the Alpine regions of Europe during the late 16th century, but the coldest period of the Little Ice Age did not occur until the late 17th century. Drier weather during the intervening three centuries, from roughly 1400 to 1700, allowed the international commerce and intellectual advancement of the Renaissance to flourish. The abundant stores of the medieval period were never matched, however, so winters were hard on livestock, which meant there would not be enough manure to use as fertilizer. Famine and disease remained ever-present threats throughout the Renaissance, particularly among the poor.

Food preparation and cooking during the Renaissance continued the traditions of the medieval period, but as trade increased, so too did the European appetite for sugar, spices, and foods from foreign lands. Cakes, candies, and other sweets were in high demand. Among the foods from the New World that gained a foothold during the Renaissance was the potato, which became such an essential staple in Europe that it devastated Ireland during the notorious potato famine of the 19th century. Though a variety of vegetables were enjoyed by the elite, the poor were usually limited to the few root vegetables and herbs that grew locally. Meat was scarce. By far, the most widely available crops were grains, and when they were viable, they formed the foundation of the diet for both humans and livestock. Some scholars argue that an overreliance on grain and a general lack of nutrition triggered a mental agitation that fostered the religious fanaticism and political upheavals that framed the period.

Christianity was severely tested during the Renaissance. The Ottomans seized Constantinople in 1453 and, with it, the Orthodox Church. In the early 1500s, the Catholic Church was rocked by the Reformation. In its most extreme, Protestantism gave rise to Puritanism. As the New World became accessible, the Mediterranean began to lose primacy as the center of the known universe, and Protestantism flourished in distant lands. Those deemed witches, and what were interpreted as the pagan ways of witchcraft, became easy scapegoats for otherwise inexplicable problems such as crop failures or natural disasters. Evangelism and apocalyptic fervor swept across northern Europe, fueled by mass printing of the Bible.

Health and Hygiene

Not surprisingly, "disease" was considered synonymous with "filth," and both were deemed impure and sinful. By the 16th century, the church had had a long history of caring for the sick, and being physically clean and healthy was linked to being spiritually pure. This concept likely generated popular support for advances in medicine and insight into

the spread of disease, which then gave rise to public sanitation practices. Hospitals kept contagious people isolated and clothing worn by the sick was prohibited from being resold or otherwise reused. Still, epidemics raged through military ranks and other tightly housed communities.

Personal hygiene was desired and attempted, but usually too expensive for the average person to sustain on a regular basis. The components of soap, such as olive oil and plant-derived fragrances, made the final product so costly that soap was usually reserved for washing linens and clothing, rather than the body. Keeping one's body clean was achieved by changing clothes and bed linens as often as could be afforded. In Germany, people could enjoy subsidized public baths, but elsewhere, heated water and other components were too difficult or expensive to be maintained.

No matter how earnest the attempt to keep clean, bugs and vermin were ever-present facets of personal space. Attempts were made to dispel offending creatures and odors, but filth was everywhere. In an effort to stem the spread of disease, some cities enforced legislation requiring that streets be cleaned, sewers drained, garbage removed, and inspections made of food and imported goods. The rich had private toilets designed for comfort and proper drainage, and hired workers to keep them clean. They also hired women to launder their clothes and linens. Such workers sometimes doubled as cooks, which gave rise to a separate variety of hygiene problems. The social dilemmas of Renaissance sanitation and hygiene, complete with associated raunchy puns, are vividly detailed in contemporaneous art and literature, such as Dante's *Divine Comedy*.

Conclusion

The topic of consumption and waste in the Renaissance would be left incomplete without touching on some ideas that are harder to quantify. What were the effects of deforestation to provide the wood used to construct ships, granaries, and musical instruments? How expensive was it to use egg albumin to bind pigments or to create gold leaf for illuminated manuscript pages? Were European Christians more receptive to Muslims in commercial arenas than they had been during the Crusades? Can the consumption of ideas and cultural exchange be measured? How much does imagination drive consumption, or ignorance fuel waste? Such questions only scratch the surface of a period that served to set the stage for the political revolutions, industrial innovations, and ground-breaking inventions that ushered in the modern era.

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See Also: Bubonic Plague; Culture, Values, and Garbage; History of Consumption and Waste, Medieval World; History of Consumption and Waste, World, 1500s; History of Consumption and Waste, World, 1600s; Human Waste.

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History of Consumption and Waste, U.S., Colonial Period

The intellectual roots of consumer culture during the U.S. colonial period can be traced back to 17th-century western Europe and the antimercantilist idea that domestic markets were sufficient to sustain national economies. By the mid-18th century, as capitalist ideology and early industrialization spread through England and the rest of Europe, it also enhanced the culture of consumption. Specifically, the 17th- and 18th-century English culture had a dominant influence on consumption patterns of colonial America. Colonists considered English-made goods as indicators of status and respectability in society.

The abundance of land in the colonies prompted a focus on agriculture. By around 1715, the colonies had also achieved extensive community stability—family formations had reached levels that allowed for self-sustaining growth. During the first half of the 18th century, the colonies enjoyed ample harvests and, increasingly, a better quality of life. Regional patterns of agriculture and agricultural exports evolved. The south specialized in products such as tobacco, rice, and indigo. Mid-Atlantic farmers grew wheat, which in raw and processed form comprised the second-leading export in the mid-18th century.

Because of rocky soil, horticulture was constrained in New England, and it had to rely more on exporting fish and whale products along with foodstuffs, livestock, and rum. There were differential patterns of reinvestments; the southerners focused on reinvesting their profits in the land without diversifying their holdings, while the northerners invested in various enterprises, hence causing economic differentiation.

Social Stratification

With the accumulation of wealth, social class structures became more distinct, the greatest stratification occurring in coastal areas linked to transatlantic markets. Perhaps fewer than 20 percent of colonists lived at or close to the subsistence level, but the majority of them lived in artisan or yeoman families that earned a decent livelihood. With the rise of disposable income and more efficient ocean transportation, more households bought British household goods. More than half of properties were owned by the upper-class whites who also owned the lucrative plantation and counting houses. They aspired to have the status and power of the British upper classes and did so by buying the urban luxuries imported from that country.

Growth and Consumption

The population of the American colonies grew at a very fast pace after the mid-18th century, and along with it grew the per capita consumption of British imports. More than half the colonists were younger than the age of 16 and were primarily responsible for the exploding demand. The market for import goods rose 120 percent between 1750 and 1773. Even in rural regions, consumers began relying on them. For example, a study found women in rural North Carolina willing to pay a very steep price for Irish soap. The colonial consumer was faced with an unprecedented variety of choices in the marketplace.

For example, in 1720, merchants in New York City rarely advertised more than 15 different imported items per month. By the 1770s, the list had expanded to over 9,000 different manufactured goods. With the expansion of the number of items, the descriptions of the categories became more vivid. Between the 1740s and the 1760s, the New York merchants went from simply advertising for paper to listing 17 varieties by color, function, and quality. Similarly, customers went from expecting a generic variety of satin in the 1730s to being offered a dozen different varieties by the 1760s. No carpets were available in the 1750s, but by the 1760s, brand names such as Axminster, Milton, Persian, Scotch, Turkey, Weston, and Wilton were carried by stores. Since the 1750s, gloves were sold as "orange," "purple," "flowered," "white," "rough," "chambois," "buff," "Maid's Black Silk," "Maid's Lamb Gloves," "Men's Dog Skin Gloves," and so on.

Consumption and Taxes

For most of the colonial period, individual citizens rarely paid any federal taxes, since federal revenues were mostly derived from excise taxes, tariffs, and customs duties. Before the U.S. Revolutionary War, the colonial government had only a limited necessity for revenue, while each of the colonies had their individual revenue demands, which were met with different types of taxes. For example, the southern colonies principally taxed imports and exports, the middle colonies from time to time imposed a property tax and a "head" or poll tax levied on each adult male, while the New England colonies raised revenue primarily through general real estate taxes, excise taxes, and those based on occupation.

England's need to generate revenues to pay for its wars against France necessitated the passage of the Stamp Act in 1765, which was the first tax imposed directly on the American colonies, followed by Parliament's imposing a tax on tea. The colonists were asked to pay these taxes without representation in the English Parliament, leading to the rallying cry of the American Revolution and establishing a persistent skepticism regarding taxation as a part of U.S. culture.

Hygiene and Waste Management

The American colonies lacked organized public works for street cleaning, refuse collection, water treatment, and human waste removal prior to the mid-18th century. Recurring epidemics mandated initiatives to improve public health and the environment. Early European visitors to the American colonies in the 17th and 18th centuries frequently complained about the absence of reliable supplies of soap and water, the prevalence of mud and manure, flies and insects, and disgusting tobacco stains (from both spitting and chewing). More than 80 percent of the colonists lived in hygienically primitive situations on small farms or in country villages. Even in larger cities like Philadelphia and Boston, epidemics such as cholera and typhoid necessitated efficient water and sewer systems and stimulated massive public works construction, yet changes in personal and domestic cleanliness practices came slowly.

Some of the earliest citywide sanitary systems in colonial America were built in the early part of the 19th century. Few communities boasted of sophisticated systems, and much of the responsibility lay in the hands of the individual. The casting of rubbish and garbage on the streets was commonly practiced during most of the 18th century. Animals such as pigs, rats, and raccoons ate most of the garbage, while natural systems, such as the sun and wind, eventually eliminated the trash. Since the colonies had plenty of land and natural resources at their disposal, early waste management practices did not severely damage the environment. Urban area dwellers also had a higher tolerance for filth.

Diseases during the colonial period were mainly attributable to garbage because it contaminated water supplies and served as a breeding place for flies, rats, and other disease-carrying vermin. Diseases such as dysentery, bubonic plague, cholera, and typhoid fever increased because of appalling sanitary conditions. On hot summer days, cities smelled of odors from open-air markets, rotting trash, dead animals, animal waste, and leaking privy vaults in the basements of apartment buildings in the city slums. Even in rich neighborhoods, piles of garbage and the sickening odors of decaying refuse were evident. Dust and soot were very common. Sewer systems typically ran into the nearest rivers and oceans, contributing to the stench of daily life. Town thoroughfares were filled with manure from horses and animals scavenging through garbage thrown on the streets. Rainstorms turned streets into rivers of slime.

According to the American Public Works Association (APWA), Benjamin Franklin was responsible for designing the first colonial waste management system and municipal cleaning program in Philadelphia in 1757. The Corporation of Georgetown (now in Washington, D.C.) passed one of the first ordinances in 1795 outlawing dumping in the streets and strong refuse on private property. President John Adams hired a private refuse carter when he moved into the newly constructed White House in 1800. Refuse from other federal buildings was burned on the grounds of the buildings. The smell of burning garbage sickened President Thomas Jefferson while riding in his carriage, which led him to institute a plan to have the solid waste collected from the federal buildings and burned elsewhere. By the early 1800s, private waste collectors were responsible for cleaning the streets of Washington,

D.C., periodically and keeping the solid waste at tolerable levels, at least according to the standards of the time.

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See Also: Consumption Patterns; Culture, Values, and Garbage; Household Consumption Patterns; Recycling.

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History of Consumption and Waste, U.S., 1800–1850

By 1800, Euro-Americans were already accustomed to the variety of consumer choices, moral ambivalence, and standardization of consumer behavior that accompanied the consumption of ready-made commodities. However, this period saw significant social, economic, and technological changes that made it unique from the patterns of commodity consumption and waste preceding it. Transportation projects, urbanization, and the redistribution of wealth had some of the most profound effects on consumption and waste. New transportation networks enabled commodities to reach more consumers.

While both waste and consumption increased slightly, because of urbanization, waste became much more concentrated in cities. While the miasma theory of disease linked filth and garbage with the epidemics raging through cities, concepts of urban ecosystems or the political structures that could tackle citywide material problems had not yet developed. The 1900s would usher in both an environmental consciousness and, slightly later, a commodity culture. Finally, the stratification of social classes due to the redistribution of wealth resulted in very different consumption patterns and waste management practices for different groups of people.

Transportation Networks

Massive canal and railroad projects between 1820 and 1850 revolutionized markets and market relations as goods circulated more widely and became cheaper. Not only could commodities now reach rural farmsteads and villages in larger quantities more regularly but also the savings in costs-per-ton-per-mile of transporting goods was passed onto the consumer in a "price revolution," making consumer goods more affordable. However, while there was a fully commercialized network of production in urban areas in 1830, mass production and mass consumption would not occur until the 1900s. Instead, the circulation of goods (and waste) remained largely local or regional, akin to cottage industries, even though U.S. import merchants were introducing increasing numbers of foreign-made goods.

Urbanization and Wealth Redistribution

Simultaneously, the saturation of settled rural land along the eastern seaboard resulted in an urbanizing trend that was to characterize the century. In the first federal census in 1790, 5.1 percent of the recorded population lived in 24 cities. By 1840, this number had risen to 10.8 percent in 131 cities, though only New York City's population exceeded 250,000. Thus, consumption patterns, access to commodities, and experiences of waste were different for rural and

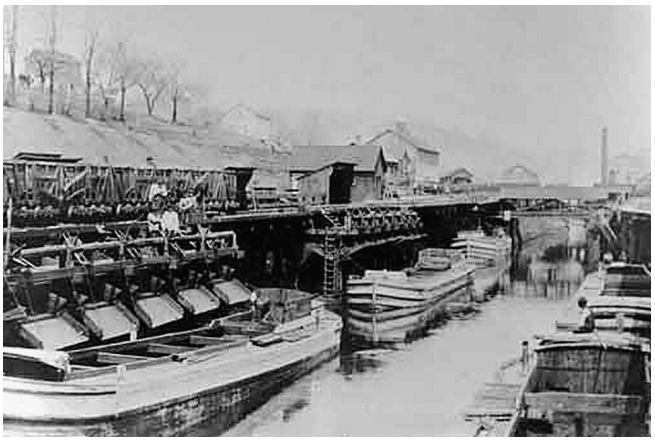
urban dwellers. Cities were generally sites of filthy streets, polluted water, and epidemic diseases, but rural areas could bury, burn, and otherwise dilute their trash with fewer immediate repercussions.

Finally, wealth was radically redistributed during this time. By 1850, the top 10 percent of the population owned 90 percent of the wealth, and the most privileged 1 percent owned 50 percent. Most of this wealth came from importing, exporting, and finance. At the local level, this gap in wealth and resources led to more economic distance between social classes, which differentiated both consumption and waste patterns.

Barter, Thrift, and Reuse

The major form of commodity distribution in the first half of the 19th century, especially in rural areas, was the peddler. The peddler did not only bring ready-made commodities to households but also enabled a two-way barter economy between domestic settings and industry. Industrial production relied heavily on scavenging for raw materials, and rural consumers—particularly the women who managed their household economies—had little cash. Rags, bones, ashes, and fat could be traded for tinware, cloth, tools, and kitchenware. Thus, people obtained manufactured goods by saving waste, though "waste" might more appropriately be thought of as scraps or useful materials within this context. The concept of "garbage" as an undifferentiated mass of undesirable cast-off materials did not yet exist.

Not all scraps were traded for ready-made goods, however. Many things were still made at home, both rurally and in cities. Historian Susan Strasser has written about how women's domestic manuals taught women and servants how to reuse, mend, and repurpose everyday objects and leftovers. Just as the case of saving scraps for barter allowed people to participate in commercial consumption, so did thrift and reuse. Domestic frugality and what Strasser calls the "stewardship of objects" was meant to prolong the life and use of new commodities. It included remaking clothes or display objects to participate in changing fashions, for example. In other words, thrift was not necessarily an ideal or end in itself but instead was one means to achieve greater comfort and consumption.



Barges await coal loads along the Delaware and Hudson Canal. Massive canal projects in the mid-1800s revolutionized markets as products became cheaper to transport and were more widely distributed. Consumers ultimately benefited from the cost savings.

Charity

The prolonged life of objects allowed them to enter into informal and formal economies beyond the peddler barter system. For example, before the sewing machine was invented in 1846, little ready-made clothing was affordable; all women knew how to sew, regardless of their social class or standing. Clothes had long lives, despite fashion trends, and were constantly darned, mended, remade, and passed down. While a significant quantity of clothing was sold to a large secondhand clothing market, upper-class women gave clothes to servants, slaves, or those "less fortunate" than themselves. This charity was considered part of their domestic duties. Goodwill was established in the United States in 1845; the Salvation Army began two decades later. However, the concept of charity through passed-down clothing was common long before it was institutionalized in the 21st century.

A second domestic duty that tied charitable domestic economies and scraps was food waste. Iceboxes remained an expensive luxury after their invention in 1827, until technological advances in ice cutting allowed affordable, urban ice carts to become a regular sight in city streets by 1850. While many food scraps were saved for future meals, "pantoting" (the practice of domestic servants receiving food scraps) was also common. It was sometimes considered either stealing or charity, and other times

it was arranged by contract. In rural areas, food scraps provided excellent animal feed, and slop buckets were a permanent fixture on front steps. In cities, food scraps also went to livestock of sorts. Once scraps were thrown out the window onto the streets, roaming pigs, goats, and dogs performed the Herculean task of garbage disposal. In addition to animal scavengers, many more-organized structures existed to collect food waste and slops for transport and sale to regional farms.

Urban Waste

However, pigs, goats, and more-organized collections of waste could not keep up with the trash in city streets. Throughout the 19th century, locals and travelers recounted the overwhelming stench of "filth" that made most urban roads impassable. Seafaring travelers could smell New York City before they could see it. Cities were sites of epidemic disease, polluted wells, and overflowing privies. By mid-century, public health boards had formed in many cities. They reiterated laws that had long been in the books, passed new ones prohibiting dumping in streets and waterways, and outlawed roaming scavenging animals, all with little effect. Municipalities that set aside money for sporadically "purging" the streets of waste or for hiring cartmen to pick up unlawful waste also struggled to keep streets clean and clear. One main issue was that there were no clear lines of responsibility or enforcement for refuse collection and disposal. A second issue was government corruption and graft, where money, inspection positions, and private collection contracts usually went to political allies, rather than effective street cleaning enterprises. Ad hoc systems of waste removal developed, using both private contracts (mainly for businesses and wealthy neighborhoods) and public agents, which rarely offered comprehensive community-wide programs. Waste collection was thus organized according to class and social standing.

Consumption

Consumption patterns were also heterogeneous across and within class divisions. Not only was there no "mass" consumption but also there was not a steady increase in average per capita consumption from 1800 to 1850, if such a thing could be said to exist. The upper class solidified as 90 percent of U.S. wealth was redistributed to 10 percent of the population. Within the working class, earnings rose between the 1820s and 1840s but fell in the 1850s. Both skilled and unskilled workers did not have enough resources to support their families with basic comforts like regular food and heat. This resulted in reducing consumption of meat and other expensive foodstuffs, fuel, and new, ready-made commodities. When the working class did purchase ready-made goods, their use and symbolism was appropriative, rather than strictly emulative of the upper classes. The working class did not have access to the bourgeoisie "dream worlds" of leisure entertainment and shopping centers where the symbolism of ready-mades would have been articulated. Mass production, mass consumption, and mass communication would radically change this in the following century.

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See Also: History of Consumption and Waste, U.S., Colonial Period; History of Consumption and Waste, U.S., 1850–1900; Miasma Theory of Disease; Street Scavenging and Trash Picking.

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History of Consumption and Waste, U.S., 1850–1900

The second half of the 19th century was the era of railroad transport in the United States. Railroads interconnected the states from coast to coast (after 1869) and sped economic development and urbanization. Railroads were the only efficient and economical means of moving goods and people across

the country. The railroads reduced the use of steamboats in the midwestern and southern states served by the Mississippi River system (including the Mississippi, Ohio, and Missouri rivers).

At the time, there were several types of cities: (1) cities that showed enormous increases in population and commerce as a result of industrialization and that also experienced a huge migration wave from Europe, (2) small, old cities, and (3) newly founded cities. In large cities, horse wagons coexisted and competed with interurban (trolley or "street running") rail lines. In San Francisco, California, the very first successful cable-operated street railway was the Clay Street Hill Railroad, which opened on August 2, 1873.

Industrialization, Consumption, and Waste

Railroads helped many industries, including agriculture. Farmers had a new way to send wheat, grain, and other products to ports. From there, ships could carry the goods around the world. Trains had special container cars with ice to keep meat, milk, and other goods cold for long distances on the way to market. People could get fresh fruits and vegetables throughout the year. Locally grown crops could be sold nationally. By 1880, there were more than 160,000 miles of railroad in the United States. Rail traffic spurred the growth of industrial cities in the midwest, especially Chicago, which became a center for trading grain, lumber, and meat in the late 19th century.

Environmental consequences for these industries were concentrated. Chicago became known as the "hog butcher to the world" after 1865, slaughtering thousands of animals each day for distribution across the nation. Wastes from the slaughterhouses dumped into the adjoining fork of the Chicago River created the infamous Bubbly Creek, where methane from organic wastes bubbled constantly, and a thick skin on the water allowed both chickens and humans to stand on the surface.

Demographics and Statistics

In 1850, the U.S. population was 21,191,786. Farm population consisted of 11,680,000 farmers—about 64 percent of the labor force. In just 30 years, the population increased to 50,155,783, while the farmer demographic decreased to 49 percent.

Industrialization influenced the growth of the value of products of certain manufacturing industries differently:

- The highest growth was seen in iron and steel production, from ca. $200 million in 1870 to ca. $800 million dollars in 1900. Slaughtering and meat packing grew from less than $25 million in 1850 to almost $800 million in 1900. Flour and grist mills grew from ca. $150 million in 1850 to ca. $550 million in 1900. Similar increases were seen in the clothing and textile, cars (steam railroad), and cotton and wool industries.
- The United States was the world's leading producer and consumer of zinc in 1850–1900 and afterward. U.S. mines and smelters produced 15 and 20 percent, respectively, of world output, and U.S. zinc consumption accounted for about one-fourth of the world total—63 million tons (1850–1990). Dissipative uses and landfill disposal have accounted for about 73 percent of the potential zinc losses to the environment, followed by mining and smelting (22 percent), and manufacturing (5 percent).
- The production of leather increased to ca. $200 million in 1900. The production of paper and wood pulp, silk, agricultural implements, clay products, hosiery, and knit goods increased from $50 million to ca. $100 million dollars.
- The statistics show a considerable increase in the consumption of water in the United States toward the end of the 19th century, from 42 gallons per capita in 1850 to 101 gallons per capita in 1994 (Boston). In Detroit, the consumption of water almost doubled from 120 gallons per capita in 1882 to 209 gallons per capita in 1889, but it fell to 150 gallons per capita by 1891, in particular, because of elimination of waste at the pumps, among other reasons.
- In the 1860s, the California Volunteers under Col. Patrick E. Connor discovered copper in the mountains of the Salt Lake Valley. The Walker brothers, Salt Lake City merchants, hauled the first wagonloads of copper from Bingham Canyon in 1868. Throughout the 1870s and

1880s, copper was essentially a by-product of the lead-silver ores mined in Bingham and elsewhere.

Innovations

During the second half of the 19th century, many essential innovations became embedded in people's everyday consumption, including the first refrigerator, electricity available for households, and the telephone. In 1859, during the Ginseng Rush, for one week only, about 12,000 pounds of ginseng were exported through Faribault, Minnesota. This was also the period when the first commercial chewing gum, Coca-Cola, breakfast cereals, and self-rising flour were introduced. Other inventions from this period included condensed milk, dry milk, and milking machines; potato chips; margarine; and the oil hydrogenation and methanol industries that grew out of the research by Paul Sabatier on catalytic organic synthesis. In addition, this period spawned the first vegetable oil used in the United States (cottonseed oil), the first large vineyards planted (Sonoma Valley, California), the first tin can with a key opener, pascal celery, and the first Nestle chocolate bar, among numerous other innovations.

From the perspective of food, the second half of the 19th century was a period of diversity in food styles. Queen Victoria ruled England, but her way of life was imitated all over the world, including in the United States. Immigrants—Europeans and Chinese—introduced new traditions and ingredients to U.S. dinner tables. In addition, many traditional foods and recipes were brought from west Africa through slave foods and preparations.

Sustainability, Health, and Sanitation

During this period, people generally avoided wasting things. According to narratives, even middle-class people traded rags to peddlers in exchange for teakettles or buttons. Most meats, fruits, and vegetables were bought fresh from markets or were raised and processed by the household. Canning was the common method for preserving food.

In 1852, the first public lavatory opened for business in London. Five years later, H. N. Wadsworth received the first U.S. toothbrush patent. Mass production of toothbrushes in the United States began in 1885. In 1972, Silas Noble and James P. Cooley of Massachusetts patented a toothpick-making machine.

Waste and Disposal

From 1850 to 1900, the main waste strategy was to burn garbage or deposit it in rivers and oceans. Typical problems with garbage were smoke, odors, rodents, flies, litter, and ground and surface water pollution. One of the results of burning garbage was air pollution. This practice was one of the components of increasing sulfur emission—from 311 to 9,345 ($GgSO_2$). The increase of garbage, in the course of industrialization, created a new problem: how to find the best management strategies. This was resolved in the early 20th century through the systems of landfills.

One of the newly founded cities at that time was Alpine (former Upper Dry Creek, Lone City, Mountainville) in Utah. Just several years after its founding, the garbage situation was out of control. On June 25, 1862, a $1.00 per month assessment for garbage pickup was to be payable with the water bill.

In 1885, the first U.S. garbage incinerator was built on Governor's Island in New York. The first rubbish-sorting plant for recycling was built in 1898 in New York. Since people were commonly frugal, household wastes were much less in volume compared to the 21st century.

As late as the U.S. Civil War, pigs, goats, and stray dogs were free to roam the streets as "biological vacuum cleaners." The theory that filth could contribute to human illness began gaining popularity and gradually made its way from England to the United States. As a result, local governments began setting standards for the protection of human health. The nation's first public health code was enacted in New York City in 1866.

By the late 1800s, the germ theory of disease, and its correlation to sanitary conditions, was reaching its peak largely because of three epidemics in the 1870s. A cholera epidemic in the Mississippi Valley in 1873 killed approximately 3,000 people, while New Orleans and Memphis were both struck with yellow fever epidemics. Then, in 1878, the south was struck with the worst yellow fever epidemic in the country's history. Death from disease in the Old West was typically due to infections from typhoid,

yellow fever, diphtheria, malaria, measles, tuberculosis, cholera, and dysentery. Death from typhus and typhoid were particularly common because of overcrowding and poor sanitary conditions in many early camps and towns. In large part because of these epidemics, the federal government finally began to realize it should play a role in ensuring sanitation and created a National Board of Health in 1879.

Nevertheless, the streets of New York City were several feet deep in horse manure and garbage by 1882. The city reeked, and any garbage that was collected was dumped into rivers, lakes, and oceans. Private businesses specializing in waste hauling and trading grew substantially during this period. The rag trade, in force since the early 19th century, remained a major industry, although the advent of wood pulp in paper manufacture had begun to affect markets for cotton and linen rags by the end of the century. Trade in old iron, fueled in large part due to the expansion of the railroads, grew in the last third of the century, with scrap peddlers, yards, and brokerages growing in most northern industrial cities. While work in much of the waste trades was subsistence based, industrial demand for secondary materials (including copper and precious metals) allowed businesses to grow. First-generation immigrants from southern and eastern Europe founded many of these businesses; they would grow the waste trades as the United States entered the 20th century.

The period between 1850 and 1900 was a bridge to the contemporary world of diversity in consumption and of overconsumption, technology, public health concerns, and the highly developed technology of waste and garbage. It was an innovative period in the field of consumption and a period when contemporary waste and garbage technology began as one of the most essential tendencies in developing sustainable social sensitivity.

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See Also: History of Consumption and Waste, U.S., 1800–1850; History of Consumption and Waste, U.S., 1900–1950; Industrial Revolution; Industrial Waste; Meat; Population Growth.

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History of Consumption and Waste, U.S., 1900–1950

From 1900 to 1950 in the United States, consumer expenditures increased sixfold, while the amount thrown away rose steadily. However, it is inaccurate to conclude that Americans simply became more wasteful. This period witnessed a dramatic transformation in practices concerning consumption and waste resulting from numerous intersecting changes and their unforeseen consequences. In the burgeoning mass market, large-scale production generated new kinds of waste, such as packaging and disposable items.

Estimating garbage increases, however, is problematic because until the 1930s individuals were largely responsible for managing their household waste. At the same time, mass production created greater efficiencies in homes, factories, and farms. Innovations for household use allowed consumers to enjoy more free time. New technologies enabled producers to produce in greater numbers and variety. Invention also rendered some goods obsolete.

Broad access to myriad goods held the social benefit of diminishing class lines. While the perception of waste as improper to use or something without value did not change, what was deemed wasteful remained a matter of debate. Both consumption and production practices came under fire. Critics argued that manufacturers profited by squandering materials and labor on luxury goods or low-quality items that would need to be replaced, instead of producing long-lasting basic products. Under this strategy, manufacturers relied on limited supplies rather than maximized output in order to increase prices, which many perceived as exploitative and inefficient. Others expressed concern that consumers bought things that they did not need or carelessly discarded perfectly good items for more fashionable versions. Many even viewed the Great Depression as punishment for the profligate spending of the 1920s. Whether mass consumption improved U.S. quality of life or was outweighed by its negative impact on the environment and social relations remains debatable. Regardless, from 1900 to 1950, consumption of mass-produced commodities emerged as the U.S. way of life, reuse changed from an ordinary practice to a symbol of poverty, and consumers ascended as a political group as vital to the nation's wealth and identity as industrial and agricultural producers.

Impact of Mass Production

Several factors rendered 19th-century household habits of repurposing and saving rags, bones, and scrap metals for sale to peddlers less practical and unnecessary. Nationwide distribution via the railroad system and standardized manufacturing enabled consumers to purchase products that previously had been homemade, too expensive, or inaccessible. At the same time, industries recycled many by-products of mass production, selling them in huge quantities to one another. For instance, soap manufacturers purchased grease from meat processors, and paper mills bought textile scraps. This effectively eliminated some outlets for household discards, as peddlers could not compete in terms of quantity with corporate salvage at a time when consumers no longer needed to spend time making things such as soap. Likewise, the steady increase in manufacturing jobs resulted in a population shift to urban centers; by 1920, more than half of the U.S. population lived in cities. These citizens lacked storage space as well as time for remaking odds and ends.

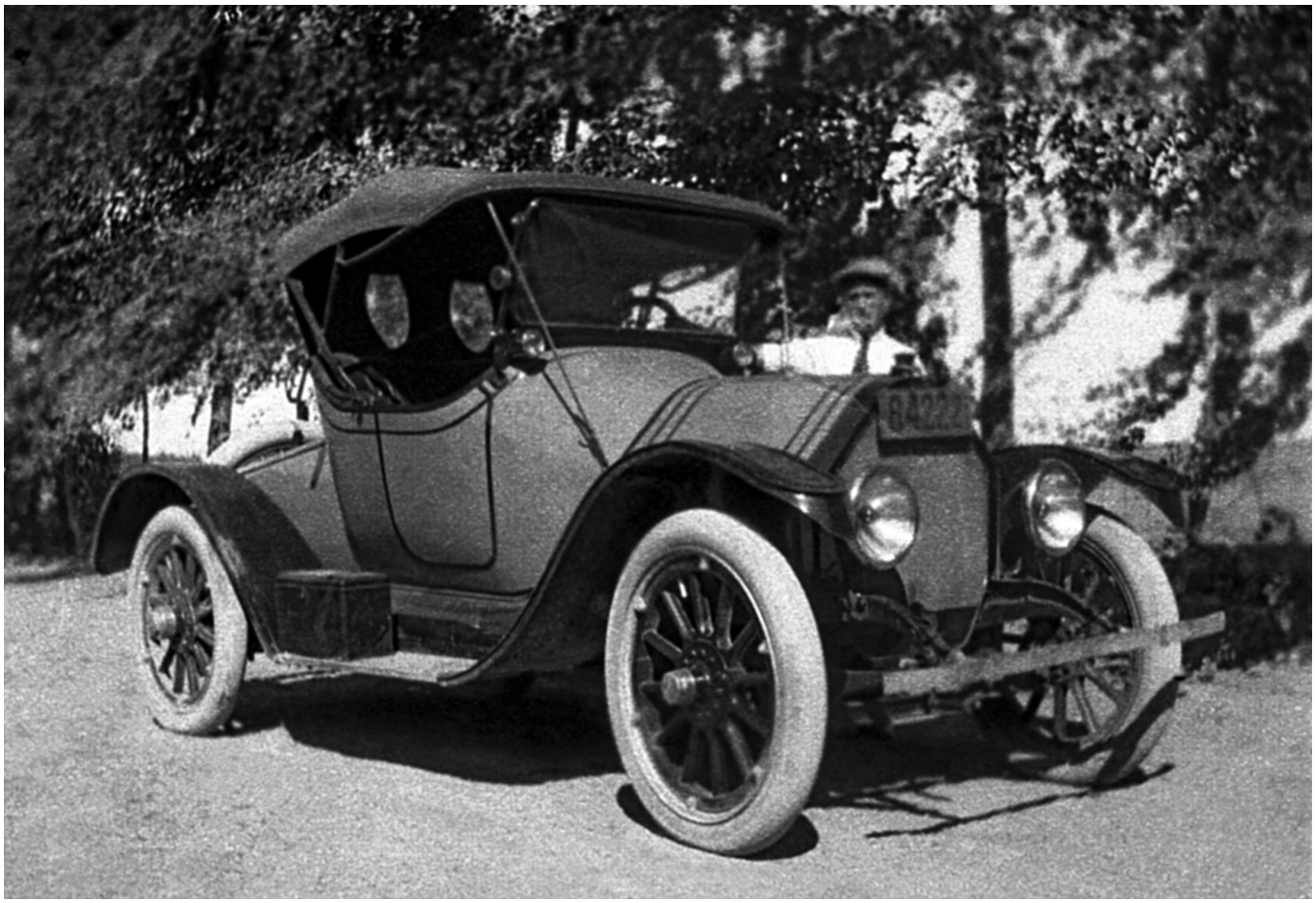
While the feasibility of reuse decreased and thus changed leftovers from resources to garbage, rapid advances in design and assembly-line production increased manufacturers' capacities and product variety. In the digital age, it is easy to imagine the excitement an ever-growing parade of new products from radios to refrigerators stimulated and how quickly a new technology might prompt consumers to toss outmoded items. The rise in consumption of mass-produced goods reached new heights by the end of the 1920s. The largest increases in expenditures were on items that promised more leisure time or recreation. The purchase of processed foods, household appliances, and ready-made clothing freed women from hours of domestic labor each week. By 1929, one in five Americans owned a car, cutting travel times from farms to towns and enabling tourism. Additionally, products manufactured for one-time use, like toilet paper and napkins, made disposability, not durability, a desired product feature. Mass-produced products became associated with convenience and a better quality of life; more stuff was bought and then discarded for more fashionable or technologically improved models.

Packaging and Marketing

Packaging represented an integral part of changing consumption practices and was a new form of waste. Manufacturers used packaging to market their products as superior to the competitors' in terms of quality, style, and experience. High subscription rates to magazines, littered with advertisements, created product branding. Advertising associated products with values ranging from wholesomeness to rugged masculinity; using certain products offered a way for consumers to express their identities. Although packaging also improved product cleanliness and minimized damage, it proved fundamentally worthless once stripped from a product.

Charity and Salvage

Charitable institutions established at the turn of the century, such as the Salvation Army and Goodwill, allowed consumers to unload unwanted items and justify buying new ones. In the process, they fostered the association of secondhand with poverty.



A classic Model T Ford from the early 1900s. By 1929, one in five Americans owned a car, cutting travel times and boosting tourism. The largest increases in expenditures during that time were on items promoting leisure time or recreation. By the 1930s, the Great Depression derailed consumerism and dramatically altered Americans' perception of production. During this period, ample supply stood in contrast to a lack of purchasing power. To reignite consumption, New Deal policies attempted to restore the balance of production and demand.

The experiences of the Great Depression and two world wars demonstrated castoffs' potential value, simultaneously reinforcing reuse as a method of making do in times of crisis. Salvage campaigns conducted during the wars connected reuse with patriotism. However, war represented a disruption to ordinary life.

Great Depression and the New Deal

The Great Depression not only disrupted growing consumerism but also radically changed how Americans thought about production, consequently politicizing consumers. Americans believed that producers formed the basis of the nation's wealth by literally creating material abundance, whether by cultivating land or making automobiles. Even Progressive-era legislation designed to protect consumers from adulteration and price hikes limited the government's regulatory power because free market competition was assumed to be the best regulatory measure. By the time President Franklin D. Roosevelt took office in 1933, however, the "paradox of want amid plenty" belied faith in laissez-faire capitalism and the value of ever-expanding production. The paradox described the situation of ample supply and high demand without purchasing power. It seemed most visible in agricultural commodities rotting in fields because the unemployed could not afford to buy them and farmers could not afford to harvest them. New Deal policies attempted to end underconsumption by restoring purchasing power and bringing production into balance with demand.

The National Industrial Recovery Act (NIRA) and the Agricultural Adjustment Act (AAA) curtailed production, focused on increasing consumers' purchasing power by mandating a minimum wage and maximum work hours and integrating consumer councils that lobbied for fair prices. Policy makers considered consumption vital to economic recovery and so began to recognize consumers as an interest group distinct from industry, labor, and agriculture.

Wartime production of the 1940s helped to end the Depression, but it also caused consumers to save rather than spend. Rationing limited what could be legally purchased, and industry shifts to military production created a scarcity of consumer goods. After more than 15 years of making do and going without due to economic crisis and war, consumers with huge savings accounts and high employment were ready to spend. The ability to do so had become so integral to how Americans understood their capitalist democracy that during the cold war, mass consumption was touted as evidence of the United States' superiority to communist nations.

Waste Management

Municipalities' responsibility for waste handling grew alongside the rise in mass consumption; together, they ultimately changed how the country dealt with and thought about waste. At the turn of the 20th century, rural households and city dwellers were still largely responsible for waste removal. This often entailed garbage being thrown out windows onto streets, burned, composted, or sold. Some cities at this time began organized trash collection to control stench and disease, as well as to improve aesthetics. Collection practices initially mirrored household methods of sorting and salvaging materials; private waste collection firms and city agencies required households to sort trash so as not to waste a revenue source. By the time that publicly funded waste collection became widespread in the 1930s, however, reuse as part of waste management had largely given way to engineering cheaper and pleasanter disposal. Municipalities used various methods including burying, reduction, incineration, and river, lake, and ocean dumping until the 1950s. Military technologies developed during World War II improved landfills; inexpensive, sanitary, and the least offensive to the senses, landfills became the dominant form of trash disposal. As opposed to unsightly and malodorous methods, landfills could mask garbage as green spaces. Though the amount of garbage increased, this kind of waste became less visible.

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See Also: Consumerism; Economics of Waste Collection and Disposal, U.S.; History of Consumption and Waste, U.S., 1850–1900; History of Consumption and Waste, U.S., 1950–Present; Household Consumption Patterns; Overconsumption; Underconsumption.

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History of Consumption and Waste, U.S., 1950–Present

In 1950, Americans had begun to emerge from the austere Great Depression and rationing of World War II to enter a new consumptive era. If wartime rationing had meant a moratorium on domestic

housing construction, automobile manufacture, and the distribution of luxury goods, the postwar era saw accelerated rates of consumption and waste beyond any the United States had seen before the market crash in 1929.

Changes in policy and corporate structure aided what historian Lizabeth Cohen calls the "Consumers' Republic." During World War II, federal military contracts allowed a few corporations such as General Motors, Boeing, and U.S. Steel to grow far larger than they had before the war. In the 1950s, these behemoths employed hundreds of thousands of white-collar and blue-collar workers who were at once producers and consumers. Without serious economic and financial competition, the United States enjoyed not only unparalleled productivity but also global dominance, at least for a time. Buoyed by consumer spending and unprecedented "peacetime" military budgets (inflated by the cold war with the Soviet Union, in which American materialism provided ideological ammunition for both sides), the nation's material production expanded so explosively that Harvard scholar John Kenneth Galbraith's *The Affluent Society* in 1958 gave a name to a phenomenon captivating writers in the United States for years.

Affluent Society

Never in the history of humankind had so many people in any nation enjoyed so much prosperity, even though the impoverished continued to number in the millions. According to William Leuchtenburg, the United States had only 6 percent of the planet's people at mid-century, yet it was producing and consuming over 30 percent of the world's good and services. The phenomenal domestic production growth that occurred after the war depended on international political and economic networks of which it formed a constituent part, but it also depended on a series of domestic compromises and repositionings on the part of the major actors. A complex of dynamic industries arose, including automotive, steel, petrochemical, and construction. Some of the propulsive engines of growth, based on technologies that had matured in the interwar years, had been prompted after the war by both new extremes of rationalization and links to academic research and development.

From 1946 to 1958, writes Leuchtenburg, corporations put an average of $10 billion a year into new plants and machinery. Consequently, large corporate power was further deployed to assure steady growth of managerial expertise in both production and marketing and the mobilization of economies of scale through product standardization. The state, for its part, assumed varying social and political obligations. Given that mass production required heavy investment in fixed capital, it also required relatively stable demand conditions to be profitable. The state strove to curb domestic business cycles through a mix of fiscal and monetary policies directed toward public investment in transportation, suburbanization, and public utilities; in the establishment of social wage agreements, social security benefits, and federal guarantees of mortgages earmarked for a mass of ex-GIs—all pursuits that were vital to the perpetuation of the flows of mass production and mass consumption. In the meantime, the civilian labor force expanded, as Leuchtenburg put it, from "54 million in 1945 to 78 million in 1970."

Suburban Nation

Increasingly, these people lived in new housing built in suburban subdivisions away from aging city centers. Federal mortgage policies developed to stimulate the housing market during the New Deal allowed banks to offer millions of Americans 25- and 30-year mortgages, providing the dream of home ownership with a modest down payment. Between 1950 and 1970, the exodus to the urban periphery transformed the United States from an urban to a suburban nation; historian William Leutchenburg sums up the demographic shift by noting the following:

> . . . by 1950 there were 37 million suburbanites; two decades later, the number had nearly doubled. As many moved to the suburbs each year as had come to the United States in the peak year of transatlantic migration.

These new houses were built on what had been farms, fields, forests, meadows, and prairies. Wildlife habitats from Long Island, New York, to Malibu, California, were demolished to make way for

new human communities with new demands on local resources. Historian Adam Rome summed up the transformation of the landscape:

> In 1950 the U.S. Census concluded only 5.9 percent of the nation's land as urban or suburban, whereas in 1960 the figure was 8.7 percent, and in 1970 it reached 10.9 percent. Throughout the 1950s the nation's cities and suburbs took a million more acres—a territory larger than Rhode Island.

The subdivisions had effects on the land, water and air: aside from planting millions of houses on uninhabited land, the new homes required new sanitary landfills to dump their garbage. Too far from existing sewer systems in central cities, the new houses required septic tanks to handle human wastes. Leaking tanks could contaminate groundwater. The new modern conveniences such as air conditioners, dishwashers, and television sets required more and more energy to power, which had effects on local air quality around power plants.

Air pollution was more commonly associated with the millions of automobiles the new suburbanites required to commute to jobs in the central cities. Tailpipe emissions were blamed for visible smog, ambient lead (before the removal of lead as a fuel additive in 1972), and (by the end of the century) greenhouse gases associated with global warming. The automobile became integral to American life as the population sprawled across the continent; aside from the journey to work, Americans (inspired by marketing campaigns to "see the USA in your Chevrolet") used their automobiles for vacations, to see movies at drive-ins, to shop at the giant suburban malls developers hastily constructed in the 1950s, and to engage in most recreational and cultural activities that were beyond a walk in postwar land-use planning. By 1961, essayist John A. Kouwenhoven noted the centrality of the automobile to American life when he titled his collection *The Beer Can by the Highway*. In it, he observed:

> Two aspects of American civilization strike almost everyone: the abundance it enjoys, and the waste it permits (if it does not enjoy that too). As a *London Times* reviewer observed, in a discussion of three important books on American history, the occupation and development of this country has been a wasteful process, and the American god was not, is not thrifty. Nor is he, or was he tidy.

Not all Americans participated equally in the new, highly consumptive suburban way of life; federal mortgage policy and longstanding social discrimination (including attitudes of leading housing developers such as William Levitt) barred African Americans from using mortgage insurance to purchase housing in the new subdivisions. Unequal access to housing, education, restaurants, transit, and other public accommodations inspired consumer-based protests such as the 1955 Montgomery Bus Boycott, in which the African American population in Montgomery, Alabama, successfully forced the Montgomery Bus Line's segregated seating policies to change by withholding their business. Consumer actions, including the use of sit-in protests to desegregate lunch counters, became important tools in the emerging civil rights movement.

Those Americans who did enjoy all the modern conveniences of suburban life grew disenchanted with aspects of their consumption. If new suburban homes were marketed as escapes from polluted central cities, the environmental destruction of the subdivision aroused anger in many of its residents. Worries about environmental health, catalyzed by Aldo Leopold's 1949 book *A Sand County Almanac* and Rachel Carson's 1962 book *Silent Spring*, led suburbanites to join existing preservation groups such as the Sierra Club and create new environmental protection groups such as the Natural Resources Defense Council.

Worries about consumer safety increased, especially after consumer advocate Ralph Nader published a scathing exposé of Chevrolet's Corvair automobile in 1965 titled *Unsafe at Any Speed*. Interest in impartial evaluations of products by *Consumer Reports* magazine increased, and Nader founded state-based public interest research groups (PIRGs) and the national organization Common Cause to hold manufacturers accountable for the safety of their products.

Concern about garbage disposal, littering, and waste in general inspired many municipalities to

develop recycling programs, appropriating a long-used efficiency measure of manufacturers for the purposes of environmental protection. Pressure on elected officials (especially in the northeast and on the Pacific Coast) led to bipartisan federal efforts to protect land, air, water, wilderness, and wildlife in the 1950s, 1960s, and 1970s under several acts signed into law by presidents Eisenhower, Kennedy, Johnson, Nixon, Ford, and Carter. Republican support for environmental protection effectively ceased with the presidency of Ronald Reagan, ending a period of national innovation in environmental protection laws.

Wilderness Recreation

Before the 1950s, few Americans ventured into the pristine backcountry. By the 1960s, however, a burgeoning population driving automobiles across the nation's interstate highways stampeded the wild woodlands. Wilderness managers, who faced ascending popular interest in outward-bound pursuits by the 1970s (visits to rural areas during the 1960s and 1970s, claims Roderick Nash, grew 12 percent annually), presumed that uncontrolled wilderness recreation was just as much a threat to the backcountry as economic development.

Wilderness management, some scholars reason in a mingled spirit of Thoreau, Leopold, Muir, and Brower, is a contradiction in terms. By Old English etymology and tradition, the word *wilderness* means *wildeorness*, a space of wild beasts. By contrast, the word *management*, derived from the Latin *manus*, meaning "to handle." With this interpretation, Nash quips that the "National Wilderness Preservation system might be regarded as a kind of a zoo for land." Marvin Henberg scoffs, moreover, that the four federal agencies responsible for administering wilderness lands have been forced into a wilderness management that smacks of "a paradox if ever there was one."

Even before Nash and Henberg wrote, others considered the shrunken, despoiled landscape. "Take a last look," William Whyte wrote in a 1959 issue of *Life* magazine, which entertained the woes of suburban sprawl.

> Some summer morning drive past the golf club on the edge of town, turn off onto a back road and go for a short trip through the open countryside. Look well at the meadows, the wooded draws, the stands of pine, the creeks and streams, and fix them in your memory. . . . this is about the last chance you will have.

Only a few years later, the writer Wallace Stegner lamented:

> Something will have gone out of us as a people if we ever let the remaining wilderness be destroyed; . . . if we pollute the last clear air and dirty the last clean streams and push our paved roads through the last of the silence, so that never again will Americans be free in their own country from the noise, the exhausts, the stinks of . . . automotive waste.

The remarks by Nash, Henberg, Whyte, and particularly Stegner show an acute sense of concern about the contradiction between the natural environment and too much built environment. But it is Stegner's concern that touches most closely the paradoxical emergence of progress and chaos embodied in the stupendous surges of productive consumption and productions of waste. Productive consumption and waste were accelerating, while the life span of products was decreasing. The years from 1950 to 1970 can be called the age of throwaway items and an epoch of plastic and paper packaging. The years after 1980, with their proliferating productions of e-waste, add to the cascading mess. The best available quantitative measurement of waste production perhaps comes from the U.S. Office of Technology Assessment of 1989, which, basing its figures of national municipal waste in the United States on the EPA/Franklin model, pronounces that in 1979, 136 million tons of waste was produced (though while this model in 1979 had estimated 136 million tons, its 1986 version estimated that the waste for 1977 was 122 million); that in 1986, there arose 158 million tons; and that, by 2000, waste generation was to reach 198 million tons.

The EPA/Franklin model captures well enough the production of waste from the late 1970s through the 1980s, but its prediction for the turn of the century was not on the mark. According

to David Pellow, writing in 2007, "The volume of municipal waste generated in the United States between 1998 and 2001 grew by 6.6 million tons, or 20 percent, to a total of 409 million tons per year," a striking figure, since it "has only 5 percent of the world population but generates 19 percent of its waste."

Waste Disposal

While the United States had come of age as a supremely progressive technological country, its major disposal solutions became problematic. Sanitary landfills emerged between the great wars. They multiplied after the war as supposedly the most effective solution to the twin problem of the putrid open dump and the one-time highly touted but belching incinerator, even though Louis Blumberg and Robert Gottlieb (quoting the EPA) note that as many as 14,000 communities were likely still using open pits during the 1970s.

Martin Melosi reports, the landfill in the 1970s became the "central symbol of the garbage crisis" because availability of landfill space plummeted, especially throughout the northeastern states. Availability can be interpreted as scarcity of land, for, as Melosi shows, the National League of Cities and the U.S. Conference of Mayors issued a report in 1973 that claimed in part "[w]ith most of our cities running out of current disposal capacity in from one to five years, American urban areas face a disposal crisis."

Although trash mounted rapidly after 1950, a sole focus on space availability confounds the complex social and historical predicament of waste disposal, As reported in William Rathje and Cullen Murphy's *Rubbish!,* in 1889, the chief health officer of Washington, D.C., claimed "appropriate places for garbage are becoming scarcer year by year." Available space mattered, but so did the contentious sociopolitical struggles buzzing around causes such as NIMBY (Not in My Backyard), property values, political opportunism, costs, and privatization of waste disposal.

It was not until the 1980s—when the Environmental Protection Agency, through its Resource and Recovery Act, began to protect social and environmental health by requiring landfill operators to either close their landfills or restructure them by instituting leachate- and methane-collection systems—that a major waste disposal squeeze surfaced nationwide.

Facing more stringent enforcement, operators of many of the nation's sanitary landfills failed to embrace the mandatory structural improvements. Hence, many landfills ceased operation, so that, as Elizabeth Royte declares, the nearly 8,000 sanitary landfills that functioned nationwide in 1988 plummeted to 2,314 in 1999 and to 1,777 in 2002. Over the course of these years, when state authorities could find precious few solutions beyond instituting stringent requirements to the waste problem, many communities and regions found waste disposal fixes either in an expanding web of intrastate waste exchanges, as Edward Repa aptly shows, or in a thriving global trade of waste, as a headline in a 1983 issue of *New Scientist* suggests: "U.S. Steps Up Trade in Toxic Waste."

Recycling

As a solution to waste disposal, the nation's experience of recycling, as important and useful as it remains, has been no less disenchanting than its experience with the sanitary landfill. Recycling was practiced during the 1960s as a grassroots approach to resource reduction, but it gained mainstream popularity during the 1980s amid a recurrent debate between sanitary landfill and incinerator proponents. Melosi affirms that, before 1980, fewer than 140 communities boasted door-to-door recycling collection service, and that, by 1995, more than 9,000 communities established curbside collection of recyclables.

Recycling developed strong social and political appeal as aggressive programs sprouted throughout states like Connecticut, New York, New Jersey, Pennsylvania, Rhode Island, Florida, and Oregon. Even amid the ascent of national recycling pursuits, it was wondered whether creative incentives could be formulated to prompt broader household compliance; whether markets could be developed to take burgeoning volumes of recyclables, especially since recycling (like incineration) almost always results in production of waste that must be landfilled; and whether merit existed in John Tierney's *New York Times Magazine* article of 1996 "Recycling is Garbage," which argues that recycling costs

more in labor than is saved, that shortages in natural resources are so mythical that recycling is pointless, and that the nation embraces it "as an act of moral redemption."

Morals have not always reigned supreme in the recycling business, particularly considering the e-waste fiasco during the first decade of the 21st century. Joseph Ladou and Sandra Lovegrove declare that there is an escalating trade in obsolete, discarded computers collected in the United States, where as much as "80 percent of the e-waste collected for recycling . . . is not recycled domestically, but instead exported to developing countries." Catherine Komp, writing in 2006, charges that there is "a monstrous e-waste trade in which municipalities and businesses blindly give their electronics to 'recycling companies,' which, in turn, sell the toxic trash to 'developing countries' at a profit." Why is this so? Simply, the United States refused to sign the 1989 Basel Convention treaty, which was designed to reduce the transfer of hazardous waste to less developed countries, and was ratified by 172 countries.

The United States has also refused to sign the Basel Convention's 1995 amendment, which strictly prohibits the exportation of hazardous waste from developed countries to developing countries—an amendment implemented by 32 of the 39 developing countries to which it applies. Not surprisingly, then, the Basel Action Network claims that "informed [recycling] industry insiders have indicated that what comes through their doors will be exported to Asia, and 90 percent of that is destined for China . . . and as recycling rates are expected to increase 18 percent per year, we can also expect the amount going for export to increase as well."

Conclusion

Environmental consciousness did not reduce American consumption at the end of the 20th century so much as transform it. The advent of municipal recycling programs, historian Susan Strasser argues, did not inspire Americans to change their consumption of goods so much as to separate the disposal of goods, which they put into the municipal waste stream with "the belief and expectation that the material would be reused."

Expanded access to credit, in the forms of credit cards and loans for real estate, education, and goods, increased consumer spending. Where consumers spent their money also changed. As suburban malls developed, the model of the downtown department store gave way to the big box store with a giant surface area and huge parking lots. Walmart, an Arkansas-based chain, became the model for the big box retailer, becoming the largest corporation in the United States in 2002, with an inventory that recalled the variety of the old county store on a far larger scale. Using the slogan "always the low-priced leader," Walmart developed supply-chain and inventory practices that reduced labor costs and compelled its suppliers around the world to engage in what critics called a "race to the bottom," reducing the quality of life of workers so consumers would have the cheapest possible goods. Walmart was not alone using this model, but it became the largest retailer practicing it.

Supermarkets also grew and adapted to changing consumer values. Concern about food quality fostered the development of organic co-operative stores in the 1970s. In 1980, an Austin, Texas, store named Whole Foods was founded and developed into a national chain of supermarkets selling organic foods. A far cry from the small local co-op, the Whole Foods store resembled the giant supermarkets found in 1960s suburbs, only with foods labeled organic. The foods evolved from products of small family farms to nationally distributed brands such as Cascadian Farm, Annie's Naturals, and Santa Cruz Organic. Even Walmart expanded its organic food offerings by 2010. The corporation with the most sophisticated inventory system in the world understood that foods labeled organic were highly valued by American consumers, and reacted accordingly.

The mass marketing of organic food joined the ever expanding world of goods and services Americans bought in the 60 years after World War II ended. Suburban sprawl was fueled by the use of automobiles consuming so much gasoline that the United States' imports of oil grew substantially from the 1960s onward. The geopolitical dimensions of this consumption were made clear when a 1973 Organization of the Petroleum Exporting Countries (OPEC) embargo led to long lines at gas

stations, and when criticism of two wars the United States waged with Iraq involved allegations that the United States wanted to secure supplies of oil from the Middle East.

Houses evolved in the 1980s and 1990s into larger structures that earned the name *McMansions*. These houses contained more amenities (including home computers and computerized appliances) that consumed ever-greater amounts of energy. The rise of the Internet brought with it the rise of online shopping, made easier by the expansion of credit to make purchases. In the early 21st century, American consumers could even sell their unwanted possessions online via eBay.

All this consumption outpaced income after 1965 and levels of consumer debt rose. Sociologist Juliet Schor observed in her book *The Overspent American* that the number of goods and services Americans deemed necessities rose, and that even upper-middle-class Americans had concerns about being able to afford what they "needed" to consume, increasing loans for homes, education, automobiles, and balances on credit cards. One aspect of consumer debt hit a crisis when expanded mortgage lending led to a wave of home foreclosures in 2007, the collapse of several banks in 2008 and 2009, and years of depressed real-estate values in the United States.

In 2010, the U.S. Congress passed the Dodd-Frank Wall Street Reform and Consumer Protection Act, creating the U.S. Consumer Financial Protection Bureau (CFPB) organized by consumer advocate Elizabeth Warren in 2011. Time will tell what (if any) effect this law has on American consumers, but its passage reflected widespread concerns about American consumption in the early 21st century.

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See Also: Barges; Culture, Values, and Garbage; Economics of Waste Collection and Disposal, U.S.; Environmental Protection Agency (EPA); Landfills, Modern; Post-Consumer Waste; Recycling; Recycling Behaviors; United States.

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History of Consumption and Waste, World, 1500s

The 16th century marked a substantial increase in contact and trade across the Earth's civilizations. In particular, the expansion of European economies into the Americas developed the Columbian Exchange (named after Christopher Columbus's voyage to the New World), with significant consequences for resource extraction, nutrition, disease vectors, and redistribution of wealth and political power around the globe.

Expansion of the Islamic world in the 15th century, including taking control in 1453 of the vital trading city of Constantinople (subsequently renamed Istanbul) allowed Muslim traders to control most of the land and shipping routes between Europe, north Africa, and India, developing substantial amounts of wealth in Istanbul. One effect this had on European economies was a redirection of efforts to find western sea routes to India and China. As a consequence, several European nations established contact with the Americas, and in the 16th century, they extracted a variety of resources and foods from the New World. Foods, including maize, potatoes, and tomatoes, began their spread through Eurasia during this period. In return, infectious diseases from Eurasia had devastating consequences on indigenous American peoples, in many regions killing off more than half the existing population during this period. American foods had rather more beneficial effects on the rest of the world's population.

Consumption

In the 1500s, in the Americas, Europe, and other countries, consumption was dependent on necessities. Around the world, people were generally farmers or herders, raising more plants and animals each passing year. For example, consumption was based on eggplant, parsnips, turnips, and other vegetables in Europe. Peasants and nobles had different consumption habits because of different sources and opportunities. Peasants could mostly consume porridges made from grains with vegetables like onions, cabbage, and turnips. Bread was the basic food, and water sources were generally polluted because of not having a sewer system. Nobles, on the other hand, could also eat meat from pigs, chicken, or fish. Therefore, in the 1500s, waste was mainly based on food scraps, coal ash, and a small proportion of simple manufactured products, such as paper and glass.

Garbage

The garbage crisis occurred when people determined to move the garbage into dumps, which meant disposal everywhere. Larger pieces of waste were thrown into the streets and were eaten by semidomesticated animals; the rest was simply left or burned. Dumping, slopping, and scavenging were the methods of dealing with wastes in the Americas and Europe until the 1800s. A slopping and scavenging system remained the same for most developing countries.

In the 1500s, people dumped garbage into valleys or on the outskirts of cities. The trash was burned slowly, covered with dirt, or left in the open. This approach created health and environmental problems by attracting rats, dogs, cats, insects, and scavengers. Garbage was also scattered by wind, creating litter everywhere in towns.

The most preferred option of disposal was burying garbage, because it was the cheapest method. In Australia and China, for instance, food leftovers were fed to pigs, chickens, and dogs, and the rest was buried in the soil or left for composting. The people of Australia tried to protect the environment. For example, they used tools produced from natural materials and repaired or adapted them for other uses. They threw away the tools whenever there was no use left.

Reuse

People also used leather and feathers as recovered materials and green wastes as fertilizers. Timber was usually reused in shipbuilding and construction. Precious metals such as gold have always been melted down and reworked several times. Later, scrap metal and paper were also included in the recovery activities. For example, in the 1500s, for cementation of copper, Spanish copper mines used scrap iron. In England, Elizabeth I gifted special rights for the people who collected rags to make paper. Households kept rubbish indoors until it was removed by the pickers in Britain, which also

prohibited keeping garbage in public waterways and ditches, because of increasing numbers of people throwing wastes out of windows and doors. For instance, garbage was also piled outside the Paris gates so high that it nearly restricted city defense in the 1500s. In Germany, the government used wagons to carry products into the cities and waste outside the cities. In Philadelphia, the Rittenhouse Mill produced paper from recycled waste papers and rags. In Germany, people started to place their papers in wrappers. In the 1500s, people preferred to throw away their waste in random ways and governments tried to prevent those behaviors by law, with little effect.

Energy

In the 1500s, varied energy sources had different impacts on the environment. For example, people used animal-fat candles for light, peat and charcoal for cooking and heat, wind for sailing, and water wheels for grain crushing. They also manufactured a small amount of goods in their houses. Charcoal is one of the most environmentally damaging fuels in the world and is a significant source of indoor pollution. In the 1500s, it was produced in traditional kilns and mounds that gave off dangerous smoke.

Disease

Trash has played a significant role in world history. Diseases such as cholera, bubonic plague, and typhoid fever changed the populations of continents in the Middle Ages. The diseases were caused by contaminated water sources and spread by rats. For example, the plague killed 30–60 percent of Europe's population—almost 400 million people. The disease was caused by garbage on unpaved streets, which were attractive places for rats. Fleas on the rats then spread the disease to humans. The plague created religious, economic, and social problems throughout the world, and Europe needed 150 years to recover.

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See Also: Bubonic Plague; Germ Theory of Disease; Miasma Theory of Disease; Open Dump; Recycling.

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History of Consumption and Waste, World, 1600s

Major events in the 17th century that affected production and consumption included the Little Ice Age, the plague, and European colonization of Africa, Asia, and the Americas. Crop failures, famines, and the plague reduced the European population and increased the value of labor. Production, trade, and consumption grew with the incomes of the rising numbers of wealthy merchants and middle-class craftsmen and women, whose families produced an increasing diversity of consumer goods, with more venues for purchasing them, as guilds lost control.

Women's domestic production, including textiles, butter, cheese, eggs, chickens, beer, and cider were important parts of economies. International trade was dominated by men, although some Dutch women were renowned in the North American fur trade. The Little Ice Age increased the demand for warm woolen clothing, fur coats and hats, and led to the innovation of fireplaces, starting in elite homes in the1450s.

Colonies

Feudalism began to break down as landlords enclosed common lands for sheep grazing, forcing tenant farmers and dairymaids into the towns or to colonies, despite resistance. Many poor people paid for their passage to colonies by indenturing themselves to work for several years for wealthier

colonists. Governments shipped their destitute and criminals to colonies. Inexpensive European consumer goods, such as glass beads, copper beads, rings, pendants, kettles, iron knives, hoes, red cloth, and old guns, were exchanged with Native Americans for valuable beaver furs that were used in Europe to make expensive top hats. Native American women who were traders or "country wives" of European traders consumed trade goods for status display for themselves and their families. Most of the trade in consumer goods within the American colonies was conducted through barter because European money, or specie, was rare.

Production and consumption increased as the inexpensive or free resources of colonies enriched many European colonists, trading companies, royalty, and aristocracy. A triangular trade developed: African slaves were shipped to the Americas, where they and enslaved Native Americans inexpensively produced new crops such as tobacco and potatoes, as well as cotton, rice, and sugarcane in the Caribbean. The sugar was manufactured into molasses and rum to sell in New England and Europe. The great popularity of tobacco, and the development of the European clay pipe industry, is apparent at archaeological sites, where quantities of clay pipes suddenly appear in layers from the later 17th century. Colonial timber was in demand in Europe, where the use of charcoal for small-scale industrial production of goods such as glass, copper, and iron had so depleted the supply of wood that in the 1550s King Henry VIII reserved the remaining wood to build ships for the English navy. New England households were assigned a quota of required textile production by women and children.

Pottery

In the 1600s, food was stored and prepared in woodenware, redware, or stoneware pottery vessels. Food was consumed using predominantly woodenware and horn cups in the lower to middle classes, pewter in the upper-middle class, and silver in the elite class. Chinese porcelain increasingly replaced silver and pewter over the century. Shared bowls, plates, and mugs were common, especially in the lower classes and in the colonies. Cutlery included knives and spoons. Forks were introduced to Europe by a Byzantine princess who had married the doge of Venice in 1075. Forks became popular in Italy with the elite in the 1300s, spread to the merchant classes by 1600, then to Western Europe by the mid-17th century, and its colonies in the early 18th century.

Seventeenth-century pottery produced and consumed in Europe and its colonies consisted of earthenware and stoneware. Traditional lead-glazed redware pottery was manufactured for everything from milk pans for dairies to plates and mugs of slipware made in England or Germany. Seventeenth-century slipware decoration often involved finer lines of white slip than in the previous century. Since the 16th century, lighter pink earthenware covered with a white opaque tin glaze and decorated in multicolored designs on large status-display plates was called faience in France, galleyware and blue-dash chargers in England, and majolica in Spain and Italy. In sgraffitoware, patterns of lines were scratched through the tin glaze to reveal a dark redware body. Germany, the Netherlands, and England produced brown and gray stoneware mugs, tankards, pitchers, jugs, and food-storage vessels. Fine small brown stoneware teapots appeared shortly after tea was imported from China ca. 1650. In the 17th and 18th centuries, the Dutch imitated Chinese porcelain with blue hand-painting on white tin-glazed earthenware, called Delft for the Dutch town that first manufactured it. The number of factories in Delft increased from 14 in 1650 to 30 in 1670, as the trade became international. Starting in the late 17th century, potters such as the Elers brothers became famous for their small, thin, fine red stoneware teapots with applied vines and crabstock handles. Pottery consumption increased markedly after 1650 along with the increasing importation of Chinese porcelain and increasing production of Delftware and specialized stoneware, such as Westerwald and Bellarmine jugs.

Trading Companies

European merchants grew wealthy and supplied an increasing diversity of consumer goods from trade forts and colonies from Africa to the Far East, starting with Portugal in the 1400s. In the 17th century, the English and Dutch East India Companies ended Portuguese monopolies in the major trades for African gold, ivory, coffee, and slaves;

Indian cotton, ivory, tea, cinnamon, indigo dye, saltpeter for gunpowder, and opium; Indonesian pepper, nutmeg, and other spices; and Chinese and Japanese porcelain, silk, and tea. The Dutch East India Company imported the most Chinese porcelain, rapidly increasing from 50,000 pieces per year in 1605 to 100,000 pieces by 1610 to 200,000 pieces by 1620. When the Chinese porcelain trade was interrupted by unrest during 1644–64, Japanese Imari-style porcelain was imported to Europe. The king of Portugal outlawed the trade in Chinese slaves in 1624. Until it was outlawed in the 19th century, the African slave trade provided free labor both in Europe and in the American colonies, enriching Europeans.

Wealth Disparity

Increasing wealth among Europeans led to increasing demand for consumer goods, starting in Dutch towns and then spreading to surrounding farms. In the first half of the 17th century, wealthy urban Dutch merchants began to display Chinese porcelain, silk, ivory, and new styles of furniture. After 1650, they started to build brick townhouses with separate drawing rooms, dining rooms, and bedrooms. A study of probate inventories in and around a small industrial and market town near Amsterdam found that half of the town's households had Chinese porcelain in the 1650s, and half also had Delft by the 1680s. In contrast, by the 1690s, only 20 percent of the surrounding farms had porcelain, and 75 percent had Delft. Towns contained more wealthy households than the countryside.

The new architecture and consumer goods spread throughout Europe and its colonies in wealthy and then middle-class households. A study of 3,000 British median-probate inventories from 1670 to 1730 found that during this period the percentage of inventories at least doubled, listing a clock, pictures, looking glasses, curtains, tea and coffee utensils, saucepans, and earthenware dishes. Other studies found an increase in interior decoration and new furniture. British inventories in County Kent listed five new types of furniture: court and press cupboards, chests of drawers, cabinets, and new styles of chairs and tables. In the early 17th century, just 30 percent of households owned any of these items, compared to 80 percent of households by 1750. In the same period, the median number of pieces of furniture in wealthy and merchant households doubled, from 12 to 24. Working-class and many rural middle-class houses retained the medieval vertical plank, wattle and daub, or half-timber house styles, with few if any separate internal spaces or specialized rooms and rarely any of the new furniture.

Tea Consumption

The English East India Company defeated Portugal to dominate the trade with India. Tea first arrived in Englishmen's coffeehouses in the 1650s. Catherine of Braganza, wife of Charles II, introduced tea to the women of the English royal court in 1662, where it became very popular as the most high-status beverage. Tea became associated with women in the court and aristocracy, and then spread to wives in the merchant, artisan, and laboring classes, becoming the most popular beverage in England by the end of the century. By the 1690s, tea was already considered an "ancient custom" among ladies. Women controlled all aspects of the tea ceremony, from buying tea and selecting teaware to inviting the guests and serving the tea. Documentary research has revealed that through their tea ceremonies, women displayed their family's status and controlled the reputations of neighbors.

Within patriarchy, 17th-century wives in Europe and its colonies held a few rights as independent adults, such as the ability to own land, control their inherited property, and operate businesses, ranging from goldsmiths, blacksmiths, printers, and sailmakers to weavers, brewers, vintners, bakers, cooks, fishmongers, peddlers, and storekeepers. Women produced and sold a wide range of consumer goods, most often in partnership with husbands or as widows. Wigs also became increasingly fashionable from the second half of the 16th century through the 17th century. Sumptuary laws were abandoned in England and Holland by the early 17th century, while in France and Spain, greater restriction of fashionable dress to elites lasted until the late 18th century. Cotton-printed calicoes from India democratized fashion in the 18th century because the cloth could be afforded and was popular from the elite to the servant classes. As the Little Ice Age abated in the 18th century, clothing shifted from heavier to lighter wools, mixed linsey-woolsey, linen, and cot-

ton. Consumption of clothing increased due to the shortened fashion cycle of clothes as the elite instituted new styles to overcome the trickling down of older styles into the middle classes.

Human and Animal Waste

Women and girls were usually responsible for house cleaning and discard, whether by sweeping trash and pet wastes out the doors, or throwing garbage, or human waste from chamberpots, out of windows. In towns and cities, pedestrians walking beneath windows could be hit with waste from windows as well as splashed with mud and filth by carriages. Despite late-17th-century laws requiring fencing of domestic animals, pigs, cattle, sheep, and goats roamed freely, depositing manure in fields and village and town streets alike. This situation led to the chivalrous custom of men walking on the outside edge of sidewalks and sheltering women under the second-story overhangs of colonial garrison houses. Dogs and cats defecated freely in private and public buildings and there was no municipal garbage collection. Pigs and goats roamed through neighborhoods, eating garbage and gardens. Farmers' homes and yards were filled with surface scatters of garbage and trash.

Since the 1400s, widespread plagues led to the European belief that bathing caused disease. The normative practice involved washing only hands. Starting around 1550, changing into a clean linen undershirt for men, or a chemise for women, was considered safer, more reliable, and scientifically superior to washing with water because white linen was believed to attract and absorb sweat.

In the 17th century, a rage for clean white linen developed among the royalty, the aristocracy, and then the rising middle classes. At least one clean linen shirt or chemise was required daily per person, developing a growing market for white linen. Medieval paintings of bathhouse scenes were replaced by paintings of clean linen undershirts spread in bleaching fields, in neat stacks in linen chests, and peaking out from under overshirt necklines, cuffs, slashed sleeves, and doublets. The normative practice of monthly washing by slaves or servants meant that probate inventories and wills listed more linen shirts and chemises than any other article of clothing. In contrast, a piece of flannel was commonly pinned up over the lower bodies and legs of infants from shortly after birth until the flannel envelope fell off.

Further, some people tightly bound infants against a board to straighten their backs and lessen crying by slowing their metabolisms. Starting in the late 16th century, etiquette books urged people not to relieve themselves in public (suggesting that this had been a common practice), but to instead use privies. In urban areas, people were most likely to maintain privies by hiring scavengers to clean them out at night, while in rural areas, full privies were simply covered with dirt and a new privy hole was dug. People were accustomed to the smells of unwashed bodies and waste that surrounded them.

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See also: Bubonic Plague; History of Consumption and Waste, Renaissance; Human Waste.

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History of Consumption and Waste, World, 1700s

The 18th century brought an increase in the world of goods as trade expanded and industrialization in Europe emerged to increase that continent's economic and political power. The resulting economic activity had important and enduring consequences for consumption patterns across the Earth.

While economies in the Islamic world, India, and China remained vibrant, a significant development during the period was continued increase in the strength of European wealth and power that had emerged with the dawn of the Columbian Exchange (between the New World and Old World) at the end of the 15th century. In the second half of the 18th century, major increases in consumption and discard resulted from the Industrial Revolution, in which factories and mechanization greatly increased production and decreased costs of consumer goods, including textiles, ceramics, buttons, buckles, boxes, and toys. Water-powered machinery was increasingly replaced by steam-powered machinery, spreading from British factories after 1775. The Industrial Revolution was led by the shift from charcoal to coal and coke, permitting large-scale production of iron and steel used for the construction of steam engines, water pumps, and bridges. Industrial waste was discarded across landscapes. New kinds of status-display goods were introduced to the elite in European colonies, such as individual place-settings of white ceramic tableware, tea caddies, forks, brass candlesticks, clocks, and scientific instruments such as thermometers, barometers, globes, compasses, and telescopes. However, consumption and discard of these status-display items was rare except for ceramics; whiteware ceramics are the most commonly excavated artifacts and were discarded by all classes.

Ceramics

New kinds of ceramics invented in the 18th century were discarded in trash pits and surface scatters that are excavated at historic sites. While traditional craft production of lead-glazed redwares and salt-glazed gray and brown stonewares continued, the Enlightenment led to scientific experiments, especially by English potters, resulting in an increasing variety of whiteware ceramics. Tin-glazed, hand-painted Delftware was produced until 1790 to imitate expensive, Chinese porcelain. Expensive white, salt-glazed stoneware was produced until the 1770s. Thomas Wheildon invented and produced creamware with a mottled glaze as well as rococo vegetable and fruit-shaped tureen lids and teaware from 1740 to 1770. In 1750, Josiah Wedgwood invented a further-refined creamware with a slightly green glaze that he marketed to the elite as Queensware after Queen Charlotte admired it in 1765. Subsequently, Wedgwood marked down the price of plain creamware to sell it first to the middle class and then to the working class. In 1780, Wedgwood invented pearlware by further refining the creamware body and its glaze by adding cobalt, which made pearlware appear whiter, although it was actually greenish-blue. Undecorated, edged, or hand-painted creamware and pearlware predominate at sites in England and its colonies in the second half of the 18th century.

Consumer Culture and Choices

Consumer choices expanded and diversified as factories decreased the cost of producing many goods, resulting in lower prices. The amount of discard increased in the 18th century as fashions changed rapidly with inventions of new consumer goods, from clothing styles to ceramics. Consumer choices about what to buy and whether things were carefully curated or carelessly used and frequently broken and discarded were conditioned by many interrelated factors, such as the availability of goods, wealth, prices, taste, symbolic meanings of objects, desire to display socioeconomic status, and intersection with gender ideology, religious ideology, race, or ethnicity. Socioeconomic status was important, but it was not the only factor in consumer choices. For instance, increasing ownership of scientific instruments by the elite not only displayed their ability to afford these instruments but also symbolized their interest in the development of science in the Enlightenment. In another example, some religious groups, such as Puritans, Quakers, and Shakers, were against status display. Consumer choices could also be conditioned by the complex intersections of multiple identities, such as gender, class, race, ethnicity, or religion.

The availability of consumer goods and their falling prices also led to changes in consumer choices by people in different classes. Communal eating with hands from a shared bowl was common among the working classes until at least the late 18th century. But by 1730, the elite added the innovations of individual plates, glassware, and forks to their previous use of spoons and knives for eating. Over the century, the elite kept up with rapidly changing fashions in dress and the latest styles of porcelain, glass, and silver tableware, while the middle class demonstrated respectability with pewter and ceramics imitating porcelain, and the working classes, impoverished by low wages in laissez-faire capitalism, predominantly used secondhand or old styles that were out of fashion.

Feminist historical archaeologists have argued for the importance of analyzing gender power dynamics in the past, including who controlled household consumer choices and discard of material culture. The person who controlled the selection of a household's artifacts also controlled how the family displayed its status to friends and business acquaintances. In 18th-century Europe and its colonies, patriarchal men ruled families. Wives and children had the status of minors, dependents, and chattel and had very few civil rights. While husbands had the legal right to control their families, feminists still found evidence of the social agency of wives as producers and distributors of consumer goods. Wives were often their husbands' business partners and traders of their own domestic products in Europe and its colonies. Women's production of butter, cheese, textiles, beer, and cider were important items of exchange both within the American colonies and in international markets. Many women operated stores selling a variety of goods, from imported exotic items such as coffee and chocolate to ordinary food items, nails, medicines, textiles, or crockery. Some women produced consumer goods that they sold in their communities by working in occupations such as blacksmith, tanner, printer, seamstress, and occasionally tanner or slaughterhouse operator. It was also common for wives to operate their family businesses when husbands were absent or dead. In contrast to the dominant gender ideology that women and their domestic sphere did not participate in men's sinful public-sphere capitalism, women often produced and distributed consumer goods for sale in men's public sphere.

Women also often made family consumer choices of status-display items, including ceramics, since at least the 18th century. Documentary evidence indicates that although men often bought ceramics and other consumer goods because they legally owned all the earnings of family members, fiancées and wives often selected the ceramics acquired by men. Women also often bought ceramics, especially teaware. In the mid-18th century, a letter in the *London Gazette* discussed how all the elite ladies went to Warburtons to buy the most popular queensware ceramic tableware. While elite wives usually bought the teaware that they used in serving tea, their husbands often bought the large sets of matched dinnerware. In the Americas, elite men such as George Washington and Thomas Jefferson bought large sets of ceramic tableware, but it is possible that their wives influenced the selection of ceramics. Throughout the 18th century, women bought household status goods and performed status rituals such as serving tea, as well as carving and allotting dinner meat to guests.

Females continued to perform house cleaning and discard of trash, garbage, and human and animal wastes. Excavations of four 18th-century American house sites have dated ceramic dumps to 12 changes in female heads of household, who each discarded the whiteware of the previous female head of household and bought new whiteware. These house sites provided excavated evidence of several wives, single women, and widows who controlled their household acquisition of whiteware ceramics for status display at dinners and teas. Since discard did not occur until there was a change of the woman in charge of the housework, this evidence indicates that women, rather than men, made the decisions to discard old ceramics and select new ones.

Waste Management

As early as 1700, city and town ordinances were passed prohibiting people from discarding waste in streets. After 1750, Europeans increasingly dumped trash and garbage in square backyard pits, often seven-feet-deep, probably in reaction to widespread cholera epidemics. These orderly pits may have developed from the Enlightenment belief in

masculine rational-scientific conquest and ordering of irrational mother nature. This belief also underlay the construction of elite Georgian houses, with half basements raised above leveled land, shaping female nature to men's cultural constructions. At less wealthy house and farm sites, surface scatter continued, and there was still no garbage collection. However, gardens and fields began to be fenced to prevent animals from eating crops.

Bathing was still considered unhealthy and washing was usually limited to hands and face, with feet becoming recommended by French etiquette books ca. 1750. Etiquette books did not recommend a complete bath until 1820. Some scholars believe that 20–30 years could pass between bathing and hair washing. Wigs declined in fashion after the death of King Louis XIV in 1715 and became unfashionable after the French revolution. Daily wearing of a clean white undershirt or chemise was still considered the epitome of cleanliness. During the 18th century, the production and consumption of linen continued to grow and most gentlemen owned a minimum of 12 undershirts; only one set of clothing might be owned by a frugal academic. Clothing was washed at most once a month, and often not at all on the American frontier. Human waste of infants often accumulated in diapers that were not washed but might be placed by the fire to dry and then put back on the baby. Doctors began to decry this practice in the 19th century. Adults relieved themselves in the bushes more often than in privies, which landowners did not clean often enough. Although three water closets were invented in the 1770s, few people installed them in their homes. Waste disposal and cleanliness were only slightly improved from the 17th century.

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See Also: History of Consumption and Waste, U.S., Colonial Period; History of Consumption and Waste, World, 1500s; History of Consumption and Waste, World, 1800s; Human Waste; Residential Urban Refuse.

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History of Consumption and Waste, World, 1800s

The 19th century was a critical period in the development of modern modes of consumption and waste disposal. Europe had begun intensive industrialization in the 18th century; by 1900, this had extended to much of the world, transforming economies from Japan to the United States. Transportation, including the expansion of rail and transition from wooden to iron ships, expanded the distribution of foods and durable goods worldwide. Factory production of textiles, machinery, and increasingly specialized housewares transformed the consumption habits of millions of people, not to mention their workplaces and residences. With rapid industrialization came exponential population growth cen-

tered in urban areas. This led to serious strain being placed on existing sanitary infrastructure. Coupled with a growing awareness by reformers of the role of environmental factors in the spread of disease, a sanitary movement emerged, which championed the enforcement of strict hygiene and the planning of citywide waste disposal networks. In the first half of the century, these developments were focused in Europe and particularly in its largest city, London; by the end of the century, they had spread worldwide, particularly to the emerging metropolises in North and South America.

Sanitation

Throughout the 19th century, London was the largest city in the world, with over twice the population of its nearest rival, Paris. Even before the rapid deterioration of London's sanitary state in the first half of the 19th century, the city's watercourses were never particularly salubrious, as testified by Ben Jonson's mock epic poem describing a nauseating journey along the river Fleet in the early 17th century. But with the population of London increasing almost threefold from 1800 to 1850, the city's sanitation, or the lack of it, became a dominating concern. This exponential growth of the city's population, largely concentrated in already densely crowded areas of the city, led to serious strain being placed on a once effective and sustainable system of natural drainage. London's many rivers—tributaries of the Thames, such as the Fleet, Westbourne, and Tyburn—had, up until the beginning of the 19th century, provided a ready means of draining rainwater within the built-up area.

The gradual expansion of this built-up area led to these rivers being systematically built over, putting an ever-increasing strain on this existing system, which had been in place for centuries. The usual method of disposing household sewage—even up until the mid-19th century—was to empty it into pits, known as cesspools, located close to dwellings, with most households having access to one. Workers, known as nightmen, removed the sewage from cesspools at night and were able to dispose of it at a profit to farmers, whose fields were close to the city limits. The city's population also benefited from developments in the supply of piped water in the early 19th century. The substitution of cast iron for wood in the manufacture of water mains meant that the new London water companies were able to deliver a more regular supply at higher pressure. Coupled with the invention and subsequent popularity of the water closet, the increased availability of water resulted in much greater volumes of water and sewage being discharged into both London's rivers and its existing sewers.

By the 1840s, densely populated areas of London became the focus for sustained investigation by would-be sanitary reformers, particularly insalubrious areas of the city, such as the Kensington Potteries and parts of the parish of St. Giles in Westminster. These reformers, such as Edwin Chadwick (1800–90), began to investigate the detrimental effects of poor sanitation and to use the evidence they collected—often in the form of lurid descriptions—to argue the case for reform. Chadwick's interest in sanitation arose partly as a result of his work as secretary to the Poor Law Commission, established in 1834 under the Poor Law Amendment Act.

The new commission attempted to reform London's administrative boundaries by setting up a centralized, government-funded body to administer poor relief to its less fortunate citizens. The commission overrode London's existing system of governing welfare, which was legally and administratively a loose conglomerate of some 300 individual parishes and wards. From his involvement in the commission until the publication of his "Report on the Sanitary Conditions of the Labouring Population of Great Britain" in 1842, Chadwick used his influence to focus the attention of the commission on the relationship between poor sanitation and disease, arguing that those who required poor relief were often victims of the unsanitary environments in which they lived.

In 1848, a new centralized governing body, the Metropolitan Commission of Sewers, headed by Chadwick, was set up in late 1847 to replace the heterogeneous group of governing bodies that had existed for centuries, the London Sewer Commissions. The Metropolitan Commission of Sewers was formed with an explicit goal: to plan and construct a new citywide sewer system for London. Even though such a system would not be built for another decade, 1848 marked the genesis of the

main drainage system in that it saw the emergence of a new way of seeing the city's sanitation. The period from 1848 to 1868 represents the years when London's new system of sewers was first planned and then constructed in its first and most important phase. Designed by the engineer Sir Joseph Bazalgette (1819–91), the main drainage system consists of five distinct, large-scale sewers that cross London either side of the Thames from west to east, converging in outfall sewers running roughly parallel to the river. These are known as "intercepting" sewers in that they intercept waste from existing street sewers and divert it to outfalls on the Thames outside the city limits. The sewage was originally discharged into the river at high tide to prevent it from flowing back into the city area. Included in the main drainage system are four principal pumping stations, situated at points in the system where the sewage needed to be lifted from low-lying areas up to the level of the river.

Throughout the 19th century, in both Britain and Europe, experts debated how best to dispose of urban sewage. Many were guided by one overarching principle: the hope that the agricultural use of urban sewage could finance much urban improvement. Using human wastes as agricultural manure reflected a growing interest in Britain in the 1840s regarding the possibility of turning waste into profit and formed the subject of many parliamentary committees and debates in the second half of the 19th century. Ideas on sewage utilization, or recycling, were derived from the German chemist Justus von Liebig (1803–73), who was one of the leading promoters of sewage recycling as an essential requirement for the long-term sustainability of agricultural productivity. On the one hand, sewage recycling made economic sense; as Liebig argued, it would release a previously untapped mine of gold and simultaneously sustain rapid population growth in urban areas and the agricultural productivity necessary to sustain that growth. And yet, sewage recycling was also a solution to an important theological dilemma: was human waste really part of God's bountiful creation? In the mid-19th century, natural theology made commonplace the notion that the character of God was evident in the laws of nature. Waste and decay were seen as a perversion of natural cycles, which occurred only when organic wastes were not quickly returned to the soil. The almost obsessive interest in sewage recycling in this period was one way of resolving the theological dilemma raised by the idea of human waste. However, despite the power of these arguments, sewage recycling was an expensive and inefficient process and—although tried in limited areas of London and Paris—was eventually replaced by the wholesale flushing of waste into urban rivers. From the 1880s onward, the development of increasingly sophisticated methods of treating sewage meant that the question of sewage disposal lost its previous sense of urgency; human waste was accepted as just that—waste—and the emphasis shifted to how best to limit its polluting nature.

London's main drainage system was the first citywide sewer system and perhaps the most influential example in terms of its impact on other developing urban centers. Bazalgette's work as a consultant demonstrates this; from the 1850s onwards, he advised on sewerage schemes for both provincial towns and cities in Britain, including Bristol (1863), Oxford (1865), Belfast (1866), and Northampton (1871), as well as the foreign capitals of Budapest (1869–74) in Hungary and Port Louis (1869) in Mauritius. By the early 20th century, Bazalgette's main drainage system had become the model, whether directly or otherwise, for any metropolis aspiring to be "modern" in terms of the disposal of its wastes and was widely adopted in the rapidly expanding cities of Europe and the Americas.

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See Also: Population Growth; Public Health; Sewage; Sewers.

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History of Consumption and Waste, World, 1900s

The 20th century was the most devastating period of world history in terms of consumption and waste. It began with the declining age of European empires and ended with the increased pace of globalization and worldwide commodity consumption. During this period, large political, social, and technological changes resulted in new forms of consumption and commoditization. Waste emerged as a major problem inherited from the Industrial Revolution and was intensified to the extent that, at the end of the century, a social and political ideology known as environmentalism or "green" politics emerged in many nations. New forms of waste appeared as a result of various technological and scientific innovations. The 20th century, in the words of historian John McNeill, was unusual for the intensity of environmental change and the centrality of human effort in provoking it.

Mass Commodity Culture

The intensification of a mass commodity culture and the increasing waste as a result of industrialization, consumption, and urbanization bewildered various social and economic thinkers at the beginning of the 20th century. The establishment of a world capitalistic system, the innovation and circulation of large numbers of new commodities, the growing sizes of the cities and their populations, and new technological discoveries became influential processes of social and economic change.

The intensification of capitalist culture, which would become focused on mass production and consumption, had been predicted by Karl Marx. Marx argued persuasively that human labor had become alienating and commodities had come to replace human relationships. At the end of the 19th century and the beginning of the 20th century, another economist and sociologist argued that waste was the result of a leisure class that had developed through business and had as its main preoccupation conspicuous consumption. Thorstein Veblen developed a theory of a leisure class, which was based on a lavish acquisition of goods for the purpose of displaying wealth, social status, and social differentiation. Such attitudes were generally viewed as negative consequences of mass consumption in the 20th century.

Two World Wars

The most devastating events of the 20th century in terms of consumption and waste were the two world wars and the arms race, which brought large social, political, and technological changes. This first period of the century could be described as the age of the catastrophic wars. During this period, the capitalist and liberal Western societies lost faith in their economic and constitutional values, a bourgeois culture was replaced by an emerging middle class, material and moral progress was interrupted by acts of violence and intolerance, and the Eurocentric colonial empires whose soldiers had conquered large parts of the world began to break apart into nation states and independence movements. The first four decades of the century brought new forms of waste that would have been unimaginable in the 19th century and resulted in a huge consumption of continuously developing weapons that would be used even in the most remote islands of the Pacific.

In World War I, tanks, grenades, machine guns, chemical weapons, and aircraft were used for the first time in a war and completely changed the strategies of the empires involved. The use of chemical weapons such as tear gas and mustard gas, along with lethal agents that included phosgene and chlorine, became a regular part of warfare. Despite the fact that only a minority of soldiers were killed due to chemical warfare, the pollution of the environment during this period was large scale. In France, for example, at the end of the war, 40,390 square miles were cordoned off because of unexploded materiel. Shells of chemical weapons are still found

regularly by farmers or building operations in areas where the war took place. The use of chemical agents in warfare was internationally condemned with the Third Geneva Convention signed in 1925. However, more than a decade later, in World War II, poison gas played an important role in the Holocaust.

As a result of the chemical innovations of World War II, new forms of plastic material were developed. Polystyrene was among the first and most widely used plastic materials in everyday life. Polyamide, also known as nylon, was developed a few years later and became widely used in various new consumer goods. Stockings, for example, became widely popular and consumer demand resulted in the nylon riots of 1945. In the United States, 4 million pairs nylon stockings a day were sold in 1939, but when the country entered the war, production companies interrupted their operations and produced only war materiel. As a result, a stocking panic emerged as the few nylon stockings that could be found in the market were produced in the prewar era.

The wide use of polystyrene in food packaging, clothing, furniture, and everyday consumer goods had an inconceivable environmental impact. A major cause is the fact that discarded polystyrene does not biodegrade for hundreds of years, it is resistant to photolysis, and the majority of these products cannot be recycled.

Warfare was further advanced during World War II, with major innovations in aircraft, tanks, machine guns, rockets, and nuclear weapons. The use of the atomic bomb in Hiroshima and Nagasaki at the end of the war signaled a new era of nuclear warfare that had devastating effects on humans and the environment. The discovery of nuclear fission during World War II resulted not only in an arms race between the Soviet Union and the United States but also in commercial energy use by various countries such as France, Japan, and Germany. Since then, the extended use of nuclear energy and the waste that such nuclear power plants produce has been the most threatening and irreversible process of environmental destruction. Large-scale nuclear accidents in the 20th century include the Chernobyl disaster in 1986, which released large quantities of radioactive contamination in the Soviet Union and Europe.

During the first period of catastrophic wars (1900–45), a large proportion of the world's population lost faith in liberal capitalism and adopted socialist and communist ideas and political systems. In Russia, the revolution of 1917 resulted in the creation of the Soviet Union, the world's largest state, covering an area over 13,918,715 square miles, and which became head of a later socialist network that included China and amounted to one-third of the human population. Within this constitutional socialist state, commoditization and consumption took different trajectories from liberal democracies, as Western commodities were scarce, limited, and even prohibited.

The unease with liberal capitalism grew greater with the world economic crisis of 1929 that brought instability and insecurity not only to the weakest but also to the strongest capitalist countries of the time. Even the economic system in the United States that was not ruined by World War I almost collapsed. It was within this context that fascism and its sphere of influence advanced in most parts of the world and resulted in World War II.

Prosperous Age

The second period of the 20th century, which can be identified as the prosperous age of world history, are the two decades following World War II (1947–73). This era was extraordinary in terms of social, economic, and cultural transformation. It included the period of the cold war, the decolonization process, and the division of the world into spheres of socialistic and capitalistic influence. Within this context, production, consumption, and waste emerged as fundamental categories in an effort to assess and understand the impact of those transformations. This period was probably the most influential ever recorded in terms of consumption and waste, as industrial capitalism expanded the Fordist system of production worldwide and had devastating effects for the environment. The standardization of production, the establishment of the assembly line, and the increased salaries of workers resulted in the invention of an enormous number of mass commodities that could be bought and consumed by the workforce.

The main philosophy of the period was the combination of mass production with mass consump-

The most devastating events of the 20th century in terms of consumption and waste were the two world wars and the arms race. During World War I, new military hardware and chemical weapons completely changed wartime strategies. Environmental pollution from chemicals was widespread, and large tracts of land in Europe were unusable because of unexploded material. The discovery of nuclear fission during World War II resulted in the atomic bomb and ushered in a new era of nuclear warfare and commercial nuclear energy use.

tion, sustained economic growth, and material progress. These ideas became widespread in liberal capitalistic economies globally and gave rise to a golden age of capitalism. Mass commodities like cars, the refrigerator, the television, and an enormous number of household devices appeared in the market. A new cultural industry emerged, and consumption became a synonym for capitalistic freedom. Moreover, the first supermarkets were established shortly after World War II and became highly popular.

The emergence of the supermarket in contemporary society signaled a type of consumption revolution, as consumers were able to purchase a wide selection of products from near their homes. More innovations and new products appeared in the market, such as frozen and microwavable food, so that styles of dining and eating rapidly changed. Despite some positive effects of the supermarket culture, the increased pace of production and consumption within this context resulted in large amounts of waste deriving from food packaging and household chemical substances and products.

During this period, various innovations in communication and transportation changed society as well. The telegraph was replaced by the telephone and opened up new possibilities for communication from one part of the world to another. Television and cinema became the means of a new process of consumption and reception, and the culture industry appeared as a major force of social and economic transformation.

In transportation, mass-produced cars became an everyday part of the social life of humans, and the innovation of the jet engine in commercial airliners made long transatlantic flights easier. In fact, by the 1960s, all large civilian aircraft were jet powered, which resulted in compressing large distances

around the globe and a changing conceptualization of space and time. Despite these major changes in transportation, the jet engine would become a major pollution problem in the decades to follow. Aircraft emissions have been polluting the air and resulting in large amounts of carbon dioxide in the atmosphere. Similarly, the pollution of automobiles has been a major problem in the 20th century, attributed to the internal combustion engine and the large amounts of gasoline used.

The golden period of liberal capitalism collapsed with a new economic crisis that began in 1973 as a result of the increased price of oil, and this affected most sectors of the economy. Most international economies viewed the crisis as a temporary lapse in their development and governments tried to apply short-term solutions. However, this last period of the 20th century (1973–99) was one of long-term structural problems and irreversible waste encounters. The ideas of the free economy, mass consumption, political emancipation, and waste management seemed to be failing. Most of the liberal countries were soon faced with mass unemployment, high inflation, poor housing, and increasing pollution problems.

Globalization

Within this context, a new term emerged: *globalization*. In terms of economic capital, globalization resulted in a specialization of the world economy and, more particularly, in movement that occurs across national and political boundaries. This internationalization was nothing new, but the speed of the circulation of capital, commodities, and markets was surprising and unique. Capital, labor, and consumer markets shaped the world economy. Furthermore, the domination of financial capital shaped the main directions and trends globally and led to increasing inequalities across countries. Globalization increased the circulation of people, capital, images, and concepts around the globe.

Globalization was characterized by an intensification of social and economic life that was further expanded in an effort to overcome the problems of the Fordist regime of production. Within this context, the shift to a post-Fordist era of flexible accumulation was characterized by the appearance of new sectors in the economy, increasing and new consumption patterns, new sectors of production, new markets, and an intensification of information networks that aimed to speed up the processes of consumption and production. In addition, the flexibility of production, consumption, and labor became central in the establishment of a new form of capitalism. The speeding up of social and economic life resulted in the expansion of large multinational corporations and a well-known process: transnational capitalism.

It has been observed that this form of capitalism brought large-scale social inequalities around the globe and created fears of a global consumer culture that would homogenize the world. Consumption was intertwined with globalization primarily because globalization was thought of as "McDonaldization." This entailed a world connected by trade and information technologies, a global village that consumed similar images and shaped similar identities, and a process of "time-space compression" with a major goal of speeding up the production and consumption of transnational capitalism on a global basis. Commodities such as Coca-Cola and whiskey could be found almost anywhere in the world; music was becoming increasingly globalized; global movements followed similar styles; and issues of global meaning, such as the environment and the greenhouse effect, circulated around the world.

One of the most influential changes within the context of consumption and society during this last period of the 20th century was the electronics revolution that included the establishment of the personal computer in the 1980s and, during the last decade of the century, the World Wide Web. The personal computer in the form of desktops or laptops became an everyday device in almost every household that could afford it, introducing new possibilities of working and communicating, such as word processing, e-mailing, hypertext, and video conferencing. Moreover, the Internet became a global source of information and communication during the 1990s and a large socializing arena through social networking sites. As a result, new possibilities of social interaction emerged through the Internet, which became a political, economic, cultural, and social network that would influence almost every aspect of the social life of humans.

By the end of last period of the 20th century, two major consequences of the social and economic transformation were apparent. The first change was in relation to population growth. The world's population had exploded in size since the beginning of that century and almost tripled, despite the fact that the 20th century was the bloodiest, with 187 million victims as a result of various conflicts. The second consequence of the mass production and consumption processes was ecological. Nature became a central topic of discussion during and after the 1970s, with governments, international organizations, scientific communities, and ecological movements trying to identify the problems of accelerating growth and production of waste.

Within this context, waste became a central argument in relation to environmental catastrophe, even if the majority of pollution came from the rich and developed countries of the Western world or Asia. A large part of the environmental movement and scientific community argued for sustainable development, which meant a balance between the resources that a society consumed and the waste produced and recycled. In that way, the effects on the environment would be controlled and minimized. However, it was not clear how such a plan could materialize in relation to population levels, production rates, technology, and consumption. What was the right proportion of population growth and death rate or consumption and waste rate? It became apparent that the solutions to environmental problems could not be found in scientific formulas or big innovations but were intertwined with political, economic, and social interests. Despite that fact, the realization that society and nature are not two entirely different spheres and cannot be kept apart had a limited range.

By the end of the 20th century, waste and consumption were radically different concepts in comparison to earlier centuries. Europe was no more the center of mass commodities, industrialization, and global domination. On the contrary, the European empires had been dissolved into small nation-states without colonies, and other countries such as the United States and China had emerged as influential powers and waste producers. Globalization had changed the types of commodities that were consumed by expanding and encompassing the entire world and bringing, even to the most remote islands, mass-produced products, the Internet, and satellite television. Consequently, even the smallest communities had to deal with waste treatment. Therefore—despite the fact that in the 20th century many people became literate, innovations in medicine extended life expectancy, natural science and technology made the biggest steps ever in human history, including nuclear fission and the exploration of the moon—humanity went through the new millennium with a deep feeling of uneasiness about the future and what it could bring. Modern consumption and waste with all their consequences, were a significant part of this uneasiness.

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See Also: Capitalism; Commodification; Consumerism; Environmentalism; Human Waste; Industrial Revolution; Nuclear Reactors; Politics of Waste; Sociology of Waste.

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Hoarding and Hoarders

The term *hoarding* describes the excessive acquisition of relatively worthless things to the extent that it compromises the living space or daily activities of the affected person. This individual is referred to as a "hoarder." Hoarding is considered a symptom of obsessive-compulsive disorder (OCD), but many

people who hoard show no other OCD traits. In the 21st century, researchers are working on understanding hoarding as a distinct and separate mental health problem, rather than one aspect of OCD.

Hoarding is a condition that can strike anyone of any age, gender, or economic level. It is difficult to determine how common the disorder is because researchers have only recently begun to study it, and hoarders often hide their condition. Many hoarders do not recognize that they have a problem, which can make treatment difficult. There are various levels of hoarding behavior, ranging from the relatively harmless "pack rat" to intense acquisition that causes life-threatening conditions.

Signs and Symptoms

There are a number of risk factors or common characteristics found in individuals exhibiting hoarding behavior. Hoarding often starts in early adolescence and worsens with age. It is more common in individuals who have a family member who also hoards. A stressful life event such as a death, divorce, natural disaster, or fire can trigger hoarding in a person already harboring the tendency. While hoarding often leads to social isolation, lonely or withdrawn people may hoard to find comfort and control in having their possessions surrounding them. Hoarders are frequently perfectionists, wanting to make exactly the right decision on what to do with their possessions. Hoarders have increasingly cluttered living spaces because they cannot bear to throw things away but cannot stop acquiring more. A fear of losing information or knowledge that may be needed in the future results in massive piles of newspapers, magazines, and even junk mail. The fear of throwing out something that may be useful later causes anxiety. Clothing, broken appliances, bits of string, foil, gift wrap, and almost any item has value and represents endless possibilities for reuse. The inability to organize and worry about making the wrong decision compound until the hoarder is incapable of making any decision at all.

Quality of Life

Hoarding eventually impacts the quality of life of both hoarders and their families. Unlike most homes where a varying amount of untidiness is normal, the excessive clutter in the homes of hoarders makes the use of rooms for their intended purposes an unattainable goal. Doors and hallways may be impassible. The kitchen may not be functional because the counters, stove, and table are covered with clutter. The bathtub may be filled with stuff, making bathing impossible. When there is no more room inside, the clutter often overflows to the garage, yard, and vehicles.

Hoarding at this level becomes dangerous. There is a greater risk of fire when so much debris is stacked in the home, and, in the event of a fire, it is more difficult for people to get out and for firefighters to get in. There is the danger of falling and getting hurt, especially for elderly hoarders. Large stacks of newspapers can topple over, trapping people underneath. Respiratory problems and other health risks are factors if the clutter includes rotting food, mold, or other organic debris. Health issues are exacerbated when animals are hoarded in addition to (or instead of) objects. The health and safety of the animals is compromised to the same extent as the owner's. Overcrowding among pets often leads to malnutrition, neglect, and disease.

Treatments

There is no cure for hoarding, and treatment can be challenging. Many people who hoard do not see their activity as something that has a negative impact on their lives. Some acknowledge they have a problem but do not see a need to stop. If they receive comfort from their possessions or animals, why should anyone interfere? The pressure to change this behavior is usually initiated by family, friends, or neighbors attempting to deal with the mess.

There are two types of treatment for hoarding: psychotherapy and medication. Cognitive behavioral therapy, a specialized form of psychotherapy, involves a series of strategies to help the hoarder control the urge to acquire and save possessions. The therapist will help the hoarder explore the reasons they feel the need to hoard, teach organizing and categorizing skills, foster decision-making skills, teach relaxation exercises, and help the individual learn to let go of a few items at a time. A therapist will go to the patient's home and help them apply what is learned in therapy sessions. While cognitive behavior therapy has some success helping hoarders declutter

and feel better about themselves, few people are actually cured. Even after a full course of therapy, which can be intense and time consuming, periodic visits and ongoing treatment may be necessary to keep the individual from slipping back into old behaviors.

Medications used in the treatment of obsessive-compulsive disorder are often prescribed to people who hoard. Selective serotonin reuptake inhibitors (SSRIs), a type of antidepressant, are most commonly prescribed. Drugs may not cure hoarding, but they can help an individual manage a hoarding problem by alleviating other conditions that worsen the behavior. Many hoarders have additional conditions or health problems, such as depression or attention deficit disorder, that can interfere with the ability to focus and to stay on task while sorting and organizing possessions.

What drives the need to hoard? Researchers do not yet understand what causes this condition, making prevention impossible. However, hoarding is a mental condition that displays a known series of tendencies or habits. Getting treatment early, as soon as symptoms begin to appear, may help prevent hoarding from becoming so severe that it affects quality of life.

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See Also: Consumption Patterns; Culture, Values, and Garbage; Household Consumption Patterns; Magazines and Newspapers; Personal Products.

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Home Appliances

Most households in 21st-century Western societies employ an array of labor- and time-saving devices to accomplish the basic tasks associated with day-to-day living practices. These objects, designed and acquired with a particular instrumental (as opposed to strictly aesthetic) purpose in mind, are referred to as home appliances. Often, they are designated in terms of their primary role (e.g., clothes dryers, washing machines, or cd-players), although this is not always the case (for example, the term *tea kettle*). Home appliances play an important role in the lives of consumers and present a number of possibilities in terms of their production, use, and disposal.

While each appliance is a distinct object it its own right, it is also embedded in the broader utilities framework of the household. The most obvious cases of these are the provision of electricity and water and the means by which these appliances are able to connect to these utilities. Without an appropriate degree of integration with these services, the ability of appliances to fulfill their intended purpose is severely hampered, if not entirely diminished. Thus, a washing machine is only recognizable as such due to its ability to wash clothes with the aid of plumbed water, electrical current and the appropriate connections, and some type of cleaning agent.

Development

Many contemporary home appliances are the result of relatively recent technological innovations and are often electrical or computerized improvements on manually operated appliances that performed a similar function in the past. Examples include the electric shaver replacing the razor blade, the air-conditioning unit replacing the ceiling and standing fans, and the CD player replacing cassette tape player. In similar cases, newer appliances may be acquired to supplement, rather than entirely replace,

older devices. For example, electric clothes dryers have not entirely replaced outside clotheslines (or drying racks), but nonetheless are designed to perform a similar task.

Energy Consumption

Home appliances have come under the scrutiny of various regulators and independent groups concerned with energy security and environmental sustainability. It has been estimated that these appliances comprise approximately 17 percent of household energy consumption. Further, 10 percent of this electricity is consumed by appliances that are not even in use in what is known as standby power. Appliances are frequently assessed by independent programs, such as Energy Star, which partner with various public and private organizations in order to offer energy and water efficiency ratings for a range of home appliances. Such rating systems are designed to both inform consumers about the energy requirements for a given appliance on the market, as well as offer a means to compare the efficiency of different models of a particular appliance type.

Effects on Perceptions and Behavior

Social scientists have attempted to understand the role that appliances play in the lives of their users beyond the immediate instrumental tasks they are intended to perform. For instance, there has been an increasing prevalence of air conditioning units inside the home, as well as in other in spaces such as the workplace, car, and shopping mall. Sociologist Elizabeth Shove has noted that this widespread use of air-conditioners has contributed to changing expectations about what is considered normal ambient temperature.

This includes a reluctance to tolerate temperature fluctuations commonly found in climate uncontrolled environments and the almost universal acceptance of a mean comfortable temperature of around 22 degrees Celsius (71.6 degrees Fahrenheit). This development is subsequently implicated in changing patterns of dress and the decline of practices previously used to insulate people from the heat of the day, such as the siesta. As such, home appliances are not only labor-saving devices but are also increasingly associated with more abstract notions of domestic life, such as comfort and convenience.

Manufacture and Design

Technology has clearly played a critical role in the story of appliances in the home. The manufacturers' ability to economically manipulate and integrate steel with plastic is a rather basic, but essential, development in the mass production of home appliances. Globalization and the liberalization of trade agreements opened access to cheap labor markets, thereby making many appliances affordable for large proportions of consumers throughout the world.

In addition to the application of various design features for ergonomics and usability, many home appliances are increasingly becoming computerized. Users are often able to program appliances with more specificity than past iterations of the same appliance; for example, the length and temperature of a washing machine cycle, or controlling the emission of steam from a clothes iron. However, the complex circuitry that comprises many computerized home appliances is difficult to comprehend for those without specialized knowledge and equipment. Consequently, these items are more difficult to repair and maintain for the average consumer. Repair of home appliances has been found to be financially unviable in many cases, since the cost of repair labor outweighs the cost of simply replacing the broken device. This suggests that many newer appliances, while offering a range of new performance features, are also more prone to disposal due to their structural complexity.

Reuse, Recycling, and Discard

The replacement of appliances with updated models is one of the driving forces in the creation of waste from home appliances. While appliances, by definition, are primarily utility-serving devices, the sale and marketing of sleek and stylish home appliances as a key part of the modern home suggests that they have an aesthetic component to them. As such, they are often discarded on this basis, having lost their original allure through general wear and tear or by being seen as dated through possessing particular stylistic appearances and features (or deficiencies).

Charity groups often encourage consumers to donate old and unused appliances. This stands as an alternative to merely disposing of appliances from the household, as the charity groups attempt to sell unwanted goods for a reduced price, thus preventing them from going directly into the waste stream. However, the willingness of charities to accept these goods has occasionally led to consumers' dumping unusable appliances and other objects into their hands as a means of disposal rather than donation. Consequently, the capacity of these groups to absorb unwanted but still usable goods is compromised as the waste removal costs are merely transferred from the consumer to the charity organization.

Increasingly high commodity prices have led to discarded appliances being salvaged for their resale value as raw materials. Copper recovered from power cords, gold recovered from computer circuits, or steel from appliance bodies can all be viable sources of income for those willing to acquire the discarded objects and separate their constituent parts. These practices are undertaken at a variety of scales, both automated and by hand.

Home appliances are ubiquitous for those engaged in the domestic practices of day-to-day life. An appliance can embody many ideals, including simplicity, style, durability, or usability. The production, use, and disposal of these goods are critical for issues of consumption and waste, as well as modern life generally.

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See Also: Appliances, Kitchen; Computers and Printers, Personal Waste; Household Consumption Patterns; Personal Products; Sociology of Waste; Ventilation and Air-Conditioning.

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Home Shopping

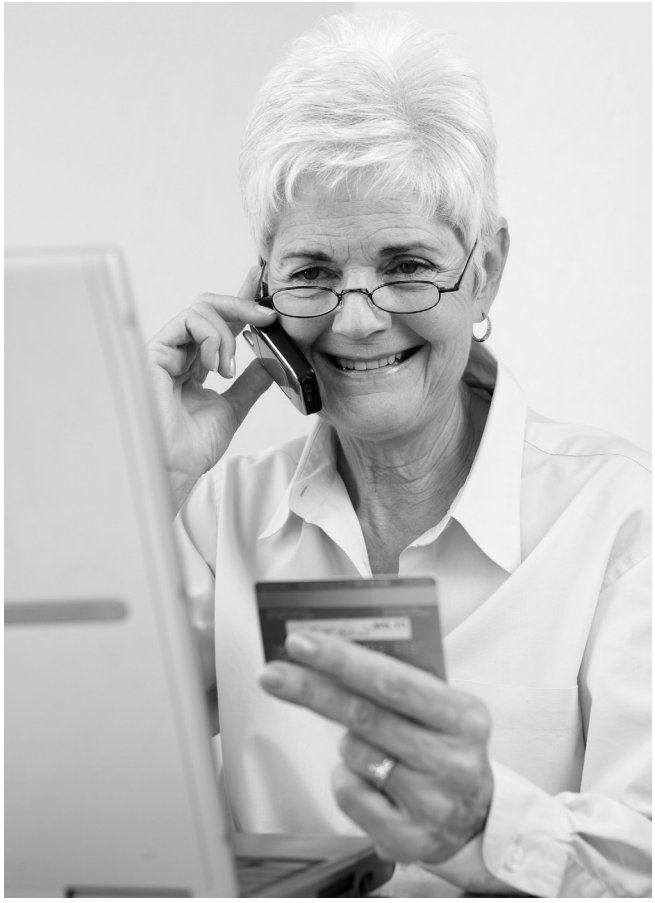
The rise of home shopping—the ability of individuals to purchase goods and services from their homes, generally over the Internet—has not only changed patterns of consumer spending but has also changed the environmental impact of consumption. In large part, this is because home shopping—itself an element of a larger trend in retailing called e-commerce—necessitates a reevaluation of how carbon miles are calculated in the cycle of purchasing goods and services. Carbon miles—the cost of transporting goods and services—is only one element of the calculations involved in totaling the carbon footprint of a given artifact over its life cycle. For consumers, it is often the most visible of the many factors that contribute to the total amount of energy embodied in an object over its life and expended in its creation, distribution, and consumption. The total carbon footprint of home shopping, or e-commerce more broadly, is difficult to determine, but in assessing its impact in terms of how much environmental waste it produces, it is generally most important to look at the distribution and transportation of an object or service. The production of a given service or object is not affected by the mode of retail and distribution; home shopping's innovation lies in changing patterns of distribution.

Home shopping is a relatively recent phenomenon, and although in the United States it bears similarities to the late-19th- and early-20th-century phenomenon of catalogue shopping or purchasing goods from door-to-door salesmen who represent a larger company or organization, the catalogue mail-order services were mainly invented to serve rural populations who had little access to urban retailers. Home shopping over the Internet, on the other hand, is as likely to serve urban populations as it is to serve rural consumers. It has contributed to the remarkable globalization of consumption—goods are available to anyone who can access the Internet and afford to purchase and have items shipped to them. It has also paradoxically reaffirmed local networks of service and consumption that many critics of globalization have argued are among the most significant casualties of a rootless, placeless global economy.

E-Commerce

But if home shopping can be criticized as a symptom of globalization—goods, for example, that might be made in China can be imported to the United States, warehoused, and shipped on demand to customers, and then redistributed to other countries in the form of waste—it has also presented environmentalists with a conundrum. Does the centralized storage and distribution of e-commerce and home shopping reduce overall waste by saving on transportation costs and consolidating the energy involved in warehousing products, or are those savings lost when increased packaging or the hidden costs associated with e-waste are considered?

It is therefore worth making distinctions between the kinds of shopping available over the Internet, for each has a different local and environmental impact in terms of energy expended or wasted, as well as in their implications for post-consumer waste. One can broadly categorize the goods available to consumers in their homes as those offered by big corporations that distribute and market, but do not fabricate, a range of objects from different manufacturers. Perhaps the most famous example is Amazon.com, but in this category one can include those sites that retail objects from a range of producers, such as shoes, jewelry, housewares, and linens. The most famous of these is Overstock.com. Such retailers, large and small, are noteworthy because they often do not have their own retail stores; rather, they store goods in warehouses (or, in the case of etsy.com, in homes or workshops), and ship on demand. For such retailers, the costs of storage and shipping and packaging represent the waste produced by online shopping. The second sort of online retailer with which many patrons are familiar are those retailers that have retail outlets in addition to online sales. Such retailers include major box stores like Target or Walmart, which are consolidated in local geographic areas but will ship goods to local stores on demand for pickup by consumers. This list of corporate online retailers can include those corporations that sell or rent digital media directly to consumers in place of actual artifacts, for example, digital books that are downloaded directly to an e-reader or digital music and films downloaded directly to an mp3 player or smartphone.



While the growth of home shopping over the Internet has contributed to the globalization of consumption, it has also reaffirmed local networks of service and consumption such as shipping. Warehousing may also be more energy efficient.

Swap and Barter

But corporatized e-commerce does not represent the whole of home shopping; there is a great deal of home shopping that takes place through brokers and is dedicated to used goods. The most famous site for this sort of retailing is eBay, which is among the most successful Websites in the world. eBay was founded in 1995 and, according to its own Website, is committed to sustainability because it offers a venue that "extends the useful life of millions of products, keeping items out of landfills and reducing the need for new manufacturing." Similarly, an important venue for home shopping is organized around barter sites such as Craigslist.org (founded in San Francisco in 1995, with over 50 million users and 700 local sites in 70 countries, according to its Website) and freecyle.com, a local nonprofit Website

of objects for sale, trade, or for the taking. Craigslist and Freecycle are locally operated, with various geographic areas sponsoring their own sites (though eBay now owns 25 percent of Craigslist.org). Freecycle, like eBay, is self-consciously committed to "reuse and keeping good stuff out of landfills."

Of the various home shopping venues, the local swap and barter sites appear to be the most environmentally friendly in terms of their overall carbon footprint, especially because they operate locally, traffic in used items, and tend to reduce packaging and shipping costs by requiring that interested buyers pick up their purchases from the seller directly. However, it is still difficult to come by any real data about the success of e-commerce and home shopping or about its environmental impact. There are a handful of companies that attempt to track online commerce, including Forrester Research, which produces an annual report called "The State of Retailing Online," or *Plunkett's E-Commerce and Internet Industry Annual Almanac*. Forrester Research, for example, is mainly focused on marketing strategies and is geared toward increasing retailer profitability, rather than measuring the environmental impact of e-commerce and home shopping.

Although there are industry standards for the regulation of Internet commerce, it is not easy to find information about the environmental impact of home shopping, even when a corporation trumpets its concern with its environmental impact. In part, this is because not all home shopping can be included in any calculations. While it is possible to find information about how much music is downloaded on an mp3 player and the impact of digital music on the music industry's conventional ways of distributing its product in stores, it is not easy to determine, for example, how the savings in making, shipping, packaging, and retailing a CD compares to the overall environmental impact of producing an mp3 player or of disposing of it.

Similarly, it is easier to find information on business-to-business e-commerce—how online sales affect a major retailer's expenditures for transportation and storage—than it is to determine the environmental waste or benefits involved in peer-to-peer or business-to-consumer home shopping. Despite the difficulties of finding and coordinating such data, scholars tentatively argue that shopping at home through the Internet can offer substantial savings in terms of how much waste is generated by consumers in terms of packaging and transportation and are currently devising models that can satisfactorily account for the environmental costs and benefits of e-commerce and home shopping.

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See Also: Household Consumption Patterns; Packaging and Product Containers; Shopping.

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Hospitals

A hospital is a facility where healthcare services are available. A hospital can be either a private or a public facility. It can produce two types of waste. Some of it is regular waste (which can be disposed of through regular garbage disposal), while the

other type of waste is clinical waste. Some facilities have recycling programs for all types of garbage, such as paper, glass, and specialized materials such as electronic waste and medical waste. Medical waste necessitates specific disposal procedures to ensure that there is no contamination of staff, other patients, or the general population. Disposal methods include incineration and in-house treatment before regular disposal. Increasingly, hospitals are dedicating resources to recycling waste as a way to reduce garbage and costs. Nonetheless, disposal remains a challenge, especially in developing countries where limited funds require facilities to cut corners, endangering the local population.

Background

A hospital is a facility where healthcare services are dispensed to patients by dedicated staff using specialized equipment. Presence of specialized staff and equipment means that it acts as a hub for healthcare in a community, and it can have numerous patients and employees frequenting it at regular intervals. Having a high number of people in a relatively small space makes it a fertile place for cross-contamination. Hence, hygiene and waste management are key components of maintaining a healthy facility.

Hospitals can be funded either by the public sector or through private funding (foundations or by insurance companies, for example). As such, each type of facility might have a different approach to patient care and waste management. Different types of hospitals include general hospitals, specialized hospitals (specializing in specific illnesses), and academic hospitals, which are related to institutions of learning and act as practice environments for future healthcare personnel.

Types of Waste Generated by Hospitals

Hospitals generate two types of waste: regular (general) waste and clinical waste. Regular waste is akin to waste generated by most standardized businesses, such as food or paper waste, for example. Clinical waste is waste that can be harmful to human beings and has to be disposed differently than regular waste. It is also sometimes called regulated medical waste (RMW). Clinical waste is regulated to ensure that hospitals dispose it in a safe manner, and hospitals are usually required to maintain logs and inventory of all clinical waste they produce.

Clinical waste can include pathological waste such as tissues, body parts, materials from patients with communicable diseases, soiled linens, human blood, blood products, and needles. The Environmental Protection Agency (EPA) defines medical waste as "any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals." This definition includes blood-soaked bandages, discarded surgical gloves, surgical instruments, and needles, as well as removed body organs (for example, tonsils, appendices, or limbs). On average, between 10 and 15 percent of waste generated by a hospital is believed to be RMW waste.

Disposal of Hospital Waste: Regular, Clinical, and Recycled Waste

Since there are two types of waste generated in hospitals, facilities are responsible for managing them distinctly. Some hospitals go further, implementing recycling programs to incite personnel to recycle materials such as paper, glass, cardboard, and plastics. Some hospitals have more elaborate recycling programs dedicated to specialized waste, such as managing electronic waste (such as outdated computers or diagnostic machines) or medical waste.

Regular waste does not require any specific waste management treatment. As long as the waste does not qualify as clinical waste, it can be disposed of through regular waste channels. Since clinical waste is a regulated material, hospital staffs are usually well advised of which waste can be thrown away in regular waste and which waste needs special attention.

Most hospitals separate clinical waste from regular waste at the source. The most common system is the implementation of specially labeled containers throughout the facility. Many hospitals color-code waste containers to increase compliance by staff. Most hospitals prefer to separate the waste on-site, rather than collect it in a mixed container with regular waste and then separate it. This is done to reduce the risk of contamination to staff.

It is strictly forbidden to mix clinical waste with regular waste because there are many different populations who are at risk of contamination. First, there is a direct risk of contaminating the hospital staff or the people collecting the waste. These individuals are in direct contact with the waste, and it only takes a moment's inattention to accidentally touch a stray needle, leading to a potentially dangerous infection. There is also a secondary risk of contamination to the surrounding area where the waste is disposed of (such as the general population or the land) if no formal steps are taken to properly treat the waste. Therefore, hospitals found to have disposed of clinical waste through regular waste channels are subject to heavy fines.

Disposal methods used by hospitals include waste incineration or its treatment before being sent to a landfill. RMW treatment guidelines can vary by jurisdiction and can sometimes include both national and state-level guidelines. Nonetheless, incineration of medical waste is increasingly controversial because of negative environment impacts as well as secondary infections that can result from improperly maintained facilities (such as organic dust toxic syndrome, an illness contracted following the inhalation of dust).

New technologies are continually being developed to reduce the environmental impact of medical incineration. Less frequent alternatives include autoclaving (sterilization by high-pressure, saturated steam), microwave sterilization, and chemical and irradiation processes (sterilization through radiation).

Hospitals are also seeking to better manage the total waste they generate through the reduction of waste volume generated. The purchase of green products and reusable products is favored by some institutions, but costs can increase by 25–30 percent for the purchase of a green or reusable product. While hospitals face increasing budget constraints, there have been limited opportunities to use green-friendly products in hospitals.

Recycling programs for regular waste are also becoming more common. There are basic recycling programs that target everyday waste, such as paper, cardboard, and plastic. These are more popular since they are less costly and less complicated to implement. Some facilities put into practice much more specialized recycling programs, which target specific hospital waste such as electronic waste (medical devices and computer components) as well as programs for recycling medical waste. Most hospitals implementing recycling programs do it to save on disposal costs and reduce municipal waste, yet incur some costs in terms of staff training and extra steps in terms of waste handling.

On-Site Waste Disposal

Some studies estimate that 25–30 percent of hospital facilities dispose of waste on-site directly, rather than disposing of it off-site. These methods can include incineration and autoclave technologies. The reasons for having on-site waste management can vary, but most believe that processing on-site is more economical and more reliable. Some other facilities also believe that managing on-site allows better control over the disposal of the waste. Since there is an inherent responsibility in the disposal of medical waste, some hospitals prefer to take a cradle-to-grave approach to RMW waste management.

Secure Disposal of Medical Records

Hospitals also deal with another sensitive waste product—expired patient records. Many jurisdictions impose important constraints on hospitals regarding how they can dispose of hospital records, since these often contain sensitive information about patient heath and treatment. Hospitals often implement specific programs to manage the disposal of patient files. Often, hospitals outsource this responsibility to a third party, which shreds sensitive documents on-site (enabling the hospital to monitor the proper disposal of the documents). Other hospitals shred sensitive documents on-site themselves, while a minority of facilities outsource to companies that pick up the sensitive documents and shred them off-site. This is somewhat rare because the facilities are unable to directly monitor the destruction of patient records, a legal responsibility in some jurisdictions.

Challenges in Developing Countries

While waste management in hospitals might be sensitive issues in developed countries, it is even more complicated for hospitals in developing economies.

While central authorities have some defined rules for waste management, even going as far as supplying some of the needed infrastructure (color-coded containers, for example), staff compliance is uncertain and medical waste is sometimes mishandled. This creates a risky environment for the surrounding population. There can be poor or no segregation of different types of hospital waste, with general and infectious wastes often being mixed in the same primary container at the source. Training and advertising campaigns to educate workers continue to meet resistance. Disposal is also elementary, with smaller facilities practicing on-site burial and dumping of medical waste in municipal waste facilities. Onsite incinerators are also present in some facilities, but rather rare, and some lack the necessary controls to measure toxic emissions. Some hospitals dispose of waste with their generic waste, and it is not unheard of for liquid medical waste to be disposed in the local sewer system, potentially contaminating the local water supply. In addition, hospitals often lack the resources and expertise to properly track the waste once it leaves the site, endangering local populations because the waste can be incorrectly disposed of. Since the legislative framework is sometimes vague, and the enforcement of legislation is lacking, proper disposal is a long-term challenge in emerging economies.

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See Also: Incinerator Construction Trends; Medical Waste; Toxic Wastes.

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Household Consumption Patterns

At the core of household consumption patterns is the interrelation between scale and composition of the household, income, savings, expenses, and enculturation patterns.

There are many psychological factors that influence the household consumption sensibility—from the willingness to achieve and/or reproduce a specific social status, to demonstrating material culture in a competition between neighbors who have to have more and better. A series of oppositions (e.g., wealth–poverty, urban–rural, small family–big family,) represent extremes of household structural characteristics and of the character of consumption. Additionally, the specific historical and regional processes of education, enculturation, and socialization influence household decision makers as to what to consume. The transforming of American culture from a culture of consuming toward a culture of sustainability and caring redirects the evolution of household consumption patterns. However, the gradual cultural reproduction of endless wants has resulted in the emergence of forms of compulsive buying that may relate to an impulse-control disorder that was documented as long ago as the early 20th century.

The household is an elementary social unit and includes common expenses and individual expenses. The typology of households includes single member, childless households (including married and nonmarried partners), two generations (parents or grandparents and children), three generations (parents, grandparents, and children) and others.

Housing, nutrition, and clothing belong to the general common consumption pattern. Heating, cooking, lighting, cooling, and water supply have also been described as primary household consumptions (operations). Telephone, laundry, and dry cleaning services and supplies, babysitting, maid services, holiday decorations, and others belong to secondary household consumptions. They vary by household, although the main confounding factor is the number of children. Health, mobility, and recreation are among individual specific consumption patterns.

Households affect both the structure of consumption and the environment through their day-to-day decisions on what to buy and how they use goods and services, where to live and work, what kind of dwelling to have, how to manage their waste, and where to go on vacation.

Consumption and Globalization of Economy

Globalization of economy is one of the important factors that drive household consumption, along with growing incomes, technological innovations (such as the Internet and mobile phones), decreases in the number of household members, an aging population, and habits and cultures. In the European Union's 27 member states, between 1990 and 2007, consumption expenditure increased by 35 percent. Growth has been more rapid in the west Balkan countries and Turkey, rising by 130 percent and 54 percent, respectively, between 1990 and 2007. Households spend between two and six times more than the public sector. Increasing knowledge of health issues and the opportunity for free sharing of information via the Internet have begun creating a household consumption pattern of healthy nutrition that contrasts to late-20th-century overconsumption and an increasing tendency toward obesity. At the same time, in many countries of the world, smoking cigarettes is a common household problem. Results from a survey in China indicate that spending on tobacco affects other categories of consumption such as education and health, household economic productivity (e.g., farming equipment and seeds), and financial security (e.g., saving and insurance). Smoking is often found in combination with alcohol consumption and exacerbates the impact of addictive substances on household common consumption patterns. The same conclusion can be proposed for many other parts of the world—eastern Europe, for instance. On the other hand, tobacco smoking has become less popular in the United States.

One of the main roles of households that is shaping and reshaping consumption patterns globally is tourism. International tourism has grown at an annual average rate of 7 percent since the 1950s and is projected to continue to grow at 4.3 percent per year to 2020. In 2020, long-haul travel will be as frequent as nearly 70 percent of all tourism travel in 1995. Car and air travel dominate, while rail and maritime travel account for a comparatively smaller number of tourism miles. Patterns of vacation travel are changing as many households make shorter, more frequent tourism trips, although the long (over two-week) holiday is still the norm in many countries, especially in Europe.

Rural and Urban Seasonality

A preliminary study of household consumption patterns in Orissa, India, infers that in both rural and urban areas, cereals, edible oil, vegetables, spices, and fuel and light are considered necessities. Pulses and beverages are necessities in urban areas, while eggs, fish and meat, sugar, education, and medical care are treated as luxuries in both rural and urban areas. Micronutrient deficiencies reported in Nigeria are rife, in spite of the reasonable consumption of vegetables during the peak season of production. Among the reasons are the seasonal use of vegetable production and a culture that may limit the adequate consumption of leafy vegetables, even when they are in abundance.

Seasonal fluctuations in food consumption are also a serious problem in rural Mozambique, where community isolation is high, and market integration, use of improved inputs, and access to off-farm income are low. An analysis of the total expenditure elasticity of food groups reveals how precarious food security is in rural households in the poorest quintile, even in regard to the most basic staples of maize and cassava.

Households and Sustainable Consumption

During the consumer revolution (late 16th–early 19th centuries), households developed patterns of mass consumption of luxury and exotic goods. The evolution of these patterns resulted in overconsumption tendencies in the late 20th century. From critical analysis of the mass culture and mass consumption were born the models of sustainable culture that became key issues in the early 21st century. Sustainable consumption refers to goods and services, the use of which respond to basic needs and bring a better quality of life. It minimizes the use of natural resources, toxic materials, and emissions of waste and pollutants over the life cycle, guaranteeing successful social reproduction without jeopardizing the needs of future generations.

Households play a primary role in the embedding of sustainable consumption worldwide, since they are made up of decision makers about what lifestyle to have and what to consume. Among the economic tools are deposit-refund schemes and taxes on disposable products and packaging. Regulatory tools include ecolabeling, while social tools like environmental education and information on green purchasing give support to voluntary initiatives.

Development of sustainable consumption may help to resolve the problem of poverty. Surveys infer that there are means to get rid of poverty and to improve the quality of life worldwide. Since the middle of the 20th century, the global population has consumed more goods and services than the combined total of all previous generations. However, the richest one-fifth of the world accounts for 86 percent of consumption, while the poorest one-fifth accounts for about 1 percent of consumption.

One of the ways to reduce poverty is to develop household ecotourism in low-income countries and to use the services of small household hotels and houserooms. Such services, for instance, have been developing as a consumption pattern in China and in the Balkans.

Lifestyles

Lifestyles link social structure and status to attitudes and behavior by showing how people live and interpret their lives. Depending on the criteria and goal of research, there might be only one (e.g., American style of life) or numerous lifestyle choices, depending on the consumption behavior and types of preferences. Food consumption is one of the main criteria for defining different lifestyles. It does not always depend on income and social status. The same level of calorie consumption may characterize very different income levels, although consumption structure differs widely even at the same high-income level.

Household Consumption Patterns and Waste

In developed countries, growing demand for energy and water services is tied to larger homes. Municipal waste is projected to grow by 43 percent from 1995 to 2020, to reach approximately 700 million tons per year in some of the economically leading countries in the world (Organisation for Economic Co-operation and Development [OECD] members), including the United States, Canada, and Australia. The highest waste-generators among the OECD countries are the United States, Ireland, Iceland, Norway, and Australia.

During the last few decades, recycling rates have increased in an attempt to slow the rate of growth of waste destined for final disposal. Reductions have not been seen in the total volume of waste generated, although there is diversification of the waste stream.

Economists' theories of consumption (e.g., the permanent income hypothesis of Milton Friedman, the life cycle theory of Franco Modigliani-Richard Brumberg-Albert Ando) focus on the economic backgrounds that almost completely depend on household income and decision making. In turn, psychological and anthropological approaches help to understand the individual or group motivation of consumers in depth. Complex research shows that household consumption patterns have dynamic characteristics and their evolution resembles a spiral with economic, social, and cultural variable parameters.

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See Also: Consumption Patterns; Economics of Consumption, International; Economics of Consumption, U.S.; Food Waste Behavior; Overconsumption; Recycling Behaviors; Underconsumption.

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Household Hazardous Waste

Household hazardous waste consists of a variety of commercial products used in the home, such as cleaning supplies, pesticides, and pool chemicals, that are dangerous to human health or the environment and end up in the waste stream. The disposal of these products by homeowners is not regulated by most state and local governments, as long as the products are meant to be used in the home by residents. Conversely, a waste brought home from a worksite would not be considered household hazardous waste and would be regulated differently.

Development and Spread

Since the early 1900s, a wider variety of consumer goods have been made available to the general public. Many of these contain chemical components that pose a hazard to human health or the environment. These materials are marketed similarly to other consumer goods: they are inexpensive, relatively available, and ubiquitous. Some of these products have taken the place of inexpensive alternatives that were traditionally made in the home. For example, simple cleaning solutions can be made much cheaper and safer than many of their commercial counterparts. Although these commercial products are inexpensive and available in many locations, they can be very dangerous to the environment or to human health—even in small doses. A quick inventory of products in most homes will produce a list of dangerous chemicals that can do great harm to adults, children, air, water, and soil. Many of them can be used for bomb making.

Waste Management

The fact that household hazardous wastes are dispersed in hundreds of thousands of homes in small quantities makes them difficult to manage. Waste collection options are limited, and the wastes can become part of the general waste stream in a community unless there are programs designed to collect these special chemicals. Most of the collection programs focus on particular pickup dates, which can pose an inconvenience, thereby limiting participation in household hazardous waste collection programs. The end result is that a large volume of household hazardous waste winds up in the regular trash.

Particular problems occur when household hazardous waste is stored for long periods of time within homes, garages, or storage areas. Many have experienced finding a can or bottle of a household product with a missing or difficult-to-read label. When this occurs, the waste is expensive and difficult to dispose of properly. In addition, household hazardous waste stored for long periods of time may chemically transform into more dangerous materials.

Types of Household Hazardous Waste

Household hazardous waste may be corrosive, toxic, ignitable, or reactive. Labels classify consumer products using these terms if they have the potential to be harmful to human health. Examples of corrosive materials include bleach, battery acid, or oven cleaning products. Examples of toxic materials include a number of products that can cause harm or fatality if ingested or absorbed, such as antifreeze, pesticides, and some pharmaceutical products. Ignitable waste is comprised of materials

Most homes have an informal stock of dangerous chemicals that are potentially harmful to humans, animals, and the environment. Many of them can even be used for bomb making. Waste collection options for these products are limited and usually focus on certain pickup dates, which is inconvenient and discourages participation, especially when bottles and cans lose the labeling that would provide hazard and disposal information. As a result, a large volume of household hazardous waste winds up in the regular trash.

that will readily catch fire, such as gasoline, varnishes, and some paints. Finally, reactive ingredients can give off toxic gases or explode and consist of lye and pool and spa chemicals.

Along with the classification of the product's type of harm (corrosive, toxic, ignitable, or reactive), products are also classified by how dangerous they are. There are three levels of danger: caution (least dangerous), warning, and danger (most dangerous). Products listed with a caution warning can cause burning of the skin or dangerous fumes. The term *warning* is used for similar, but more health-threatening products and for products that can catch fire. The appellation *danger* is used for products having the potential to cause highly significant health problems upon exposure or ingestion, for explosive products, and for materials that can cause blindness.

These products can be found in kitchens, garages, basements, barns, sheds, bathrooms, and other settings in many households. In addition to the products listed, many electronics are also considered household hazardous waste since they contain a number of trace elements and also contain a variety of plastic products. Additionally, ammunition, aerosol cans, fuels, batteries, and automobile waste—such as used motor oil—are considered household hazardous wastes. Some unusual mercury-containing products, such as thermometers and fluorescent lighting, are also hazardous waste. Each year thousands of individuals are harmed by exposure to household hazardous waste.

Health and Environmental Problems

A variety of health and environmental problems can occur with household hazardous waste. Due to improper handling or storage, residents of a home may incur health problems upon exposure to the material. For example, improper storage of a pesticide may cause a container to rupture, thereby exposing members of a household to potentially dangerous conditions for long periods of time due to the slow release of the material. In contrast, poor handling or use of a material may cause sudden exposure, resulting in bodily harm. An example of this is the improper use or handling of oven cleaner, leading to bodily burns. When materials are stored or released outside the home—in a yard, carport, or other area exposed to the elements—they can be released into the near-home environment and can cause localized environmental damage; pet and wild animal poisoning; air, soil, and water pollution; and other unforeseen problems.

Waste workers, such as garbage collectors and workers in dumps, may be exposed to the waste

that is unloaded within the general waste stream. In addition, landfills and waste-to-energy facilities may be damaged by the hazardous material. Deposition of waste in landfills or the burning of waste in incinerators may release the hazardous waste into the ground or atmosphere. Due to the high variability of these wastes, it is difficult to predict health or environmental consequences from their release, particularly since they can be mixed with other household hazardous materials, resulting in unforeseen consequences.

Regulation of Household Hazardous Waste

Household hazardous waste is difficult to regulate. The best approach to managing household hazardous waste is to not purchase or use such products. Since the 20th century, the public has become more interested in purchasing products that are safer and less damaging to the environment. The growth of the green cleaning-product industry, for example, demonstrates the viability of the commercialization of replacements for commonly used products that are considered household hazardous waste. It is relatively easy to find or make green cleaning products, pesticides, and other products. The Internet is a particularly useful tool for consumers seeking to limit their exposure to harmful chemicals or who are interested in having a gentler footprint on the planet. Nevertheless, tons of household hazardous waste are disposed of every year. One way residents can minimize the volume released is to find others who may be able to use the products. For example, if one no longer needs a pesticide, friends or relatives may be able to use the product. Some communities have established household hazardous waste swaps where individuals can bring in their unneeded products and swap them for a product that is needed. In addition, some charitable organizations, such as Habitat for Humanity, will take unused products, such as paint, for their use or, in some instances, resale.

Another approach to managing hazardous waste at the community level is to have a collection day affording residents the opportunity to bring unwanted hazardous materials to a central collection facility where the waste can be organized and disposed of in appropriate ways. The benefit of this approach is that it enables all residents to get rid of waste during regular intervals; furthermore, the management of the waste can be handled in bulk. Sometimes, communities organize days for the collection of specific materials, such as waste motor oil or batteries. In contrast to this, other communities have routine curbside collection of hazardous waste. The danger with this approach is that public workers must handle the material and transport it to a collection facility, and, because collection usually occurs more frequently than drop-off programs, the waste is often stored at a central collection facility. Some communities have specially designed mobile units that will gather household hazardous waste by appointment or that will collect within communities during scheduled collection days. Special wastes, such as batteries, electronics, used motor oils, and fluorescent lights, are oftentimes collected by private businesses for ease of recycling.

Regardless of management options, most communities have some type of household hazardous waste program in place. One key aspect of these programs is the education of the public about the environmental and health problems associated with the waste and the ways that individuals can manage the waste. Many cities have educational Websites with information about disposal options available to residents, as well as information about alternative products. In addition, it is recommended by the Environmental Protection Agency that those involved with hazardous waste collection programs use licensed hazardous waste haulers to transport the waste after it reaches a collection facility. Individuals may transport their own household waste in vehicles. However, once at a collection site, the volume of material often requires special handling and transport to an appropriate disposal site.

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See Also: Cleaning Products; Household Consumption Patterns; Personal Products; Post-Consumer Waste; Public Health; Toxic Wastes.

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Human Waste

The term *human waste* refers broadly not only to the by-products of human physiological processes, most commonly to urine and feces, but also to sweat, phlegm, and flatus, among other bodily excretions. Urine and feces are commonly regarded as being dirty across cultures, while the mixing of human waste with food is almost always regarded as taboo. More than any other development in the history of excretory experiences, the 19th-century sanitation movement and the developing discourses of hygiene and public health transformed people's experience and relationship to human waste. Flush toilets and sewers in urban centers organized human waste disposal into a centralized system under public management, allowing human waste to be carried away by water, making excreta invisible in public spaces.

This method of human waste removal, now prevalent in the 21st century, carries tremendous environmental consequences. Flush toilets are highly water intensive, and the release of untreated sewage pollutes local water sources. Sewers and flush toilets have replaced previously common methods of handling human waste. Night soil collection, where excreta in urban centers was systematically collected and processed into fertilizer for agriculture, was widely practiced throughout east Asia and selectively in Europe and North America. In the 21st century, in an effort to provide adequate sanitation, developing countries are exploring low-cost, closed-looped sanitation systems that use human waste as a resource.

Social Stigma

Human waste has been regarded cross-culturally as a prototypical offensive substance. Various social theories have been offered for the prevalence of aversion to human waste across cultures. Some theories categorize the disgust associated with waste as an evolutionary response to guard against disease, while others hold that the aversion to human waste reflects disgust at the "animalness" of the act and product of defecation. Freudian theories suggest that the disgust toward human waste originates from the emotional trauma of the toilet training experience. Various cleansing rituals exist to separate human waste from daily life and especially from coming into contact with food. Across many cultures, social stigma is often attached to groups that handle human waste, most notably night soil collectors throughout east Asia and untouchables in south Asia.

Early History of Human Waste Disposal

Archaeological remains and archival documents of ancient cities illustrate that organized systems of human waste removal have existed for millennia. Dating back to 2500 B.C.E., excavation from the Indus basin and Mesopotamia reveal highly developed brick structures where waste from each house was directed into drains. Significant social variations in defecation practices also exist throughout history. Defecation has been both a solitary and a social activity. While most Western-style bathrooms in the 21st century contain stalls to provide privacy, the design of Roman bathrooms displays a more social setting for defecation. Excavations of public latrines in the city of Ostia indicate that toilet seats were lined up closely next to one another, forming a square with no barrier between users.

While human waste has typically been regarded to some extent as offensive, historically, both urine and feces have also been considered a useful resource. In large agrarian societies such as China and India, human waste was often collected in towns and cities to be transformed into fertilizers for the countryside through what was known as night soil collection. Human feces, collected with or without urine, was placed outside buildings to be picked up and transported by night soil collectors to the countryside, where it was processed and used as fertilizer. It is difficult to tell how far back the use of human manure extends in history, particularly because the Chinese word for "manure" (one of the most prominent regions practicing night soil collection), *fen*, does not distinguish between human and animal sources. Agricultural manuals in China dating from the 12th century offer a variety of techniques for the conversion of waste to fertil-

izer, demonstrating the awareness that human waste needed to be processed and purified before it could be applied to agricultural crops. The composting and conversion of human excreta into fertilizer to sustain agricultural production was practiced widely throughout east Asia, in France, and selectively in North America in the mid-19th century. Urine, often regarded as having disinfectant properties, was also applied widely as a pesticide, cleaning agent, and sterilizer. It was also not uncommon in 15th-century France to use urine for the cleansing of draperies and clothes.

Centralized Sewer Systems

The sanitation revolution in 19th-century Britain changed the experience of defecation and cast human waste treatment as an environmental and social risk to be managed by a centralized system of disposal. Medieval European cities were awash with filth, as it was common for human waste to be collected in chamber pots and dumped into streets. However, with the growth of cities in the 19th century because of industrialization, urban filth was associated with disease and epidemics. The miasma theory of disease, popular during the Medieval era up to the mid-19th century, held that poisonous vapors, or "bad air," was the cause of various epidemics of the 19th century, most notably cholera. Dr. John Snow's work helped in part to dispel the miasma theory of disease by demonstrating that the 1854 London cholera epidemic was spread through drinking water. The germ theory of disease (which held that disease was transferred through microbes) and the passing of Edwin Chadwick's Public Health Act of 1848 marked the beginning of the sanitation movement, which aimed to provide clean water and sewage treatment to Europe's most crowded cities. Sewers, as a means of transporting filth away from cities, also became an issue of public concern as public health bureaus became established for the regulation of sanitation projects.

Aside from the more obvious benefits of waterborne sewage systems for sanitation, the widespread adoptions of flush toilets and sewers were also linked to the changing sensibility of modern elites who sought to be released from the filth of medieval cities. Sewers and Victorian water closets facilitated the domestication of waste, where waste was cast as a morally offending substance that needed to be removed from the public sphere. The creation of hidden sewer networks below the surface of the city rendered morally offending substances invisible and transformed the sensual experience of the city, especially in relation to smell and sight.

Flush toilets became the primary mode of waste treatment in the United States and Europe. However, they require a vast amount of water, and the discharge of untreated waste from sewage systems has caused pollution and contamination, especially to local water sources. According to the United Nations, in 2008, more than two billion people still lack access to improved sanitation. Inadequate sanitation infrastructure and untreated wastewater can also transmit diseases such as cholera, and unprocessed excreta often leads to intestinal infections and diarrhea, one of the biggest killers of children younger than 5 years old. Moreover, a lack of sanitation facilities often has an uneven social impact on women, as open defecation poses shame and difficulty during menstruation.

Ecological Sanitation

International sanitation movements are experimenting with ecological sanitation as a cost-effective and environmental alternative method of human waste disposal. Ecological sanitation borrows the idea of a closed loop waste treatment system exemplified by traditional night soil collection to treat waste and wastewater as a source of nutrients for agriculture. Contemporary ecological sanitation projects are wide ranging and include methods such as dry waste treatment, greywater reuse, and human excreta reuse in aquaculture (using human waste as a source of fertilizer for raising fish as well as aquatic crops such as water spinach). Dry waste treatment refers to both dehydration and composting treatments.

Dehydration treatments require the separation of urine and feces and the addition of lime, ash, or earth to feces in order to produce a soil conditioner. The collected urine can be diluted and used as a source of nitrogen fertilizer for plants. Urine and feces can also be composted, adding worms and other materials to the human waste mixture to help decomposition. Attempts to introduce new

ecological sanitation practices often require overcoming developed social taboos against the use of human waste for fertilization. The success of ecological sanitation projects requires attentiveness to the social and cultural experience of human waste, and proper usage depends upon sustained research into the health impacts of sanitation projects.

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See Also: Composting; Germ Theory of Disease; Miasma Theory of Disease; Public Health; Sewage; Sewage Collection System; Sewers; Sustainable Waste Management.

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Idaho

Admitted to the United States in 1890, Idaho is the 43rd state and 14th-largest state by area. Boise, the capital, is the largest city and metropolitan area. Landlocked and mostly mountainous, Idaho's northern limit forms part of the Canadian border. With 60 percent of the state's land held by the National Forest Service or Bureau of Land Management, Idaho leads the United States for forest service land as percentage of total area. The second-largest unit of the National Wilderness Preservation System can also be found in Idaho—the Frank Church River of No Return Wilderness. Agriculture features predominantly in the state's economy; leading industries include processed food, lumber and wood, machinery, chemical and paper products, electronics manufacturing, mining, and tourism. Idaho has seen two significant anthropological studies of consumption and waste disposal carried out in recent years: the Campus Trash Project and the archaeological investigation of the Minidoka Relocation Center Dump.

The 16th Nationwide Survey of MSW Management in the United States found that in 2004, Idaho generated an estimated 1,238,394 tons of municipal solid waste (MSW), placing it 44th in a survey of the 50 states and capital district. Of this, 99,590 tons were recycled, placing Idaho 45th in the ranking of recycled MSW tonnage. Based on the 2004 population of 1,463,878, this is an estimated 0.85 tons of MSW generated per person per year, the lowest per capita MSW generation in the United States. Idaho landfilled 1,138,804 tons (40th ranking) and recycled 99,590 tons (45th ranking). Only whole tires and lead-acid batteries were reported as being banned from Idaho landfills.

Campus Trash Project

At the University of Idaho in Moscow, the Campus Trash Project yielded valuable information on the human and environmental factors contributing to patterns of litter accumulation and distribution. The project provided an evaluation of the effectiveness of university waste management policies and also served as a valid training exercise for archaeology undergraduates. The use of archaeological methodologies highlighted the mundane, human, and geomorphic factors that created the pattern of littering on campus.

Research carried out as part of the project showed that university campuses produce an equal or greater amount of trash than the urban centers around them. It also highlighted the problem that, while universities have created permanent positions and initiatives

to reduce campus waste problems, they often overlook everyday human and environmental processes by focusing on macroeconomics. Trash signatures at the University of Idaho were found to be similar to those of a similar study at the University of Louisville. Approximately 19 percent of all campus waste was recycled, compared to 11 percent of recyclable waste in the rest of the city (Moscow), while only 8 percent of the state's overall waste was recycled. The state, city, and campus were all below the national recycling average of 25 percent.

The project began in 2008 as an assignment for archaeology students. Four trash-ridden zones on the campus were identified, and a group was sent to each with a map of their zone and handheld GPS units, which they used to plot relevant features, such as bins and parking bumps. Having mapped the features in the zones, a surface collection of litter was carried out and every litter artifact was bagged and located with spatial coordinates. An ethnographic element included observing and interviewing the students and staff who used the zone. The groups were given instructions on how to write up their findings structured in a way similar to an archaeological report.

Findings of the Campus Trash Project showed that prominently placed "butt pipes" for cigarette waste disposal were ignored by students smoking directly next to them. The problem was identified as being a case of the cigarette waste disposal pipes blending into their surroundings to such an extent they went unnoticed, and students lacked awareness that cigarette butts constituted litter.

The football tailgating parking lot returned 388 litter artifacts, of which 76 percent (298 artifacts) were alcohol related. The waste management procedures in place (handing out plastic bags to all vehicles entering) failed. Dividing the tailgating lot into quadrants for observation and recording during tailgating events showed that alcohol intoxication combined with poor dumpster location and coloring were the major factors contributing to litter buildup. Proposed solutions included allocated parking bays to allow the issuance of fines and more distinctive, easily-located dumpsters.

The factors accounting for accumulation of litter in a creek (Paradise Creek) and swale land were pinpointed by participant observation and the mapping of trash scatters. It had been suggested that students littering on entry and exit of the nearby recreation center created the accumulating garbage in this ecologically sensitive area. However, the actual source was three dumpsters at a neighboring student accommodation block, which were regularly left open. The conclusions reached by the Campus Trash Project included the need for more research on campus trash. University campuses were vaunted as an ideal testing ground for new waste management policies, allowing them to be observed in practice. The unpredictability of human behavior was highlighted, as was the need to test changes on the macroscale in a microscale environment.

Minidoka Dump

Near Twin Falls, Jerome County, on Bureau of Land Management–administered public land is the site of the Minidoka Relocation Center Dump. Minidoka Relocation Center was built in 1942 to intern 10,000 Japanese Americans during World War II. One of the largest and most densely populated settlements in Idaho during the war, the relocation reserve covered 33,000 acres, and its peak population reached 9,400. The U.S. Supreme Court declared internment illegal in 1944. The last internees, made destitute by their relocation, were evicted from Minidoka in 1945. In 1947–49, suitable areas of the reserve were cleared and given to World War II veterans as family farms. The administrative area, a small part of the original central area, survives in the 21st century as the Minidoka Internment National Monument, one mile south of the dump.

The original dump, used by the Relocation Center for daily rubbish between 1942 and 1945, was around 2.5 acres. When the center was abandoned, the area used for dumping increased to over 26 acres as demolition debris, construction debris, and redundant institutional furnishings were dumped. The speed of demolition and vast amount of material remaining even after reusable materials had been removed turned the original dump into a much larger wasteland. This wasteland could not be farmed, and it was seen as an ideal dumping ground by nearby residents. Until 1982, there was regular trash disposal at the Minidoka Dump, with the last disposal made in 1988.

In August 2004, the National Park Service mapped and recorded 229 trash features and over 260 distinct surface deposits consisting of piles and scatters of debris and coal residue. Features ranged in size from 1 m^2 to 4,300 m^2; the largest features and the only buried features were associated with the relocation center. Disturbance of the deposits was noted in the form of bottle digging, trampling, and vehicle damage. The debris includes piles of bricks, rocks, and concrete. Often, one type of building material is dominant, and many of the piles are linear, up to 225 feet long. The relocation-era (1942–45) rubbish was systematically deposited into a prepared pit and other nearby concentrations, and these are the only features that have stratified deposits. The dump was half a mile north of the residential area. The main feature is a partly filled 370-by-100-foot trash pit from the camp; there is also potentially an earlier capped dump from the camp.

The most useful artifacts for dating were found to be (1) glass manufacturer date codes, (2) drink can types, (3) vehicle license plates, and (4) brand names and trademarks. The recent date and narrowly separated phases of the dump meant that artifacts that are usually regarded as useful date indicators in U.S. historical archaeology were of little help. Ceramic backstamps and glass manufacturer's marks remained unchanged for decades in the 20th century, and milk can dimensions were inconsistent.

It was found that many features had artifact types from more than one decade, and these were counted in each decade represented, even where they were likely to be single-dumping events. While this method of tabulation inflates the number of features per decade, it was thought more desirable than arbitrarily assigning a decade or ignoring the feature altogether. Eighty-four features were considered undatable. It was possible to date some of the relocation center dump features to within a single year.

Significant findings in the post–relocation era garbage include increasing automobile-related artifacts between the 1950s and 1960s and a notable preponderance of alcoholic drink containers associated with the World War II veteran farmers. The presence of artifacts thought to be from the relocation camp in post-relocation refuse is also surprising, as usable goods from the centers were routinely destroyed to avoid flooding local markets. The largest numbers of features containing toys dated to the 1950s, thought to coincide with the postwar Baby Boom. It is possible that just one or two households deposited all of the post–relocation era trash. Recommendations for further work included land acquisition and fencing, additional excavation of relocation-era features, oral history collection, more recording of post–relocation center features, and hazardous materials (hazmat) evaluation.

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See Also: Archaeological Techniques, Modern Day; Archaeology of Garbage; Construction and Demolition Waste; Dating of Garbage Deposition; Dump Digging; Race and Garbage.

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Illinois

A hub of transportation, industry, and agriculture, Illinois is a diverse state. Featuring the third-largest city in the United States, much of the population is concentrated in the Chicago metropolitan area along the Lake Michigan coast in the northeastern corner of the state. The entire western border of the state follows the path of the Mississippi River, and the Ohio River joins the Mississippi at the southernmost tip of the state. Almost 13 million residents

lived in Illinois in 2010, 5,194,675 of them in Cook County. From a consumption and waste standpoint, downstate Illinois differs considerably from the Chicago area. Most of the land area in Illinois is south of Chicago and is often just given the general designation of "downstate." Central and southern Illinois are largely agricultural areas interrupted by a few larger cities. In addition to agriculture, southern Illinois has a considerable amount of coal mining as well as some oil fields. Both of these extraction activities have led to significant waste and pollution issues downstate. Northern Illinois and Chicago have also been long-known for their steel mills. The vast majority of the iron ore is actually mined out-of-state and transported in by railway.

History

Illinois became a state in 1818. Due to its proximity to midwest railways as well as shipping routes in the Great Lakes, the Chicago area quickly became the most densely populated region of Illinois. Given its size, consumption and waste has played a primary role in a surprisingly large number of Chicago's major historical events. As early as 1849, the city had official "scavengers" (the historical term for *garbage men*). One of the seminal events in early Chicago history was the Great Fire of 1871, which destroyed nearly four square miles in the heart of the city. Disposing of the tremendous amount of waste from the fire was the first step in the rebuilding process. Debris from the fire, and later, general city garbage was pushed from the shoreline into Lake Michigan. In the 21st century, most of what is Grant Park on Chicago's Lakefront—including Soldier Field—is built on top of old Chicago fire debris and garbage. One of Chicago's long-standing core industries is the slaughterhouse and meatpacking business. Following the Great Fire, these previously scattered businesses were consolidated into the 100-acre Union Stock Yards, southwest of the central business district.

By 1890, 12 million head of cattle were slaughtered annually, which represented a staggering 150 million pounds of animal waste. In the early days of the slaughterhouses, the majority of this animal waste was simply disposed of into the Chicago River. In fact, one fork of the Chicago River, which received much of the animal waste, was nicknamed "Bubbly Creek" because of the bubbles that would rise to the surface from decaying animal matter. Fieldwork in the Chicago slaughterhouses helped Upton Sinclair write *The Jungle* in 1906. His novel helped to expose atrocious working and unsanitary conditions in the slaughterhouses and eventually led to the federal Meat Inspection Act. A profit-motivated push for greater efficiency in the slaughterhouse process eventually led to the repurposing of slaughterhouse waste into categories like fertilizer, lard, leather, soap, and tallow. This greatly reduced the amount of physical waste, but instead created large amounts of air pollution and hazardous working conditions in many of the rendering plants.

Environmental justice is a relatively recent reform movement, but Jane Addams of Chicago's Hull House fame was tackling environmental inequality issues in the early 1900s. Corrupt politicians and lax scavengers had allowed small mountains of garbage to accrue in the Hull House's 19th Ward. Connecting the trash problem to high levels of sickness and disease in her ward, Addams began a trash crusade by reporting thousands of trash ordinance violations to the city's Health Department. These tireless efforts eventually resulted in the mayor appointing Addams as an official city trash inspector.

Reversing the flow of the Chicago River is another major event in the history of Chicago that has its roots in waste management. In the late 19th century, Chicago had the ability to pull more than 100 million gallons of water per day from Lake Michigan. The water came from offshore intake pipes. For all of Chicago's early history, the Chicago River was used as the primary city sewer. As the city grew and wastes became more concentrated, the need to protect the city's drinking water became pressing. The solution was to create the Chicago Sanitary and Shipping Canal. This engineering feat involved excavating a 28-mile-long canal that would send Chicago's wastes downstream away from Lake Michigan and create a convenient shipping lane to the Illinois River. The opening of the canal in 1900 effectively reversed the natural flow of the Chicago River and caused decades of strife with cities downriver that now had to deal with Chicago's wastes.

As Chicago continued to grow, so did its waste generation. By mid-century, waste collection had become a lucrative business, and organized crime

tended to follow profitable industries. Dutch immigrants had a long history of managing most of the city's waste hauling contracts. Their market share grew even more when, in 1959, the Dutch Mafia consolidated its waste hauling businesses under the name Chicago and Suburban Refuse Disposal Association. Not to be left out of the graft, the Italian Mafia was quick to follow suit under the leadership of Willie Daddano. Daddano, nicknamed "Willie Potatoes," formed the West Suburban Scavenger Service in 1960 and used mob contacts, threats, and intimidation to take over waste hauling contracts. Corruption and graft in the garbage business did not end with the mob's involvement. From 1992 to 1996, the Federal Bureau of Investigation conducted an investigation called Operation Silver Shovel. This investigation uncovered a corrupt system of bribes and money laundering in relation to the illegal dumping of construction debris. Operation Silver Shovel eventually led to the conviction of 18 people, including many Chicago aldermen and inspectors. From the 1960s through the 1980s, incineration became the favored method for garbage disposal. When it went into service in 1971, the Northwest Incinerator was the largest in the world and handled 20 percent of Chicago's garbage. As the environmental impacts of incineration were more fully understood, contemporary Chicago again had to contend with its waste problems.

Illinois in the 21st Century

In 2008, 45 active landfills in Illinois accepted more than 50 million gate cubic yards of municipal waste. Chicago has gained the dubious distinction of having more landfills per square mile than any other city in the world. By one estimate, every Chicagoan generates one ton of waste per year. In 2010, Illinois also had 481 Superfund sites as designated by the Environmental Protection Agency. The majority of these can be found in and around Chicago—a testament to the city's past struggles with waste disposal. Within the city, there is an unequal distribution of these landfills and Superfund sites. For example, a 1983 study of the Southeast Side of Chicago revealed cancer rates double those of the rest of the city. Not by coincidence, this area also has over 25 square miles of landfill, in addition to other environmental problems. The residents of this area are predominantly poorer African Americans and immigrants. The environmental justice movement has called this unequal exposure of a particular social group to pollution, toxins, and other hazards "environmental racism." More than a century ago, Jane Addams noted that not all of Chicago's wards were treated equally when it came to trash removal. Her reform ethic has gained hold in 21st-century Chicago with early environmental justice groups such as People for Community Recovery and the Chicago Resource Center.

The Chicago Resource Center (CRC) was founded in 1975 by then University of Chicago philosophy student Ken Dunn. The CRC attempts to merge social and environmental causes. The center began with a program that paid the homeless to collect recyclables. In the 21st century, the CRC uses a multifaceted approach to help achieve social and environmental justice that includes turning vacant lots into community gardens, curbside recycling, managing a creative reuse warehouse, composting, and environmental education.

After many years of dragging its feet on a citywide recycling system, the Blue Bag Recycling Program was initiated in 1995 by Mayor Richard Daley. The concept was to have residents purchase blue plastic bags that could be filled with recyclables and tossed out with the rest of the trash. The blue bags would be collected along with the regular trash and were then to be sorted out at "recovery facilities." From the beginning, the system was plagued with problems. Many bags never made it to the sorting facilities, and those that did were often broken and unusable. The system was eventually somewhat improved by the replacement Blue Cart system. In 2010, however, a study commissioned by Chicago's Department of Environment found that only 8 percent of the waste from the 600,000 homes with city garbage service was recycled (in part because Blue Carts were distributed to fewer than half of households), and few of Chicago's many highrise buildings enjoyed recycling services. The city announced a new pilot program in 2011 to modestly expand the Blue Cart system, but at the beginning of 2012, most Chicagoans lacked recycling pickup services.

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See Also: Crime and Garbage; Environmental Justice; Race and Garbage; Waste Management, Inc.

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Incinerator Construction Trends

An incinerator is an industrial unit used to treat waste by combusting it at high temperatures. In the 1980s and 1990s, incinerator construction slowed down because of concerns over air pollution. The use of incinerators was limited to existing structures and for the treatment and disposal of toxic and medical waste. In the 21st century, there has been renewed interest in new facilities, driven by the growing interest in using waste as an energy source, the emergence of such technologies, and new regulations regarding landfills. Nonetheless, critics continue to argue against the building of new incinerators, asserting that their usage does not give consumers any incentive to recycle, reuse, or reduce consumption, and that they are more polluting than coal power plants.

An incinerator is an industrial unit used to treat waste by combusting it at high temperatures. The largest incinerators handle and dispose of municipal waste, while smaller incinerators are used for specialized materials (such as toxic and medical waste). There has been an informal moratorium in many geographical locations on the building of new incinerators because of the potential harm to the environment. Nonetheless, incinerators continue to be built and used for hazardous and clinical waste because high temperatures are necessary to destroy pathogens and toxic contaminants. With the emergence of environmentally friendly incinerators, several municipal and regional governments are studying the possibility of resuming construction, since they are an efficient method to dispose of waste in geographies where there is a high density of population or without suitable space for landfills.

Construction Considerations and Trends

Multiple considerations are taken into account when building an incinerator. One of the decisive factors is the local waste; the current and future quantity of waste generated is the prime consideration, but other factors, such as the composition of the waste, are also considered. The local political and public environment must also be carefully measured; legislation on emission controls and public perception both play an important role in choosing a locality for establishing a new facility. Other considerations include available infrastructures, locally available materials, and expertise.

Construction of new incinerators slowed (or, in the case of the United States, completely halted) from 1995 to 2006. The main reason for this moratorium was environmental concerns because of the pollution allegedly produced by these structures. Since 2006, there has been a renewed interest in the construction of such incinerators. This interest has been led by the growing use of waste as an energy source, the emergence of new technologies, and new regulations surrounding landfills.

One of the main reasons for renewed interest is that waste incineration has been granted qualification for renewable energy (RE) production tax credits in the United States, and it has obtained equivalent certification in Europe. Since many solid waste components contain hydrocarbons, their incineration generates steam and heat, which can be harnessed to generate electricity. Furthermore, the "renewable" nature of municipal waste has enabled it to qualify for renewable energy status. Hence, its designation as an RE has led to project expansions as well as feasibility evaluations for new plants. In addition, new projects devote extra attention to energy production in their proposal to evaluators and investors and take advantage of new waste-to-energy technologies in their design.

New technologies have also been developed to reduce greenhouse gas emissions and improve air pollution control. For example, a study compared the air quality in three communities with incinerators and three with no such structures. The research-

An incineration plant in Italy. From 1995 to 2006, construction of new incinerators slowed—or was completely halted, as was the case in the United States. This moratorium was due to environmental concerns of the pollution allegedly produced by these structures. However, renewed interest in building incinerators has been spurred by the prospect of using waste as an energy source. In the United States, incineration has been granted renewable energy production tax credits, and European builders can receive equivalent certification.

ers did not detect any differences in concentrations of particulate matter among the communities. These technologies, as well as the continued efforts of recycling ashes into construction materials, have defused some of the concerns put forth by environmental critics. Finally, there is less and less space available for landfilling. Land is fundamentally a finite resource. Incinerators are an ideal technology for locations with dense population because they have limited space available to bury garbage. This has convinced authorities to once again look at incinerators as a viable waste management technique.

Critics

Even using improved technologies and considering the benefits obtained from reusing waste (such as energy generation or ash recycling), critics argue that incinerator use should be far more restricted. It is believed that the proliferation of incinerators discourages consumers to reduce, reuse, and recycle because they have little incentive to do so in the first place. Cheap waste disposal is believed to inhibit consumer incentive in green programs, and the emergence of a green side to incinerators only reinforces those negative behaviors. Its designation as a renewable energy has also been criticized, as opponents allege that on a pound-for-pound basis, incinerating waste generates more pollution than a coal plant. Finally, critics remain unconvinced that the pollution and greenhouse gases emitted by an incinerator can ever be contained, managed, or mitigated.

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See Also: Hospitals; Incinerator Waste; Incinerators; Landfills, Modern.

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Incinerator Waste

Incinerator waste is a broad term for residues that result primarily from controlled incineration activities in large-scale facilities. Incineration is considered one of the most effective waste treatment operations because of high reduction and decontamination rates of physical and chemical composition of wastes. But not all substances are destroyed by the industrial furnaces, cement kilns, or other thermal installations used for incineration. Some noncombustible matters persist and are classified as residual waste streams, dealt with by sterilization, transport and landfilling actions, or recovery activities like downcycling or energy generation.

Statistics on the percentage of waste not destroyed by incineration are usually disparate, with figures anywhere between 5 and 50 percent, given distinct applied technologies, original matters, and other factors. Sizable amounts of solid components, gaseous effluents, liquid substances, and air particles remain, however, as by-products of incineration. Among these, fly and bottom ash are regularly identified as main residues, but matters like grate siftings, frequently amalgamated with fly and bottom ash, as well as slag with vitrified metals, or cleansing waters and sludges, should also be counted as wastes.

Fly and Bottom Ash

Fly and bottom ash are the major residual traces of incineration in key scientific debates and literature on thermal treatment systems. The first corresponds to small-size, light particles that emerge as flue gas from pollution control processes. It contains pollutants that change in number and concentration, given desired or required emission standards, combustion technology, and physical properties of primary residues. The second matches the unburned organic or inorganic materials at the outlet of burning chambers. Bottom ash is typically made of heavy and solid elements that settle by gravity, such as ceramic-like matters, and often has less pollutants and heavy metals than fly ash.

Much of the debate over incineration waste is focused on toxicity as in analogous arguments on other environmental "bads." Thus, matters like fly and bottom ash are often evaluated and managed with a focus on hazardous elements that are largely toxic in small amounts, such as dioxins and furans or specific chlorides and halides. When not regulated or controlled, these find their way into living environments and produce extended collective and individual disorders on health and ecological fronts. Moreover, toxicity problems also connect these wastes with geographical and social inequalities, not only from the location of incineration facilities, but also considering factors such as occupational diseases exposure in waste treatment workers, who often belong to minority populations.

Emissions Treatments

Legal and technical regulations prevent the occurrence or amplification of disturbances related to waste hazardous properties. They are in place from the development of international or national emission standards and legislation on leachability of combustion wastes and technical control devices that decrease ash emissions or reduce perilous materials in remaining bottom ashes, like the newest pollution filters made by living systems or simple scrubbers for acid neutralization. Nonetheless, after combustion, there are also considerable precautions regarding transport and deposition of residues. Measures are designed to avoid fugitive emissions and assure low toxicity in residues to be landfilled, for example, closed systems to manage fine particles and later groundwater tests.

At the conclusion of incineration, residues like fly and bottom ash may be landfilled or treated as suitable resources for matter recoveries, depending on the assessment of optimum scenarios and the foreseen environmental impacts of each option. Among waste hierarchies, recent models often choose burned wastes as reusable substances, reducing pressure on landfills and promoting sustainability in incineration. When reuse is impossible by lawful and environmental constraints or the lack of commercial markets, residues end up in landfills. But incinerator wastes have gained a wide acceptance as building materials, like bottom ash, or even nutrient sources, as in fly ash. The first is retrieved, for example, as landfill cover and secondary aggregate in asphalt pavings or bulk fill.

Incineration as a source of waste recuperations is, in fact, ordinary if seen from a thermodynamic

viewpoint. These wastes are seldom detached from recoveries, as most 21st-century incineration facilities function with waste-to-energy schemes. Combustion systems may reuse incinerator wastes from the beginning by converting burning processes into electricity or heating production, through entropic steam or waste masses as fuels. Prospects regarding incinerator waste management are even related to these procedures as routes for higher environmental and economical ratios. Nonetheless, other future treatment possibilities are also at play, designing not only better legislation and technical control of combustion but also improved thermal technologies that augment burning efficiency and extended producer responsibility platforms, considering both incineration increase and decrease scenarios.

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See Also: Incinerator Construction Trends; Incinerators; Scrubbers; Sustainable Waste Management; Toxic Wastes; Waste Treatment Plants.

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Incinerators

As applied in solid waste management, an incinerator is a facility designed for the efficient, controlled combustion of wastes at a high temperature. Incinerating waste reduces the volume of waste over a short period of time. Incineration can destroy harmful chemicals and pathogens and can be used to produce electricity and heat. Modern incinerators are designed to completely combust waste products and minimize and treat emitted air and solid pollutants. Many types of wastes can be burned in an incinerator, including municipal solid waste (MSW), hazardous waste, and refuse-derived fuel (RDF), which is pellets made from the high-energy fraction of waste.

Brief History of Incineration

Incinerators have evolved greatly since the early 20th century, when open burning of wastes (either in a chimney or outdoors) was the norm for the first half of the 1900s. Incinerators in the 21st century are highly centralized facilities designed to completely combust wastes, produce energy, and minimize and treat the resulting air emissions.

The first waste incinerator was constructed in England in 1874, and the first incinerator in the United States was built in 1885. In the early 20th century, in-house incinerators were very common in the United States, resulting in a remarkably high ash fraction in U.S. garbage (43 percent in 1939). The fast growth of incineration in the United States was halted by a growing environmental movement, which led to both increased legislation and a powerful grassroots movement that fought to keep incinerators from being sited in their communities because of concern about the emissions they produced. Both the Resource Conservation and Recovery Act of 1976 and the Clean Air Act of 1990 set strict standards with which incinerators must comply. Modern incinerators are equipped with various air pollution control devices that treat and minimize the harmful emissions from burning waste. Though popular resistance to waste incineration is strong in the United States, incineration is accepted in other parts of the world; the waste management technology is used widely in Europe and Japan, which combusted 75 and 90 percent of its MSW in 2000, respectively.

Incineration Process

Incineration is the oxidation of materials at a high temperature. During the burning of wastes, moisture evaporates from the fuel and organic compounds are ignited in the presence of oxygen. The incineration process is designed to attain complete combustion of wastes; this means that all carbon in the waste is converted to carbon dioxide (CO_2), all the hydrogen to water (H_2O), and all the sulfur to sulfur dioxide (SO_2). By-products include ash, air emissions, heat, and energy.

For an efficient combustion process, incinerated wastes should have a low moisture content (less than 50 percent) and should have a relatively high heating value (greater than 5 MJ/kg). If moisture contents are higher and heating values are lower, the wastes will require additional fuel to sustain combustion. Wastes that contain inorganic salts, high sulfur or chlorine contents, or radioactive materials must be treated in specially designed facilities. Generally, the two wastes used to produce electricity are MSW, which is unsorted waste, and RDF, which is comprised of a subset of MSW that has a higher average energy content.

A simplified representation of the complete combustion of waste can be expressed as

$$C_nH_mO_pN_qS_r + x(O_2+3.76N_2) \rightarrow nCO_2 + aO_2 + (m/2)\,H_2O + cNO + dN_2 + rSO_2.$$

As shown on the left side of the equation, waste is represented as some combination of carbon, hydrogen, oxygen, nitrogen, and sulfur, and it is burned in the presence of air, which is largely composed of oxygen and nitrogen. When completely burned, the process emits carbon dioxide, oxygen, water, nitrogen oxides, nitrogen gas, and sulfur dioxide.

To achieve complete combustion, the incinerator must provide sufficient oxygen, high temperature, adequate retention time, and turbulence. The appropriate temperature in the incinerator is maintained by balancing the feed rate of waste and the aeration rate. To assure complete combustion, excess air is provided (usually 100 percent more than strictly needed for complete combustion); the percentage of extra air provided in the incinerator is represented by x in the above equation and is a major design parameter for the facility. The target temperature for incineration is usually between 750 degrees Celsius and 1,000 degrees Celsius.

One of the goals of burning waste is to recover energy. Incinerating waste produces hot water and steam, and the steam can be used to generate electricity. Heat from the process can also be used for district heating.

Modern Incinerator Types

For unprocessed waste, there are two main types of incinerators: mass burn and modular. Both of these incinerators take waste as an input, have a combustion chamber where it is ignited, a boiler that captures the heat from the flue gases from which electricity is generated, and a number of air pollution control technologies. Mass burn facilities usually use a moving grate system to move the trash along the incinerator; as the waste passes through the combustion chamber, air is blown on the waste to achieve complete combustion. Modular incinerators are usually smaller than mass burn facilities and are comprised of two combustion chambers: the first with low oxygen levels (to prevent formation of NO_x), and the second with excess air to achieve complete combustion.

For preprocessed waste, such as RDF, incinerators usually take the form of rotary kilns or fluid bed incinerators, though RDF can also be burned along with fossil fuels in conventional power plants. In a rotary kiln incinerator, the main combustion chamber is a rotating horizontal cylinder; the waste enters at one end of the cylinder and is converted to ash by the other end. In a fluid bed incinerator, the waste is burned in a turbulent bed of hot, inert materials (for example, sand or limestone). The waste is suspended by upward flow of high-speed air.

Incomplete Combustion: Pyrolysis and Gasification

Pyrolysis and gasification are two other thermal processes used to convert waste to energy. Where conventional incineration uses excess air to completely combust fuels, pyrolysis and gasification burn fuel in an oxygen-deficient environment. Both are endothermic processes, meaning that heat must be provided to the process to sustain it.

Gasification occurs in a hot (hotter than 650 degrees Celsius) and "air-lean" environment; there is not enough oxygen to allow complete combustion of the fuel. The process results in two products: syngas (a combination of CO, CH_4, and H_2) and a solid (unburned waste and char, a carbon-rich solid). The syngas can then be burned as a fuel, and the resulting char can be used as a fuel or as a soil amendment.

Pyrolysis is the oxidation of waste in the absence of oxygen. The process has been used widely, ranging from Amazonian indigenous people who use *terra preta* (char) as a soil amendment to 21st-century commercial processes that use pyrolysis to

produce charcoal, methanol, and coke. The overall process can be expressed as

$$C_aH_bO_c + \text{heat} \rightarrow H_2 + CO_2 + CO + CH_4 + C_2H_6 + CH_2O + \text{tar} + \text{char}.$$

Both tar (a carbon-rich liquid) and char (a carbon-rich solid) can be used as fuel. Higher pyrolysis temperatures (hotter than 760 degrees C) favor the production of the gases (H_2, CO_2, CO, CH_4), and lower temperatures (450–730 degrees C) favor the production of the solid (char) and liquid products (tar).

Air Emissions and Management

All combustion processes result in the production of gases and particulates, which require control strategies and technologies to meet air quality standards. Prior to advances in air pollution control technologies, incinerators were a major health hazard; this history has resulted in sustained resistance to the siting of incinerators near residential areas.

The emissions from waste incineration depend on a number of factors, including the type of waste burned, type of incinerator, and conditions under which waste is combusted (esp., temperature and the amount of excess air provided). Incineration of waste produces the same basic by-products as the combustion of any hydrocarbon: carbon dioxide (CO_2), water (H_2O), and particulate matter (PM). The sulfur in waste gets converted to SO_2, whose emission is implicated in the formation of acid rain. In the presence of high temperatures and oxygen, the nitrogen in waste gets converted to NO_x, which plays a role in the production of ozone (O_3). Heavy metals in waste, such as mercury (Hg), lead (Pb), cadmium (Cd), and arsenic (As), also volatilize and condense onto fly ash particles; these metals are harmful to human and ecological health. Incineration of chlorine-containing fuel (such as plastics) can result in the emission of dioxins and furans (polychlorinated-dibenzofurans, and polychlorinated-dibenzodioxins), which are chlorinated hydrocarbons that are persistent, toxic, and bioaccumulating.

To minimize the emission of harmful pollutants formed during combustion, a number of air pollution controls have been developed and are standard in 21st-century incineration facilities. These include cyclones, electrostatic precipitators, and fabric filters, which all act to remove particulate matter from the flue gas. Sulfur dioxide and other acid gases are removed by scrubbers, which use alkaline mists to neutralize the flue gas. Selective catalytic reduction (SCR) and selective noncatalytic reduction (SNCR) use ammonia (NH_3) to convert the emitted NO to N_2. The emission of NO_x can also be minimized by reducing the temperature in the incinerator or reducing the amount of oxygen available in the chamber. Finally, the injection of activated carbon into flue gases removes dioxins, furans, and heavy metals by binding to the harmful chemicals.

Ash Production and Management

Combustion of wastes produces ash, as well as some waste products from air pollution control technologies. Two types of ash result from incineration: bottom ash, which is the residue left over from burned waste, and fly ash, the ash that is removed from the flue gas. While bottom ash makes up 90 percent of the total ash produced, the fly ash contains most of the toxicity from incinerator waste.

Ash can be disposed of or it can be reused. Disposal normally occurs in a specialized landfill (called an ashfill) because codisposal with MSW can produce toxic leachate when the acids produced by decomposing MSW lower the pH of the leachate, which increases the solubility of toxic metals. For ash to be reused, it must first be treated to reduce the amount of leachable metals and salts as well as to improve its chemical and physical stability. Ferrous metals, making up about 15 percent of ash, can be recovered using magnets. To make metals insoluble, fly ash can be mixed with lime and Portland cement. Once stabilized, ash can be used as either aggregate for road construction, part of asphalt mixtures, or landfill cover. In Europe, ash is commonly used as a construction material.

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See Also: Incinerator Construction Trends; Incinerator Waste; Incinerators in Japan; Toxic Wastes.

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Incinerators in Japan

Disinfection, stabilization, and volume reduction: these have been the core agendas of 21st-century solid waste management practice in Japan. It is not surprising that incineration has been adopted to achieve these goals. Japan thermally treats 38 million tons, or 78 percent, of its solid waste every year. Japan had more than 1,500 incinerators as of 2010. This represents two-thirds of all the incinerators in the world, located in an area as large as the U.S. state of California, of which more than 70 percent of the area is mountainous and not suitable for human settlement. Incineration is considered a thermal recycling process and will continue to be a core technology even under the initiative of transforming Japan to a sound material-cycle society.

Brief History

Adaptation of incineration technology began in the late 1800s, as Japan lifted restrictions on international commerce. At that time, cholera and other commutable diseases were still major threats to public health. The outbreaks of plague from 1885 to 1887 also pushed the Japanese government to enact a series of laws enhancing sanitary practices, including the Waste Cleaning Act of 1900. The Waste Cleaning Act was the basis for modern solid waste management in Japan and appointed local municipalities responsible for managing refuse. The law also stated that incineration was the preferred option for treating solid waste and thus set the path for Japan to become the most incinerator-laden country of the world.

The first incinerator in Japan was built in 1887, in Tsuruga, a port city thriving on commerce with China at that time. Other major cities followed with their own incinerators. At first, incinerators were batch incinerators—essentially, a large-scale coal stove. These incinerators required daily removal of ash and caused intense odor and air pollution problems. The first incinerator with a draft furnace was built in Osaka in 1916. A series of research projects on various topics, including thermal energy recovery, air scrubbing, and pyrolysis furnaces were conducted. The outcomes of this research were only partly successful but greatly contributed to the development of incineration technologies in Japan. Incorporating the findings of this research, the Fukagawa Refuse Treatment Plant was built in 1929 in Tokyo, capable of treating more than 700 tons of waste per day.

Waste management practices ceased as a result of World War II in the early 1940s but resumed soon after the end of war in 1945. In order to accommodate the growing urban population and the increase in per capita waste generation due to rapid economic growth, more efficient waste incinerators became a necessity. Technology development again occurred in Osaka, and the first stoker-type incinerator was introduced in the 1960s, followed by the fluidized bed incinerator in the 1980s.

Japanese Incinerators in the 21st Century

By 2008, there were 1,567 incinerators and 91 gasification plants treating general waste in Japan. Half of these facilities operate in continuous combustion, treating 86 percent of general waste, while the remainder of the incinerators found in Japan operate on a much smaller scale. The breakdown of these facilities is 965 stoker type, 241 fluidized beds, 158 fixed beds, and 213 other type of incinerators. Incinerators are also used for industrial wastes, such as medical and food processing wastes, as a means of disinfection and stabilization. Incineration is also the major technology of treatment for human waste: 54 percent of all human waste is incinerated. Energy recovery from incineration facilities is also encouraged in the form of thermal recycling, and 980 facilities have adopted

systems for electricity generation or waste heat utilization. From these sources, 1,868 MW of electricity are generated.

Health Hazards

Incineration, however, also imposes health concerns. Flue gases contain standard air pollutants, such as particulate matter and nitrogen oxides, as well as organic micropollutants such as dioxin. Some scholars claimed that as of the late 1990s, Japan was more polluted by dioxin than any other country in the world and called for mitigation. The emission of dioxin from the incinerators is regulated under the revised Water Management and Public Cleansing Law of 1997 and the Law Concerning the Special Measurement Against Dioxins. In accordance with these standards, all facilities constructed before this time were mandated to install bag filters. Further, 66 percent of them are equipped with catalytic reactors; existing facilities and by 2010 were also required to meet the new regulation combustion temperature of 800 degrees Celsius and cooling temperature of 200 degrees Celsius. In a study of 107 municipal solid waste incinerators and gasification melting facilities from 2001 to 2003, it was found that none of the facilities violated the legal discharge limit of flue gas, regardless of the size of plant.

Small batch incinerators and open burning of waste have been banned in accordance of the ordinance set by the Ministry of Public Health. Some claim that dioxin pollution is overly addressed and was used to protect the interests of plant makers. Others point out that in accordance with these regulations, local municipalities are encouraged to form a regional association and share larger and more sophisticated incinerators. This created public opposition against both the high construction cost for new incinerators and economic and environmental burdens of waste transportation. There have also been some movements toward using more holistic approaches in order to consider a wider range of alternatives for intermediate waste treatment practices.

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See also: Incinerator Waste; Incinerators; Japan; Osaka, Japan; Pollution, Air; Tokyo, Japan.

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India

The Republic of India is the seventh-largest country in the world and the second most populous country, with 1.2 billion people. It has one of the fastest-growing economies and is undergoing major reform and development. Therefore, how India charts its development in the 21st century will have a significant impact on the future of a large proportion of the world's consumption, along with environmental, financial, and social implications. Development and consumption in India have been linked to many positive changes, such as rising incomes and living standards; but new issues have arisen, such as environmental degradation, social inequality, and increasing amounts of domestic and industrial waste.

Consumption in India: Past and Present

Until the end of the 20th century, consumption in India was at a low level and based on meeting basic needs. During the precolonial period, which lasted up to the 18th century, almost all of the population resided in rural villages. Subsistence agriculture was the mainstay of the economy, alongside networks of commerce and manufacturing. Hand-based industries were common, such as crafts, food processing, textiles, or toolmaking. There was also trade between cities and exports of agricultural products

and textiles to overseas markets in Europe, the Middle East, and southeast Asia.

Consumption patterns changed when India was colonized by the United Kingdom in the early- to mid-19th century. The traditional, agrarian way of life was gradually replaced by national systems of economic, legal, and social organization. Consumption was transformed by development and urbanization, including the establishment of industries, markets, and towns. These changes brought new ways of living. The colonial period coincided with major changes in the world economy, particularly industrialization, production, and trade. However, the impact of British rule on India's economy and consumption is a controversial topic. Some argue that policies implemented by the British Raj were exploitative and led to the demise of domestic industries, causing agricultural production to be insufficient for feeding the population. When India gained independence from British rule in 1947 and became a republic with a new constitution in 1950, it was a deeply impoverished country—one of the poorest in the world. Much of the population was still surviving on subsistence levels of consumption.

From the 1950s to the 1980s, India was a socialist state, generally isolated from the world economy. It focused on self-sufficiency and encouraged consumption of Indian-made products, rather than imported goods. Economic and social development was limited by the government's adherence to socialist policies, state ownership of many sectors, and extensive regulation.

Manufacturing accounts for about half of India's gross domestic product. The country is well known for textile manufacturing, and areas such as Ludhiana and Tirupur have gained recognition as leading sources of hosiery, knitted garments, and sportswear.

The tide began to turn in the 1990s, when economic reform and liberalization opened new markets, as India moved toward a market-oriented economy. Changes included privatization of certain public-sector industries, new policies on international trade and investment, and tax reforms. Consequently, in the intervening years, India has transformed into one of the fastest-growing economies in the world, with an average annual gross domestic product (GDP) growth rate of 5.8 percent since the 1990s.

India's growing economy has fueled increasing consumption. Household spending power is greater as a result of rising wages. Similar to historical patterns in other countries, India's consumers are beginning to spend proportionally less on basic necessities. Income growth, as a result of strong economic growth, will likely continue to increase consumption in the 21st century and will most likely turn India into one of the world's largest consumer markets. Increasing consumption, in turn, creates more business and employment opportunities, further fueling the economy and consumption. Domestic consumption has played a key role in India's growth, in contrast to other Asian countries such as China, which are more dependent on exports.

However, although incomes have increased, household saving rates hinder consumption in the early 21st century. The first priority of many families is not to buy new goods but instead to save money. The Indian tradition of frugality with money, coupled with the lack of a social security safety net, encourages saving for children's education, healthcare, and old age. It is also common practice to invest savings in physical assets, such as cattle, houses, or land.

Another key driver of consumption is India's large population, which has increased rapidly since the 1960s as a result of advances in agriculture and healthcare. Population growth has been particularly rapid in urban areas, supplemented by rural–urban migration.

Cities are major centers of consumption. The largest cities in India are Delhi, Kolkata, and Mumbai—

each which a population of over 10 million—which dominate India economically. Many leading companies are concentrated in urban areas but absent in rural areas because of market inaccessibility, limited infrastructure, and low incomes. However, rural households, due to their majority share of the population, are collectively India's largest consumer group. More than 70 percent of the population still lives in rural villages of varying sizes and depends, to a large extent, on subsistence agriculture.

Consumption differs across economic and social groups. Many people in India, such as unskilled and low-skilled workers, are poor and typically spend a large proportion of their income on basic necessities. Higher up the income scale are college graduates, professionals, mid-level government officials, and traders, who have spending power above the subsistence threshold. The highest group of earners is the emerging middle and upper class, with preferences for expensive and luxury goods, but this group constitutes a small proportion of the overall population. As incomes continue to grow, the structure of consumer society will change significantly.

There is a wide variation in consumption across India's 28 states and seven union territories, which differ in per capita income, development level, poverty, and infrastructure. Economic growth rates are higher in states such as Delhi, Gujarat, and Haryana and much lower in states such as Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, and Uttar Pradesh.

Main Areas of Consumption

Increasing purchasing power of consumers has transformed India's retail market into a pillar of the economy. There are more than 12 million retail outlets operating across the country in the form of either licensed retailers (such as large retail businesses and hypermarkets) or traditional, small-scale retailers, such as local convenience stores, *kirana* shops, open markets, and street vendors. Although absent at the end of the 20th century, the shopping mall has become a feature of consumer life in cities, with New Delhi and Mumbai leading the way in terms of glamour and glitz. The retail industry is currently in a state of flux, undergoing enormous growth. There is also investment by multinational companies, as the world's largest retailers by sales, such as Costco, Tesco, and Walmart, are planning to open stores across the country. Indian retailers are also increasing their brand presence overseas. The largest categories of spending are alcohol and beverages, food, tobacco, transportation, and housing. Other categories, such as education, healthcare, personal products, services, and recreation, are likely to be popular in the 21st century.

Growth in consumption has led to higher demand in the service sector. The best-known example of India's service sector is information technology, which has grown in response to availability of highly skilled, low-cost, English-speaking workers. Bangalore is regarded as the country's information technology capital, and other important centers include Chennai, Hyderabad, Kolkata, Jaipur, and Mumbai. There is a strong demand for banking and investment services. Since liberalization of the economy, banking reforms opened up the market to private and foreign companies. Mumbai is regarded as the commercial and financial capital of India.

The healthcare system is one of the largest systems in the country in terms of revenue and employment and consists of both a government-funded sector, ranging from primary to tertiary services, and a private sector that focuses mainly on primary care. Private healthcare accounts for the majority (more than 80 percent in 2010) of Indian hospitals and hospital beds, and standards of care and quality are significantly higher than in the public sector.

India's services-led economic growth model is distinct from other Asian countries such as China, Indonesia, and Malaysia, which have followed industry-based growth. However, manufacturing is important in India, accounting for about half of GDP, although one-third are engaged in simple household industries. Major industries include chemicals, food processing, mining, petroleum, steel, telecommunications, and textiles. India is well known for textile manufacturing, and areas such as Ludhiana and Tirupur have gained recognition as leading sources of hosiery, knitted garments, and sportswear. However, the global financial crisis at the beginning of the 21st century slowed economic growth, particularly in the manufacturing sector.

Development, increasing population, and urbanization have led to increasing resource consumption. Agriculture is the largest sector of the economy, and

allied sectors such as fishing, forestry, and logging are also important. India's farm output ranks second worldwide. Major agricultural products produced and consumed in the country include cotton, fruit, milk, oilseed, potatoes, rice, sugarcane, tea, tobacco, and wheat. India has the world's largest cattle population, and animal husbandry plays an important role in the rural economy, providing eggs, hides, meat, and milk. India is the world's largest consumer of silk, the majority of which is produced in Karnataka, particularly Bangalore and Mysore.

Agricultural yields have increased since the 1950s as a result of emphasis on agriculture in national development plans, the green revolution, improvements in agricultural practices and technology, and projects promoting linkages between farmers and consumers. However, low productivity was still a problem in many parts of the country by 2010 because of factors such as agricultural subsidies, which hamper productivity; overregulation; economically unsustainable practices; poor irrigation; and inadequate market infrastructure.

India was one of the world's largest energy consumers as of 2010. Coal accounts for more than half of total energy consumption, followed by oil (31 percent), natural gas (8 percent), and hydroelectric power (6 percent). Nuclear power provides a very small proportion of total energy consumption, but it is expected to increase in the 21st century. The country has also invested in renewable energy sources. However, India lacks sufficient domestic energy resources and is dependent on imports. For example, in 2009, India imported 2.56 million barrels of oil per day, making it one of the largest buyers of crude oil.

Tourism is relatively undeveloped. As well as domestic tourism, India is a popular destination for international travelers from places such as Bangladesh, Europe, the Middle East, the United States, and Pakistan. Another type of tourism, medical tourism, is experiencing high annual growth rates, and the government has initiated tourism incentives such as marketing campaigns, improved airport and transport infrastructure, and tax incentives.

Society, Environment, and Waste

Rising living standards have transformed people's everyday lives. Poverty has significantly declined. There have been improvements in educational standards, food security, health, life expectancy, literacy rates, living standards, and overall quality of life. Millions of people have access to goods and services that were unavailable in the 20th century.

However, despite India's impressive economic growth and excitement about the potential of its consumer market, there is some distance before its income and consumption levels reach world standards. India is still very much a developing country, with the largest concentration of the world's poor. Pressing problems include meeting basic needs, high illiteracy, and malnutrition. Millions of Indians do not have access to modern toilets, regular electricity, and running water, especially in rural areas. In cities, high-rise, modern buildings are next to slums and other shabby areas that are home to urban poor, such as migrant laborers seeking job prospects. Moreover, since independence, India continues to face challenges such as naxalism (extremist communist groups) and regional separatist insurgencies.

There are also numerous factors that curb consumption and growth, including poor infrastructure; insufficient energy, as electricity supply outstrips demand; regional variation between cities, states, and territories; inequalities in income and wealth distribution; and corruption. To maintain long-term growth, there needs to be agricultural and rural development; energy security; opening up of the manufacturing sector; modernization of industries, such as retail; reforms in the financial and public sectors; and incentives to attract international trade and investment.

Consumer complaints are common and include fake products, poor services, poor product safety, and substandard goods. The most common counterfeit and pirated goods are CDs, DVDs, cigarettes, and clothing. To deal with these issues, the Consumer Protection Act of 1986 and the Department of Consumer Affairs were created to ensure the rights of consumers. It should be noted, however, that not everyone in India is positive about its new consumerism. Some worry that traditions are eroding, the poor are being abandoned, and Indian companies are being taken over by multinational companies.

India's consumption has placed a heavy burden on the environment. Issues include drought, floods, deforestation, desertification, habitat destruction,

and soil erosion. Rising demand for energy has led to air pollution, climate change, and water pollution. Air pollution from industry emissions and vehicles is a problem in cities. Rising demand for natural resources, such as forest-based products, is causing deforestation and encroachment onto forest land. These problems extend to other countries, as India's huge consumption has led to imports of natural materials from elsewhere. For example, India is a large importer of palm oil, mostly from Indonesia and Malaysia, causing environmental and social problems there.

Waste and sanitation are problems. Most urban household waste is buried in open landfills and only a small proportion is composted or incinerated, although composting is widespread in rural areas. Although some cities operate good sanitary landfills, most are poorly operated and in many cases are simple, open dumps. Many areas do not have adequate waste treatment facilities and technical expertise. Large amounts of household and industrial waste are untreated, causing pollution and threatening groundwater quality. Many cities dump untreated sewage and even partially cremated bodies into rivers, even though the water is used downstream for bathing, drinking, and washing. For example, the Ganges River, a national symbol of India, is polluted with sewage and industrial waste, even though it is used by more than 400 million residents and an estimated 2 million pilgrim bathers.

Household waste is dominated by organic matter, although the proportion of waste glass, paper, and plastic is rising as the country adopts modern ways of living. Ash is another major component in household waste because many homes use coal for cooking and heating. Recycling of household waste is underdeveloped. There are few recycling companies, laws, regulations, and policies. However, a great deal of recycling is done by waste collectors who sort through rubbish in streets, households, and even landfill sites to collect recyclable products to sell to traders.

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See Also: Delhi, India; Developing Countries; Kolkata, India; Mumbai, India; Slums; Street Scavenging and Trash Picking.

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Indiana

A midwestern state in the Great Lakes region, Indiana is the smallest state in the continental United States west of the Appalachian Mountains. However, the capital and largest city Indianapolis is the second-largest state capital, and there are several metropolitan areas with populations greater than 100,000. Indianapolis has a diverse economy and is part of the Corn Belt (an intensively agricultural region) and the Rust Belt (a manufacturing region, recovering since the 1970s) of the United States.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that in 2004 Indiana had an estimated 13,570,231-ton municipal solid waste (MSW) generation, placing it eighth in a survey of the 50 states and the capital district. Based on the 2004 population of 6,302,646, an estimated 2.15 tons of municipal solid waste (MSW) were generated annually per person, the highest in the United States. Indiana landfilled 8,469,912 tons (ranking 9th) in the state's 35 landfills. It imported 2,165,429 tons of MSW, and export tonnage was unreported. In 2006, Indiana was increasing its 245,570,987-cubic-yard landfill capacity, and it was ranked joint 16th out of 44 respondent states for number of landfills. Only whole tires and lead-acid batteries were reported as being banned from Indiana landfills, with a partial ban on yard waste (no leaves or coarse wood debris longer than three feet). Indiana's average landfill fees per ton were $29.57, where the cheapest and most expensive

average landfill fees in the United States were $15 and $96, respectively. Indiana has one waste-to-energy (WTE) facility, which processed 569,263 tons of MSW (14th out of 32 respondents), and 4,531,056 tons of MSW were recycled, placing Indiana eighth in the ranking of recycled MSW tonnage.

Archaeology of the Homeless

Professor Larry Zimmerman at Indiana University-Purdue (IUPUI) has used archaeology to study the homeless subculture in Indianapolis. Working with Jessica Welch, a former student and ex-homeless person, Zimmerman used previous experience from investigating a homeless campsite in Minnesota. He stated, "homeless people, often invisible to those around them, have, use and dispose of material culture as they move across the landscape. But because people are homeless, many Americans think they lack material culture." Discarded food remains, containers, personal items, and bedding at former campsites, as well as caches of material left for future use, are often regarded as refuse by society at large. Abandoned cars, discarded mattresses, and personal belongings stored in garbage bags can appear to be trash when homeless people are actively engaged in recycling them.

The Indianapolis study is completely unlike past anthropological studies of homelessness, which have mainly been ethnographic and taken place in controlled settings like shelters and hostels. Avoiding interacting—and therefore interfering—in the lives of vulnerable people, Zimmerman and Welch located camps and shelters, which they photographed, and inventoried the items left and discarded there. They did not open caches of goods sealed in trash bags and hidden in discreet places, as these had been hidden by homeless people for future use. The refuse of the homeless showed that aid given to the homeless often constitutes society's preconceptions of what it thinks homeless people need, rather than what they actually require. For example, Zimmerman and Welch found numerous hotel-sized bottles of shampoo, conditioner, and toothpaste, but only the toothpaste had been used by the homeless, as dental care is a greater priority to hair care and access to water is limited. Large numbers of used food cans were found that had been opened by hitting them with rocks or heating them until they exploded—ownership of a can opener was rare.

Landfills

As Indiana generates more MSW per person than any other state, disposal is a major issue. Two of the most contentious cases in recent years have been the landfills at Randolph Farms and Mallard Lake.

Randolph Farms Landfill in Modoc, Randolph County, is owned by the Balkema family of Michigan. It serves six Indiana counties and two Ohio counties, and 2,000 cubic yards of waste are buried daily in 4-by-6-foot lifts. In 2004, the Balkemas began petitioning for a third time to expand the landfill from 120 acres to 340 acres to allow a further 50 years of operation. This expansion was controversial to residents of the largely rural county because only 6 percent of the landfill's contents came from their county, the majority derived from Miami County, Ohio. There was concern that the expansion would allow the landfill to reach a height of 50 meters, which would make it one of the state's largest landfills and the highest point of elevation in Indiana, visible from over a mile away. The landfill is on a limestone hill, directly over highly permeable sand and gravel aquifers near the drainage basins of the White River and Whitewater River, which tests have confirmed are at high risk of water pollution. Testing in the 1990s showed low levels of volatile organic compounds from landfill gas in groundwater monitoring wells. There is a legend that Modoc, Indiana, was named by Henry Conley, one of its first settlers, after he picked up a cigar box thrown as refuse from a passing train. The cigar box contained the name Modoc, which Conley suggested would be a good name for the new town.

The Mallard Lake Landfill has been the subject of a 30-year legal battle since the Reed family applied to Madison County to rezone their farm in the 1970s. The Killbuck Concerned Citizens Association formed in 1979 with the aim of stopping the landfill, which would be sited opposite an elementary school. Repeatedly, the Reed family (JM Corp.) has had environmental law judges rule in their favor in proceedings with the Indiana Department of Environmental Management (IDEM) and the opponents of the landfill, only for the court's decision to be appealed.

IDEM issued an operating permit in 1988, which the landfill's opponents appealed, resulting in a 10-year litigation, which ended with a 1998 order for the IDEM to process a final operating permit. A dispute over the depth of the landfill's lining prevented this, and, in 2003, JM had to renew its landfill permit. This permit was applied for, but the IDEM requested additional information as landfill design regulations had changed in the interim period, and a request for additional time to supply this information was granted. However, when a potential buyer of the landfill, Consolidated Waste Industries, Inc. (CWI) began trying to get a permit, requests for further time to supply the additional information were denied by the IDEM. Negotiations broke down and CWI had to take the IDEM to court to appeal the decision, to which the opponents of the landfill filed petitions to intervene. In 2004, a court order forced the IDEM to reinstate the permit renewal application. A state panel was set for two days of hearings on the permit's renewal in late 2010.

The proposed facility at Mallard Lake is a 13-acre, 44-foot-deep landfill that will receive another six feet of composite liner final cover. The landfill is projected to have a uselife of around four years. The liner system consists of three feet of compacted soil and a 60-millimeter high density polyethylene (HDPE) geomembrane, backed up by a leak detection system. A series of perforated pipes under the landfill collect leachate, which is then pumped out and taken to a treatment facility.

Industrial and Farming Pollution

Lake County, in the northwestern corner of the state, is heavily industrialized with significant water, air, and land pollution problems caused by more than a century of steel production, chemical production, coal-burning power plants, and illegal waste dumping. While industrial capacity at U.S. Steel's massive Gary works declined in the 1970s, existing wastes continue to affect the health and land values of the community. The population of Gary became heavily African American between 1950 and 1980 as white middle-class residents moved to cleaner environments, and the community suffers from high rates of asthma and infant mortality.

Another controversial waste disposal issue that has created citizen concern in Indiana is factory farming waste from concentrated animal feeding operations (CAFOs) and confined feeding operations (CFOs). Initially, IDEM only recognized the CFO category (more than 600 hogs or sheep, 300 cattle, or 30,000 fowl fed in pens, sheds, or buildings). The more recent CAFO category threshold is defined as 700 mature dairy cows, 1,000 veal calves, 1,000 nondairy cattle, 2,500 swine over 55 lbs, or 10,000 swine under 55 lbs. CFO is an Indiana categorization, CAFO is a federal category, and both categories are regulated by the state of Indiana.

The biggest problem with factory farms is the amount of manure produced when around 20,000 pigs are confined at a single facility. Sows can spend two years in a sow barn without leaving the building, during which time their excreta is channeled from beneath the floor into huge outdoor storage lagoons to be used as fertilizer. When animals are moved out of the buildings after such long periods, both have to be power washed, creating even more liquid waste. One of these manure lagoons in Randolph County covers 7.2 acres and holds around 20 million gallons of manure. The tile drainage systems used to control surface water in Indiana make it virtually impossible to keep manure pollutants out of the water system.

The IDEM 1998 State of the Environment Report noted that 82 percent of Indiana's rivers, lakes, and streams were unfit for swimming due to high levels of E. coli bacteria. The CAFO pig-farming explosion is attributed to Governor Mitch Daniels's goal of doubling the state's pork production and a moratorium on new CAFOs in North Carolina. Indiana citizens have been vocal in the press about the IDEM's failure to regulate the pollution from CAFOs/CFOs and other issues with the factory farm industry that has spread across the state.

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See Also: Archaeology of Garbage; Farms; Landfills, Modern.

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Indonesia

Many Asian countries have large, growing populations, rapidly rising consumption levels, and massive increases in waste production. Indonesia has the fourth-largest population in the world and the largest in southeast Asia. Per capita production of solid waste (SW) is not high by world standards, but it has increased exponentially since the 1970s. It also has one of the less-developed infrastructures for waste management (WM) in the region. Consequently, problems of waste disposal are massive and growing. Government, local communities, civil-society groups, international aid agencies, and industries are all involved in developing solutions. Waste-to-energy and composting are emerging as promising directions but ultimately reduction in waste production will be essential.

Brief History of Consumption and Waste

The basis of the Indonesian economy was, historically, small-scale agriculture—mostly subsistence production for family consumption. Nonfood items were also largely produced from local natural materials, including bamboo, timber, and banana leaves. Anything useful was reused, while surplus, unused, or abandoned materials were simply left wherever they fell. Waste management consisted of periodic sweeping of organic material into piles out of the way to be eaten by chickens, dogs, and pigs, or to simply decompose. Quantities sufficient to cause inconvenience or ritual pollution were burned. Rubbish in the sense that it is known in industrial economies did not exist. Neither did the notion of "waste management."

Industrial processing began during the colonial period, largely of agricultural products for export. European-manufactured goods were also introduced in small quantities. In the latter part of the 20th century, local industrial production increased, and more manufactured goods were imported. Bicycles were replaced by motorcycles and then cars. Radios, then televisions, and computers became commonplace. Prepackaged foods and drinks replaced ones wrapped in banana leaves or served in glasses. With urbanization came dependence on consumer goods. Economic growth created new prosperity and a middle class with tastes and appetites for international levels and styles of consumption. The mass media fed these appetites, and spread to all levels of society and parts of the country. All this has led to new kinds and ever-growing quantities of waste. Traditional ideas and practices provided little precedent for dealing with the changing reality.

Waste Statistics

Quantification of waste is never easy and statistics on Indonesia are notoriously unreliable, but the following figures give some indication of the scale of the issues and patterns of growth:

- National population: 220–240 million
- Proportion served by WM Authority (2006): 56 percent
- Per capita production of SW (1989): 0.4–0.76 kg/day; (2006): 1.12 kg/day
- National production of SW (daily): 20,000–186,366 tons
- National SW production (annual) 22 million tons (2007), 38.5 million tons (2006), 106 million tons (2010)
- Increase in SW production between 1971 and 2000: tenfold
- Projected national annual production of domestic SW (2020): 53.7 million tons
- Proportion of household waste (2006): 43 percent
- Proportion of waste collected and managed: 40–69 percent
- Proportion of waste recycled: <2 percent
- Proportion incinerated: 35.49 percent
- Proportion into landfills: 7.54 percent

- Per capita daily generation of urban waste: (2001) 0.8 kg, (Jakarta, 2000) 0.65 kg, (Jakarta 2000) 1–2 kg/day
- Daily production of urban waste: 55,000 tons
- Proportion of urban waste collected (Jakarta): <66 percent
- Increase or urban domestic waste (annual): 2–4 percent
- Increase of urban waste (daily, Jakarta): (1985) < 20,000 cu m;(1991) 23,708 cu m; (2001) > 25,600 cu m
- Amount of waste arriving at final disposal sites: 13.6 million tons
- Proportion of organic material: (1989) 87 percent, (2006) 62 percent
- Proportion of plastic: (1989) 3 percent, (2006) 14 percent
- Proportion of toxic and hazardous materials: <10 percent
- Number of people employed by WM authorities: 73,500
- Number of scavengers at official landfill sites: (2006) 14,538
- Number of scavengers in Jakarta: (1995) 10,000–40,000

These figures support several generalizations: per capita production is not high; total production is large; both are growing fast; the waste is relatively high in organic matter but this is decreasing; the most rapid increase is in plastic waste; and, finally, waste management policy, practice, and capacity lag far behind waste production.

In Indonesian urban areas, some of the trash is collected by local authorities and taken to incinerators or landfills, where high humidity and temperatures generate large volumes of methane. The rest is dumped on vacant lots or rivers, or sold as construction filler.

Waste Management

New understandings, policies, and practices of waste management have simply failed to keep pace with the growth in quantity and complexity of waste. In most rural areas, waste is simply dumped on vacant land or burned. In most urban areas, there is some form of collection by local authorities and transport of at least some of it to a landfill or incinerator site. The rest is simply dumped on vacant land, or in rivers, or sold for filling building sites. Because of the high moisture content of the waste, incineration tends to be inefficient and highly polluting.

Most landfills are primitive: tip and cover with soil. Because of the high organic content, high temperatures, and high humidity, it decomposes rapidly and mostly anaerobically, producing large amounts of methane—a foul-smelling, explosive, and powerful greenhouse gas. Because of poor design, construction, and monitoring, many landfills leak toxic leachate into surrounding farmland, streams, and water tables. Landfills also support large populations of rodents and flies.

Recycling takes place at all levels of the system. An informal economy of "scavengers" or "waste-pickers" make their living collecting recycleable material (mostly glass, metals, paper, and plastics) out of the waste stream and selling it to commercial recycling plants. By the time waste arrives at a landfill, it has been well picked over, but most larger landfills, especially in large overcrowded cities, support armies of scavengers, many of them children. Working conditions are dangerous and unhealthy. Nevertheless, this informal sector forms an integral part of the waste management system and provides livelihoods for thousands of people.

Government control of waste management is weak. Environmental legislation has existed since the 1980s, and since the late 1990s, a series of environmental laws have come into force. However, enforcement has been haphazard and is often undermined by confusion between multiple levels of government and departments, serious underfunding, and corruption. In 2005, a landslide at a landfill in the city of Bandung killed 140 people and forced the government to pay attention to waste management. In

2008, a new Solid Waste Management Act came into force, and with it the beginning of a new approach to waste management involving new parties and a more complex and diverse WM system.

While the informal sector and very-small-scale private enterprise have long been involved in waste, the formal private sector has only been involved since the mid-1990s, but private sector participation is still low (less than 10 percent by 2010). As government gets to grips with modern WM practices, it turns increasingly to the private sector, often internationally, for technical expertise and capital. Likewise, international development and aid funding has played a part in improving systems. For example, loans and technical expertise from Japan were used in 2002 to upgrade the existing collection system and landfill in Jakarta. Such projects, while useful, do not address the fundamental unsustainability of landfilling. Other projects do this either by developing composting systems or waste-to energy (WTE) approaches. The logic of WTE in Indonesia lies in the surplus of waste and a growing shortage of energy, both created by increasing levels of consumption. The conversion of waste into fuel (via either methane capture or direct burning) for electrical generation has the potential to mitigate both problems. There are at least three large-scale internationally designed and funded WTE projects in Indonesia, but none were fully operational by 2010.

At the other end of the spectrum are many small-scale, community-based projects for improving local WM. Most involve combinations of improved collection, recycling, composting, and in some cases methane digestion for energy. Many of these have been initiated and supported by international aid, mostly via nongovernmental organizations (NGOs), usually in partnership with local NGOs. Some have proven unsustainable because of lack of follow-up, but others have been integrated into or imitated by government initiatives.

While the problems and the need for new solutions are apparent, there are many differences between proposed solutions. Proponents of large-scale, hi-tech industrial approaches argue that the problem calls for large-scale approaches and that only economies of scale enable the complex and expensive technologies necessary. Proponents of small-scale, lower-tech, community-based approaches begin with the needs of local households and communities and are skeptical of the ability of top-down approaches to recognize, let alone address, these issues.

Prospects for the 21st Century

Given global patterns at the beginning of the 21st century, the trend of increasing consumption and waste seems unlikely to change for some time. One alarming aspect of the global economy of waste is the export of (especially toxic) wastes, from more- to less-developed countries. Indonesia is already an importer, but the government is moving slowly to control it. On the positive side, global awareness of climate change has added impetus to the transfer of waste management ideas and technologies from north to south. At the same time, the growing carbon economy offers potential for funding of better solutions via the Clean Development Mechanism and other initiatives. While these are not beyond criticism, they have helped fund innovative waste management projects in Indonesia.

The most optimistic scenario is that Indonesia will learn from the mistakes of most of the rest of the world and turn around its growing levels of consumption and waste before they become unmanageable.

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See Also: Composting; Consumption Patterns; Developing Countries; Incinerators; Landfills, Modern.

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Industrial Revolution

The Industrial Revolution was a period that spanned the 18th and 19th centuries with deep and profound social consequences and large transformations in population, economy, culture, production, consumption, technology, agriculture, mining, and transportation. These changes began in the 18th century in the United Kingdom and gradually spread to the rest of Europe, the United States, and the rest of the world. A major trend within this period was the transformation of rural and agrarian societies to predominantly urban ones, based on manufacturing and industry.

Brief History of Innovations

During this period, an industrial capitalistic consumption culture emerged and various new commodities became available to large parts of the population. Another major consequence of the Industrial Revolution was the industrial and urban refuse problem that had devastating consequences for the majority of the population. For the first time, humans were faced with unprecedented problems of pollution, which required effective and immediate policies. The problems at first were seen merely as an inconvenient annoyance and only later as a serious health risk related to the public and the environmental crisis in general. Consequently, while the Industrial Revolution has been thought of as the major force of social and economic development, during this period excessive production and consumption as well as garbage and pollution resulted in an environmental and refuse problem. Moreover, a consumer revolution took place, and new conceptualizations of hygiene, cleanliness, and public sanitation policy emerged as major social categories. These trends resulted in the application of science to the problems of pollution and waste.

The roots of industrial capitalism in Europe originate in colonialism, the period when exploitation took the form of many new commodities that were widely circulated and traded all over the globe. In the Caribbean, for example, the mass production of sugar was structured in terms of factory culture—with different types of skilled workers divided by age and gender, tight supervision, scheduling, time consciousness, and disciplinary mechanisms—long before such industrial organization was known in Europe.

The Industrial Revolution began with small technological inventions of machinery in the sectors of textiles and metallurgy and effected large production changes in various other sectors. Steam engines, water wheels, and other powered machinery were used for the first time and gradually were spread throughout the colonial empires. Such technologies were improved and gradually incorporated into other spheres of society, such as steamships and trains in the transportation sector. Moreover, during this period the internal combustion engine and electric power generators were invented and widely used. The chemical industry also developed, with new inventions such as sulfuric acid, sodium carbonate, and cement.

The development of production resulted in a new network of transportation that was needed to connect urban trade centers, where most factories were situated, with mines and the areas that provided raw materials. Within a few decades, in the United Kingdom alone, a national network of canals was constructed, along with a more elaborate and efficient plan of roads, and, finally, a large railway system. Similarly, in the United States, steamships were widely used, the railways expanded rapidly, and transatlantic commercial lines were established. Transportation was further developed with the invention of the bicycle and automobile.

Consumption

The increased pace of production, in combination with the low cost of new mass commodities, resulted in increased consumption. For the first time, products were available in outstanding quantities, at relatively low prices, and available to anyone. A new cultural industry also emerged as steam power was applied to the printing press. Books became cheaper, newspapers were founded and published in large numbers, and magazines emerged. Mass consumption was represented in what became known as the epitome of the Industrial Revolution, the Great Exhibition of the Works of Industry of all nations held first in Hyde Park, London, in 1851. The Great Exhibition suggested the significance of industry and tried to universalize the idea that progress and development in

society were tied to industrial achievements. Colonial ideas were also prominent as various exotic subjects and objects were on display. Gradually, other exhibitions followed the pattern and later on tried to include not only machinery but also large architectural structures like the Eiffel Tower in the Exposition Universelle in 1889.

Moreover, such exhibitions served as representations of commodities that celebrated a consumption-oriented modernity. The commodities on display were not necessarily useful, but they constituted a new form of visual consumption. As Walter Benjamin noted, these industrial exhibitions were actually commodity worlds that people entered to experience this new phantasmagoria, and they erected the universe of commodities. In a perfect capitalist manner, the sphere of production was isolated from the sphere of consumption, and commodities exhibited their deep fetishistic character. Commodities appeared more powerful, illuminating, and dream-like. These Industrial Exhibitions became a capitalistic spectacle and a celebration of an emerging consumer culture.

The Industrial Revolution coincided with a kind of consumer revolution in which an increased amount of standardized consumption goods became available to different social strata. While various commodities had already been popularized in the preindustrial world, such as tobacco, coffee, sugar, and tea, during the Industrial Revolution large amounts would be massively produced, consumed, and circulated. For example while the average Briton consumed 20 pounds of sugar in 1815, by 1890, this amount increased to 90 pounds. Moreover, conspicuous consumption became intense among the middle class, and various new commodities would be used in order to assign status.

The consumer revolution became possible with a doubling of wages in Western countries, especially after the middle of the 19th century, stimulating a demand for various new commodities. While until the beginning of the Industrial Revolution most luxury and exotic goods would be available solely to the elite and restricted to others; gradually, as production increased and the cost was lowered, they would potentially become available to all different social strata. That potential did not bring immediately a better quality of life for the lower classes. In reality, there were vast income differences between people, especially in class-oriented societies. Poverty and starvation would increase in the new urban environments, and the quality of life of laborers would take many years to improve.

Urbanization

One of the most noteworthy effects of the Industrial Revolution was the demographic change. From 1815 to 1914, the population of Europe enlarged threefold, from 250 million up to 750 million. That increase took place while the death rates decreased tremendously as a result of new medication and vaccines, changes in diet and hygiene, and increased sanitation in cities. That demographic shift, which was first encountered in England, affected the size of the city and resulted in serious problems of overcrowding. The most determinant factor in the expanding size of industrial cities was the fact that factories were concentrated around them. The continuous need of capitalists for labor and increasing production brought large numbers of workers into the urban environment.

First, only the Netherlands was more urbanized than England, but gradually that trend changed. While before the 19th century, Great Britain was an agrarian society, the transformation to an urban, industrialized society brought almost half of the population to cities by 1851. During the reign of Queen Victoria, the population of Great Britain increased twofold and the majority of the population lived in cities.

Sanitation and Pollution

The increase of city dwellers resulted in serious sanitation and garbage problems, which were encountered for the first time. The increase of the population density and the concentration of factories around cities produced living and working conditions of incredible hardship, deprivation, and despair, especially among the poor. The factory, for example, introduced new ways of surveillance and discipline comparable to the "panopticon," also a product of the Industrial Revolution. Laborers were exploited in an inhumane manner by working 12–16 hours per day, and children as young as 6 years old worked as miners and factory workers. Pollution and hygiene were not emphasized, as

there was no running water or toilets within households. Large, poor neighborhoods had to share outdoor pumps and public toilets, and cities became overcrowded to the extent that several people or families shared a room. Cellars and underground storages became mainstream accommodation, and household garbage was thrown into the streets. Moreover, factories and household chimneys produced a large amount of smoke, which blocked daylight and covered the streets. In these terrible conditions, epidemics of cholera and typhoid, as well as respiratory and intestinal disease, became regular phenomena.

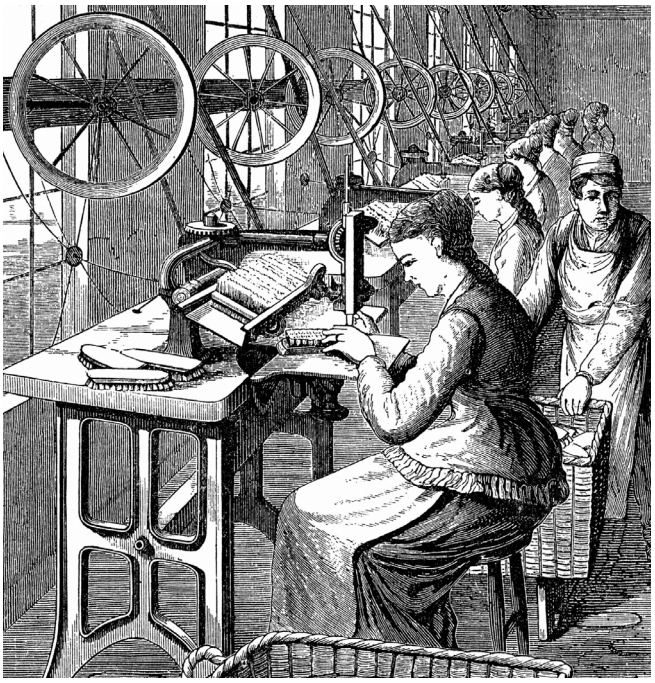
The concentration of factories in and around cities intensified the environmental problems. Iron and textile mills as well as chemical factories were constructed next to waterways in order to transport their commodities efficiently and to provide the large quantities of water needed in steam engines and chemical solutions. These factories disposed their waste in waterways, a habit that resulted in serious water pollution. Manufacturers were also responsible for land pollution by dumping garbage, ash, iron, and other rubbish onto land.

Waste Management, Public Health, and Hygiene

At the beginning, each municipality tried to independently resolve the refuse and hygiene problems that industrial society faced. An increasing number of small-scale municipal services were established, such as fire and police protection, water supply, waste collection and disposal, and public hygiene works. However, the recognition of a serious environmental crisis came at the end of the Industrial Revolution. An emphasis was placed on clean water and a sewage system, while the attempts to limit air and land pollution were not taken seriously. A consequence of the appraisal of municipal responsibility was the initiation of public health agencies and departments.

Furthermore, the establishment of modern public health science and the foundation of the Sanitary Commission in England in 1869 provided the foundation of public health legislation and policy. Sanitation emerged as a new concept to combat various communicable diseases, and scientific methodology was used to understand waste and public health issues. The first observations related communicable disease with filthy environments and waste, without a clear understanding of the factors of such diseases. Moreover, scientists tried to develop a link between mortality rate and degree of wealth. The turning point of the refuse problem was the application of science to the issue of pollution. Public health social policy, for example, became an undisputed antidote to the increasing refuse problem and the raging diseases, even if hygienists were not totally aware of what was truly "pollution." Similar programs in Europe and the United States acknowledged the need for public policy and brought relief to the overcrowded factories and the heavily industrialized urban environment.

During the Industrial Revolution, a new mentality in relation to hygiene emerged, predating the discovery of microbes. City dwellings were thought to be of poor quality, and cities were imagined as death chambers with ignorant and contagious poor workers. Within this context, cities should be transformed into clean spaces with large parks and outdoor areas, gardens, and good sewage systems.



During the 19th century, laborers were inhumanely exploited by being made to work from 12 to 16 hours a day. Pollution and hygiene were not emphasized, and garbage was thrown into the streets. In these conditions, disease epidemics became common.

Hygiene became, therefore, connected to a healthy way of life in opposition to the wealthy, industrial urban environment that brought disease and degeneration. The movement of hygienists influenced to a large extent the understandings of cleanliness and pollution that were disseminated through media, public debate, scientific methodology, and large exhibitions.

In the hygiene exhibition of London in 1884, for example, crowds could admire how a hygienic and healthy style of life could be adopted. Refrigerated meat, pasteurized milk, orthopedic shoes, healthy clothes, filters to purify water, flush toilets, and even plans of airy and heated hygienic houses with drainage and convenient-to-clean furniture were on display.

Bacteriological science emerged with general microbiology, and new inventions followed in this area, such as pasteurization. The microbe personified pollution, dirt, and all social and cultural problems that had emerged out of the environmental crisis. As such, the hygienic achievements in the years to follow would signal a clear separation between scientific and social understanding of industrial pollution.

Since then, the need to manage pollution and the environmental crisis as a result of the Industrial Revolution and the continuous industrialization of various other areas of the world has been widely recognized by the international community. While industrialization brought various technological and economic achievements, its consequences were unprecedented. By the end of the Industrial Revolution, people suspected that the level of industrialization of each country was proportional to the level of the refuse problem. But even then, society focused on the scientific aspects of problems and the new conceptualizations of hygiene, pollution, and microbes. The responsibility of each society and the social, economic, cultural, and political causes of the industrial environmental crisis would take many years to realize.

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See Also: Capitalism; Commodification; Consumerism; Garbage in Modern Thought; Industrial Waste.

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Industrial Waste

Industrial wastes are unintended by-products of industrial production and may contain hazardous substances. While the disposal of hazardous industrial wastes is well regulated in developed countries, many other aspects of industrial wastes remain underaddressed by environmental policy. Data on generation rates, material composition, and disposal methods are uncertain or lacking in most cases. Problems of contamination from industrial waste releases, as well as their export from developed to developing nations, have been somewhat ameliorated through national and multilateral policies since the 1970s. These practices, however, still pose risks to populations worldwide, disproportionately affecting poor and nonwhite people. Policies to promote reuse and recycling of industrial wastes are underdeveloped in contrast to those for municipal solid wastes (MSW), about which a great deal of data are regularly reported. The disparity in attention between MSW and industrial wastes does not correspond to quantity; industrial waste are generated in far greater tonnages than MSW. Promise for better management of industrial wastes lies in continued activism to counter unsafe industrial waste practices, along with research and development of new and efficient forms of industrial waste minimization using the model of industrial ecology.

Definition of Industrial Wastes

In 21st-century societies all over the world, the extraction or harvesting of materials from nature, and their transformation into finished products, takes place primarily through processes of industrial production. Industrial production differs from other forms of production carried out either by hand

or with personalized tools in that it entails relatively large-scale, routine, and automated activities. The unintended material by-products of industrial production are industrial wastes.

In their broadest definition, industrial wastes encompass any by-products that are emitted directly into the atmosphere or released into waterways as well as those temporarily or permanently deposited on or in the ground. Typically, however, airborne emissions are referred to as air pollution, and waterborne releases as wastewater or water pollution. Both are considered separately in policy and discourse from solid or semi-liquid industrial wastes. The latter group of materials is more commonly what is meant by terms such as *industrial wastes* or *industrial solid wastes*.

Industrial wastes may arise from mining, petroleum extraction and refining, agriculture, energy production, construction and demolition, transportation, or manufacturing activities. In some cases, industrial wastes, through statutory definition, exclude wastes from agriculture and extractive industries; for example, such wastes are not classified as industrial under the U.S. Resource Conservation and Recovery Act. Depending on the agency and jurisdiction, additional categories may be considered as falling under the umbrella definition of industrial wastes. Overall, however, industrial wastes can always be defined by what they exclude: municipal solid wastes and nuclear wastes. No country's definition of industrial wastes includes MSW, which represents instead the discards of human settlements, including households, public institutions, and nonindustrial commercial enterprises such as offices, retail, and food service. Nuclear waste is also excluded from all definitions of the term.

In many industrialized nations, a subset of industrial wastes possessing empirically demonstrated danger to health and safety is referred to as hazardous industrial wastes, hazardous wastes, or toxic wastes. These wastes are considered separately from industrial wastes not deemed hazardous and are subject to state regulations concerning transport and disposal that do not apply to other industrial wastes. The designation of some industrial wastes as hazardous may be made on the basis of rough characteristics such as ignitability or corrosiveness, may reflect intended product use (e.g., as explosives or solvents), or may reflect chemicals constituents that have been demonstrated to pose risks to health and safety.

Ongoing research in fields of public health and toxicology periodically brings to light new categories of hazardous compounds that were previously considered safe. Such research may respond to patterns of illness discovered or reported near sites where industrial wastes containing such compounds are stored or disposed. The existence of research does not guarantee, however, the classification of additional industrial wastes as hazardous without a process of administrative rule change. Such processes are highly contested, with different perspectives from industry, medicine, and citizen groups arguing different scientific points of view regarding actual or perceived risk. For this reason, even in countries in which hazardous industrial wastes are regulated to protect health and safety, industrial wastes that are not designated as hazardous may still pose a risk.

Quantity and Composition

One of the many ways in which industrial wastes contrast with MSW is in the level of public knowledge about their quantity and composition. While MSW tonnages and composition are routinely tracked and reported in detail by most developed nations—and many developing nations as well—tracking of industrial waste statistics is only required in European Union (EU) nations. Even then, data is self-reported by industrial trade groups and often reflect only a subset of the true total of industrial waste generation. One of the most far-reaching estimates of industrial waste quantity around the globe is the 2006 World Waste Survey, which cautions readers about the incomplete and inconsistent nature of industrial waste reporting. It estimates that industrial wastes not explicitly classified as hazardous are being generated at a rate between 1.3 and 2.8 billion metric tons annually, noting that such estimates reflect only selected nations (the EU, United States, Canada, Japan, South Korea, Australia, Mexico, Brazil, Thailand, Taiwan, and China) and exclude potentially large quantities in other nations, particularly nations of the former Soviet Union and India. The 2006 World Waste Survey estimates that haz-

ardous industrial wastes total roughly 200 million metric tons annually for a different set of countries with available statistics (the EU, United States, Canada, Japan, South Korea, Thailand, China, Mexico, India, and South Africa). In comparison, world quantities of MSW are estimated at roughly 1.2 billion metric tons for all continents and are considered more reliable, though far from perfect.

In the United States, one study conducted in 1987 quantified nonhazardous industrial wastes at 7.6 billion tons in that year. While this tonnage is still reported by the Environmental Protection Agency (EPA) in the early 21st century as the only official statistic on nonhazardous industrial waste generation in the United States, its datedness makes it of little value. The 7.6-billion-ton estimate is not reproduced in statistics compiled by the Organisation for Economic Co-operation and Development (OECD), which form the basis of the 2006 World Waste Survey reporting. The OECD's total national waste statistics for other North American nations, including Canada and Mexico, also omit industrial waste reporting. By comparison, nearly all European and Asian OECD member states provide data for waste generated by manufacturing, construction and demolition, and other industrial sectors. National reporting on hazardous industrial wastes is generally of better quality. In the United States, the EPA reports state-by-state statistics on generation, with tonnages totaling 47 million in 2007. Other OECD members have provided data for at least one year between 2000 and 2008, enabling the calculation of an annual generation rate of roughly 111 million tons for all members.

Data on the composition of industrial wastes, hazardous or otherwise, is even less developed, with few comprehensive statistics about the materials that make up reported tonnages. The Intergovernmental Panel on Climate Change (IPCC) is concerned with estimating degradable organic carbon (DOC) in industrial wastes because it is one of the main sources of methane emissions from land disposal. Its assessment of industrial wastes arising from selected countries in Asia, Europe, and Oceania estimated DOC content of up to 43 percent of all nonhazardous industrial wastes, with food, textile, wood, paper, and rubber industries generating the most organics-rich by-products.

Another way of thinking about quantities of industrial wastes is to use materials flow analysis, a methodology that tracks the complete flow of raw materials through the processes of extraction, production, use, disposal, and recovery within a nation, factoring in exports and imports. Such approaches, particularly those carried out by the World Resources Institute (WRI), use trade data in conjunction with information on extraction and manufacture to account for the flow of materials by weight through each nation's economy. A study completed by the WRI in 2000 estimated that manufacturing activities in Austria, Germany, Japan, the Netherlands, and the United States resulted in the release of some 2.4 billion tons of waste in 1996. However, this methodology suggested that the majority of releases were to the air in the form of direct emissions and incineration, with relatively less going to land disposal.

Regardless of methodology or region, industrial waste quantity far outweighs municipal solid waste. The production of a finished good requires a long series of steps starting with extraction, continuing through refining and fabrication, with transportation and energy inputs at each step along the way. Every consumer commodity is a point at the summit of a pyramid of materials flows that end in its provision on the market, and much of that pyramid consists of industrial wastes.

Disposal Methods

Industrial materials that are not recovered for reintroduction into manufacture may be disposed of in a variety of ways. Hazardous waste disposal is highly regulated in all OECD nations, with strong provisions requiring environmentally sound management controls from the point of industrial generation to disposal. Such provisions usually include special permitting requirements for hazardous waste disposal facilities that specify infrastructure protections against releases to the environment. They may also include prohibitions against the mixing of different types of hazardous wastes—or their dilution—prior to disposal, and requirements for separation, stabilization, or destruction of hazardous waste constituents by mechanical, thermal, or chemical methods. Common forms of hazardous waste disposal include combustion or incineration,

particularly for wastes containing organic chemicals. Hazardous wastes may also be deposited in landfills, waste piles, land application units, or surface impoundments (diked areas holding semisolid wastes such as sludges). Sludges and liquid hazardous wastes may be injected underground into wells or storage tanks, or they may be contained above ground indefinitely in tanks or barrels.

Disposal of nonhazardous industrial wastes, which are far greater in quantity than those classified as hazardous, is much less regulated. Dry wastes, if not falling under the hazardous definition, may simply be dumped or stockpiled on the industrial property. In some cases, oils, plastics, or wood wastes may be incinerated, with or without production of energy. When trucked off-site for disposal, industrial wastes come under enhanced regulatory control. Landfill and incinerator regulations for nonhazardous industrial wastes are generally similar to those for MSW in any country. There is relatively little comprehensive data on a national level about disposal methods for nonhazardous industrial wastes.

Alternatives to Disposal

The term *recycling* refers both to a process of materials recovery and a practice aimed at fostering ecological and social benefits, including resource conservation, pollution mitigation, and job creation. Most of the recovery of industrial waste materials is recycling only in the process sense—it takes place when and where it makes financial sense for the firm. Industrial wastes of a heterogeneous, semiliquid, or hazardous nature are the least likely to be recovered, while by-products that can be easily reintroduced into the same industrial process that gave rise to them are the most likely. Recycling methods in industrial settings will therefore first and foremost take place within the industrial plant; for example, scraps of waste metal, plastic, or other materials will simply be added to incoming material inputs for a second round through the production process. In other cases, industrial by-products that are clean and homogenous may be sold on the open scrap market; these will compete favorably against those coming from municipal sources, which tend to be mixed, contaminated with residue, and of lower quality. Examples of such commodities include scrap paper, metal, plastic, wood, and textiles—all of which have a long history of trade in most nations.

The exchange of by-products among industries, especially those located in proximity to one another, is a field of active research, policy development, and focus within environmentalism. The pre-eminent model of industrial by-product exchange arose between the 1960s and 1980s in Kalundborg, Denmark. In the 21st century, a constellation of symbiotic firms there includes a coal-fired power plant that provides surplus heat to local residences and a nearby fish farm and sells steam to a large pharmaceutical plant. Sulfur dioxide from the power plant's scrubber yields gypsum, which is then sold to a local manufacturer of drywall. The fish farm converts its waste sludge to fertilizer used by local farms. Finally, ash from the power plant is used for local road building and cement production.

Governmental and nongovernmental organizations pursuing sustainable waste management see great promise in fostering intentional industrial symbioses through the development of eco-industrial parks. Research has found, however, that such projects are less likely to succeed if intentionally planned than if they arise spontaneously, adapting to particular economic and material niches that vary tremendously from place to place. In the United States, Canada, and the United Kingdom, a related, though not geographically organized, area of environmental programming seeks to develop industrial materials exchange networks, often in an online format, to encourage trading of by-products among industries at a regional or national scale. Free-market exchange, often entailing global export and import of scrap materials, also takes place through online networks not concerned with environmental outcomes.

Governments regulating hazardous wastes encourage, but do not require, generating industries to apply the waste reduction hierarchy, which promotes prevention and reuse first, recycling and composting second, energy recovery third, with disposal as a last resort. Hazardous waste recycling is much more practiced in EU member nations, which average a 27 percent rate, than in the United States or Canada, which each have rates lower than 5 percent. Most such recycling involves the

The 1989 Basel Convention was developed to combat a practice that developed during the 1970s and 1980s: firms in developed countries, coming under increased hazardous waste disposal regulations, would disburden themselves by exporting discarded electronics abroad, in particular to poor developing nations in Asia, Africa, and the Pacific. Organizations such as the Basel Action Network closely monitor these transnational shipments and have made progress in limiting unsafe recycling, incineration, and disposal practices in importing nations.

separation and extraction of chemicals and metals from hazardous compounds for reuse in industrial processes. While the EU and North American hazardous waste regulations impose similar sets of restrictions, North American industrial trade groups more often call such regulations a deterrent to hazardous waste recycling, and they sometimes use this argument to lobby to reclassify or exempt certain wastes from designation as hazardous. An alternative to recycling is the prevention of hazardous waste generation in the first place. Efforts to promote this practice are organized under governmental or nongovernmental programs bearing the name "pollution prevention" in North America and "cleaner production" in Europe. Such initiatives, pursued on a nonregulatory basis, feature an array of collaborative partnerships between governments and firms to minimize waste in all forms, through product and process redesign.

Global Trade in Industrial Waste

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal of 1989 is a multilateral treaty governing the export and import of hazardous industrial wastes. It was developed in response to tendencies that arose in the 1970s and 1980s for firms in developed countries, coming under increased hazardous waste disposal regulations, to disburden themselves through proliferating channels of export abroad, in particular to poor developing nations in Asia, sub-Saharan Africa, the Caribbean, and the Pacific. The convention was implemented in 1992, and its original terms allowed the exportation of wastes only if exporting countries lacked proper disposal infrastructure and importing countries did have such capacity, or if the wastes in question could be construed as raw materials to be used in production in the importing nation.

It also required written consent from governments in importing nations. In 1994, parties to the convention strengthened its reach by voluntarily agreeing to ban all waste exports from OECD nations to non-OECD nations. In 1991, other multilateral treaties were created, including the Bamako Convention that bans most waste export to Africa, meant to protect poor nations in the Caribbean and Pacific.

These conventions have ameliorated but not eliminated the transfer of wastes from the developed to the developing world. There is a brisk illegal trade in hazardous waste exports that exploits unstable regimes in resource-poor nations. The Basel Convention exempts industrial scrap, allowing the trade in waste paper, metal, plastic, and other materials if not mixed with refuse or hazardous materials. In many cases, especially in the case of paper and metal scrap, such exports supply input materials that are in high demand in rapidly industrializing countries. In other cases, particularly with electronic waste and post-consumer plastics, such exports may contain hazardous materials and often require extensive sorting and disposal of unmarketable residue in the receiving country.

Problems with scrap exports have been documented in Europe, particularly in Germany for plastics and in those countries as well as the United States and Canada for electronics. In both cases, the export of mixed materials containing hazardous constituents as "industrial scrap" arose as an unintended consequence of extended producer responsibility policies. Such policies are meant to transfer some or all of the burdens of waste collection and disposal from taxpayers and consumers to producers of packaging and electronics. These policies require industries to literally or virtually (through financing of third-party collections) take back finished commodities at end of life, introducing a new form of industrial waste to a sector that had no precedent in handling its own spent products. As a result, industries and trade associations representing them have sought export as a method to move along product returns. Organizations such as the Basel Action Network are actively monitoring the transnational shipment of electronics and have made strong inroads into curtailing unsafe recycling, incineration, and disposal practices in importing nations such as India, Ghana, and China. The fate of plastics is less studied, although also undergoing scrutiny.

Social Movements and Industrial Waste

Several high-profile cases of hazardous waste contamination took place in the 1970s and 1980s. In the late 1970s, residents of the small town of Love Canal, New York, organized to protest health problems arising from the improper land disposal of thousands of tons of hazardous waste by a chemical company. In 1982, the EPA confirmed that recycled waste oil sprayed on roads as a dust suppressant in Times Beach, Missouri, contained dioxin from a chemical manufacturing plant. In 1984, a malfunction at a Union Carbide pesticide plant in Bhopal, India, resulted in a leak of methyl isocyanate gas, resulting in the exposure of over 500,000 people to severe risk and the immediate death of thousands, making it the worst industrial accident in history. While Love Canal and Times Beach have been remediated, the Bhopal site has not. By 2010, hundreds of tons of hazardous wastes were still stored in tanks at the closed facility.

The Love Canal case is credited with spawning the grassroots antitoxics movement in the United States, which broke from prior traditions of conservation-focused environmentalism to highlight health risks to people from industrial activities, particularly hazardous waste disposal. The antitoxics movement, with its focus on the rights of "regular people" to identify patterns of illness, brought attention to the fact that working-class residents were both burdened by and excluded from planning around the siting of industrial facilities nationwide. In 1982, residents of Warren County, North Carolina, whose minority population was largely low-income, organized to oppose the state's siting of a hazardous waste landfill with inadequate groundwater protections in Shocco Township. Protesting residents were joined by national civil rights and environmental groups in opposing the facility. This struggle formed the basis for the emergence of the environmental justice movement. Its concerns include the displacement of the dangers of industrial waste from rich to poor nations as well as displacement of risk from more to less powerful people within nations, drawing attention to power divisions based on race as well as class.

Within the United States, the antitoxics and environmental justice movements have led much if not all of the activism that casts industrial wastes as an environmental problem. These movements are, to various degrees, active in other nations along with the green parties in Europe. Other branches of environmentalist movements, particularly those concerned about resource conservation and jobs

creation through recycling, have paid relatively less attention to industrial wastes in comparison to more visible materials in municipal discards. The zero waste movement, however, supports many of the voluntary approaches to industrial waste minimization featured in pollution prevention policies, seeking to foster collaborations and interchange among firms that prevent waste and maximize by-product exchange for reuse.

Industrial Ecology

A framework for considering how to reduce industrial wastes systemically, for environmental as well as economic reasons, is being developed and promoted by planners, architects, and engineers working in the field of industrial ecology. Industrial ecology is an approach to the design of industrial production that takes as its model the study of natural systems and the cycles of materials in those systems. Its goal is to make industrial processes less harmful to the environment as they become more efficient. The reduction of industrial wastes generated through and as a result of production is one of its goals. Major proponents of industrial ecology see design of processes and products as the primary mechanism to achieve this reduction. They promote the use of all industrial by-products, either within the manufacturing firm itself or as inputs to nearby, linked industries. They seek to reevaluate processes within the factory to eliminate waste and make efficient use of energy and resources. They promote research into new materials that are less toxic and easier to recover, and they also advocate the design of finished products that can be taken back and repaired or used for parts.

By 2010, industrial ecology had not been integrated into comprehensive national industrial policy in any nation, although its influence was felt in more traditional forms of environmental policy making that emphasized data gathering and technical assistance to industries to promote efficient and sustainable practice. According to some scholars, industrial ecology's emphasis on loop closing in all aspects of economy has led to increasing interest among industry and governments in what is called "waste valorization" in Europe, Asia, and South America and "beneficial use or reuse" in North America. Both terms refer to the recovery of non-hazardous industrial wastes for use as inputs to production or fuel sources. In the 21st century, state regulatory focus on industrial waste disposal lags advances in industrial ecology. By 2010, research on various aspects of industrial ecology was vibrant, and there was considerable pilot testing of innovative ways to recover large, homogenous quantities of industrial wastes, including sludges, metal slags, wood wastes, foundry sands, and combustion ash—none of which has been traditionally addressed in the scrap trade. As concerns grow over the connection between industrial production and climate change, the field of industrial ecology offers promise to address industrial wastes through efficient, data-driven, systems-based public policy.

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See Also: Africa, Sub-Saharan; Construction and Demolition Waste; Developing Countries; Environmental Justice; Environmental Protection Agency (EPA); European Union; Hazardous Materials Transportation Act; Industrial Revolution; Love Canal; Mineral Waste; Pre-Consumer Waste; Producer Responsibility; Race and Garbage; Radioactive Waste Disposal; Radioactive Waste Generation; Resource Conservation and Recovery Act; Scrubbers; Sustainable Waste Management; Toxic Wastes; United States; Zero Waste.

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Insulation

Insulation is a nonconductor material or substance that prevents the passage of heat, electricity, or sound from, for example, a room. Societies and governments have increasingly recognized the importance of insulation as a significant means of reducing household and building energy consumption levels. This is becoming ever more important in view of the need to stabilize climate change through the responsible and efficient use of natural resources. Carbon emissions can be significantly reduced with the installation of building insulation, which reduces the demand for energy to heat or cool an interior space. This results in less demand for electricity, which reduces emissions associated with production, and it has the added bonus of saving the householder money.

Energy Loss

In the United States, the heating and cooling of homes and buildings accounts for 50–70 percent of the energy used in the average home. In the United Kingdom, the energy consumption level, for heating in particular, is even higher at 80 percent. The Kyoto Protocol and subsequent commitment by member states of the European Union (EU) to reduce greenhouse gas emissions by 20 percent of 1990 levels by 2020 has led to a variety of measures seeking to slash emissions. For example, through the emissions trading scheme (also known as cap and trade) as well as the introduction in recent years of smaller-scale but nonetheless effective national policy drivers, householders have incentives to make their homes more energy efficient. Small grants, subsidies, and tax breaks are provided for those carrying out certain energy-saving improvements on their properties. However, the longevity of such schemes and the eligibility criteria for approval is likely to become less certain in view of the economic downturn. The importance of insulation can be illustrated by the substantial contribution (25 percent) that energy lost in homes and buildings adds to the total carbon emission of the United Kingdom. In the United States, the energy loss for residential properties alone is responsible for 18 percent of total emissions. Taken together with commercial buildings, the level of emissions rises to 38 percent.

Insulation and Heat Transfer

Insulation works by slowing the movement of heat and absorbing heat and inhibits or resists the displacement of heat from a hot space to a cooler one. Likewise, insulation inhibits cold or warm air penetrating from the outside to the inside of a building. This thermal resistance to heat movement is referred to as the "R-value." The best nonconductors for insulation purposes are those with the highest R-values per inch of thickness. Movement of heat can occur through radiation, conduction, or convection. Radiation is the transfer of heat through electromagnetic light waves, such as radiant heat from a wood fire. Conduction is the transfer of heat as it moves through an object, and convection is the transfer of heat in air or water by upward and outward movement.

Installation

Walls, roofs, floors, windows, and doors can all be insulated to help prevent the escape of either hot or cool air from the building to the outdoors. However, walls and roofs are the biggest heat loss culprits. Roof and wall insulation is used within the fabric of the building and is laid between the outer cladding and an internal lining profile. The easiest time to upgrade the thermal resistance of a building through the use of insulation is during construction. However, insulation can be added or upgraded retrospectively, although the choices of insulation may be narrower in scope.

The best type of insulation depends upon the local climate and whether one needs to keep heat in,

out, or both. A building's orientation, design, and materials are also a factor. Materials used as insulation for the fabric of buildings may be grouped as organic or inorganic insulants. Inorganic insulants are made from naturally occurring materials formed from fiber, powder, or cellular structures that have a high void content, such as glass fiber, rock wool, cellular glass beads, vermiculite, calcium silicate and magnesia, or compressed cork. They are generally incombustible, highly heat resistant, and are rot and vermin proof. Generally, these insulants are in the form of loose fibers; mats and rolls of felted fibers; and semirigid or rigid boards, batts, or slabs of compressed fibers. Inorganic insulants are based on hydrocarbon polymers in the form of thermosetting or thermoplastic resins to form structures with high void content, such as polystyrene, polyurethane, isocyanurate, and phenolic. The problem with this type of insulants is that they tend to be combustible and have a low melting point. They are mostly used in the form of expanded polystyrene (EPS), either as beads or boards.

In terms of insulating walls, insulation material can be placed in one of three positions in a masonry cavity wall: on the outer face, on the inner face, or filling the cavity. Applying insulation to the outer face of a wall using specialist fixings and a weather-resistant finish can be done as part of a refurbishment. Insulation can be built into the building in the cavity as the walls are raised. This will be held in position not only by the sandwiching of the two leaves of the cavity wall but also by the wall ties. Materials that can be used for cavity walls and the inner faces of walls include glass fiber, mineral wool, and foamed plastics (such as polystyrene beadboard or loose beads, extruded polystyrene, urea formaldehyde foams, phenol formaldehyde foams, and polyurethane foams). The most effective way of insulating an existing cavity wall is to fill the cavity with some insulating material that can be blown into the cavity through small holes drilled into the outer leaf of the wall. Glass fiber and granulated rock wool of EPS beads are used for injection of insulation for existing cavity walls.

Sustainability and Environmental Effects

It is important to consider the overall environmental impact of insulation material to ensure that the material used contributes positively toward the achievement of reducing emissions and mitigating climate change. While the function of insulation material is to help reduce the movement of hot or cold air to a different place, thereby reducing energy used in heating or cooling a specific space, energy is used during the manufacture and transportation of insulation. The use of energy during manufacturing operations and transportation is referred to as the "embodied energy." Similarly, at the point at which a building is deconstructed, account should be taken regarding the potential of the insulation material to be reused or recycled. The materials that represent the greatest benefit to environmental sustainability are those that have the ability to remain within the materials economy beyond the life of the building.

Fiber glass and rock wool use a high percentage of recycled material, which helps to reduce the use of natural resources. In fact, in the first decade of the 21st century, manufacturers of fiber glass and rock wool insulation have diverted more than 20 billion pounds of glass and blast furnace ash from the U.S. solid waste stream. Both fiber glass and rock wool are highly durable and, if used in blatt, slab, roll, or sheet form, can be easily removed and reused elsewhere. On the other hand, polystyrene, polyurethane and polyisocyanurate are produced by blowing gases into the material. This operation causes the release of ozone-depleting substances into the atmosphere. While they have the best insulation value of any commonly available insulation material, they have a high embodied energy.

New insulation materials, offering more efficient insulation with lower embodied energy, are constantly coming onto the market. For instance, insulation that uses recycled paper (Warmcel 100) and blended sheep wool (Thermafleece), which has a low economic value since it is unsuitable for many applications but makes efficient insulation, is recyclable and reusable.

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See Also: Construction and Demolition Waste; Floor and Wall Coverings; Household Consumption Patterns; Styrofoam; Ventilation and Air-Conditioning.

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Iowa

Located in the Corn Belt of the midwest, Iowa is often known as the American Heartland. The capital, Des Moines, is the largest city and largest metropolitan area. The state owes its name to the Ioway people, one of the many Native American tribes that occupied the state when European exploration began in the late 17th century. At this point, the Iowan Native Americans were virtually all settled farmers living in a society with complex economic and political systems. After the Louisiana Purchase (in which the United States bought the territory from France), settlers created an agricultural economy, which endured until the 1980s Farm Crisis. Since the mid-1980s, Iowa has reemerged as a diverse, mixed economy, which now includes advanced manufacturing, biotechnology, and green energy production. Agriculture remains a large part of the Iowa economy in the 21st century, but has a less direct role.

Agriculture

Most of the state is used for agriculture—60 percent is crop-covered—and 30 percent is grassland, consisting mainly of pasture and hay. Iowa has had to use legislation to protect its agricultural interests from the adverse effects of waste disposal, such as open burning. This legislation has had instant impact on the way people in Iowa dispose of their garbage. In 1953, a state law was passed that required garbage fed to pigs to be cooked at 212 degrees F for 30 minutes in order to reduce swine disease pathogens in the feed. Prior to the law going into effect in June 1953, there were over 400 garbage feeders in Iowa, mostly small-scale operators running their operations as a side business. A month later, there were only around 60, and 70 percent of these were using homemade garbage cookers. Of the 64 percent of Iowan garbage cookers that were direct fired, 66 percent were homemade. Non-farmers operating these usually set up on or near garbage dumps and typically use wood or waste tires for fuel.

Ethanol production uses around one-third of the Iowan corn crop, and Iowa is the biggest producer of ethanol in the United States. In the 21st century, doubts have been expressed in the scientific community about the amount of logistics required to harvest, transport, and store the crop biomass needed for making cellulosic ethanol. This problem, however, is avoided by using municipal solid waste (MSW) and paper production waste as the feedstock. In 2010, Fiberight, in Blairstown, began production at the first commercial cellulosic ethanol plant in the United States to use enzymatic conversion technology and industrial and municipal MSW as a feedstock. The biorefinery was converted from a former first-generation corn ethanol plant in a $24 million investment projected to reach a commercial production capacity of 6 million gallons of renewable biofuel in 2011. Fiberight believes its core extraction and processing technology can potentially derive 9 billion gallons of renewable biofuel from 103 million tons of nonrecyclable MSW generated each year in the United States. On reaching full production, the Blairstown plant should be able to process over 350 tons of waste per day, producing biofuel at less than $1.65 a gallon. This use of MSW is believed to offer significant advantages over other waste-to-energy (WTE) methods, as low temperature and closed-loop systems exploit the MSW for a higher value while avoiding the emissions created by other methods.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that in 2004, Iowa had an estimated 4,341,454-tons of MSW generation, placing it 29th in a survey of the 50 states and the capital district. Based on the 2004 population of

2,972,566, an estimated 1.46 tons of MSW were generated per person per year (ranking 14th). Iowa landfilled 2,822,563 tons in the state's 59 landfills, making Iowa the 29th-largest landfill-using state in the United States. It exported 92,156 tons of MSW. Landfill tipping fees across Iowa averaged $39, where the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively. By 2010, Iowa had 96,753,114 tons of landfill capacity remaining and was increasing its landfill capacity; it was ranked joint sixth out of 44 respondent states for number of landfills. Yard waste, whole tires, used oil, lead-acid batteries, and white goods were reported as being banned from Iowa landfills. Iowa's single WTE facility (the Arnold O. Chantland in Story County) burned 54,496 tons of MSW. The state recycled 1,464,395 tons of MSW, placing Iowa 23rd in the ranking of recycled MSW tonnage.

Middens in Iowan Prehistory

Native Americans in Iowa first began to move away from hunter-gatherer subsistence in the Late Archaic Era (5,000–2,800 years ago), when the first domesticated plants and large enduring settlements appear. During the subsequent Woodland period, divided into Early (800–200 B.C.E.), Middle (200 B.C.E.–400 C.E.), and Late (400–1250 C.E.), many Iowan Native Americans abandoned hunting and gathering and made greater use of agriculture. With sedentary living came substantial deposits of midden, which became an important part of the archaeological record of these cultures.

At the Gast Spring site, midden features predominate; a substantial Middle Archaic midden was associated with a feature interpreted as a sunken floor with an oval pit in the center. The floor surface and the pit dug into it were also repositories for midden deposits, containing the remains of fish, turtles, birds, mammals, seeds, gastropods, fire-cracked rock, and lithics. The abundant charcoal in the midden deposits provided a radiocarbon date of 5200–4500 B.C.E., suggesting that if the Gast Spring site was a house, it would be the earliest-known house in Iowa.

Two of the three known ring midden settlement sites belonging to the Weaver culture of the Woodland period were found in Iowa: Gast Farm and Oak Village. These sites are defined by a circular concentration of midden and pit features around an open central area, and they occur throughout a large part of the midwest, from southern Wisconsin and eastern Iowa to Kentucky and Tennessee. At Gast Farm, the diameter of the ring midden was 100 meters and the depth of the midden deposits was up to 0.5 meters in places and thought to represent the location of dwellings, while the central area was used for communal activities such as feasting.

The Late Prehistoric (900–1600 C.E.) Mill Creek culture of northwest Iowa is characterized by its large midden mounds—rich deposits that have attracted archaeological investigation since the early 20th century. Mill Creek sites have been described as miniature *tels*, borrowing from Near Eastern archaeology the term for a large mound created by successive occupation on a site over a period of centuries. The sites have been elevated up to 3 meters above the original ground level by the accumulation of debris and crumbled mud-walls.

Arnold O. Chantland Resource Recovery Plant

The Arnold O. Chantland Resource Recovery Plant (RRP) in Ames, Story County, was the United States' first full-scale municipal WTE facility. It opened in 1975, 90 years after the first incinerator in the United States. Initial planning began in 1971. Money was raised by general obligation bonds against the background of peak oil, the 1973 energy crisis, and growing concern over loss of farmland to landfilling. The project was a gamble because there were few operating facilities and massive upfront expenditure was required. In the 21st century, however, the RRP is cited as the model recycling system. Continuous development and innovation has allowed the Arnold O. Chantland RRP to exceed federal and state targets for recycling.

The plant recovers all recyclable materials from garbage and sells recovered ferrous metal (5 percent of waste received) to a scrap dealer. The RRP calculates that they recover enough ferrous metal annually to make 1,200 car bodies. Garbage that cannot be reused is shredded and divided into burnable and nonburnable categories. Around 65 percent of waste received is burnable. Nonburnable material is sent to a landfill, and the shredding process significantly reduces its volume. Burnable material

becomes refuse derived fuel (RDF), which is piped to the Ames city power plant where it is used as a renewable supplemental fuel. By burning the RDF with coal, fossil fuels are conserved and sulfur dioxide emissions are decreased. The RDF makes up 10 percent of the fuel used at the Ames city power plant. The facility has thus far saved 80 acres of farmland from becoming landfill and provides enough electricity for 4,600 homes per year. The processing capability of the Arnold O. Chantland RRP is such that there is no landfill in Story County; what MSW there is remaining to be landfilled is taken to neighboring Boone County by arrangement. An environmental landfill for construction and demolition waste is operated by Story County.

Garbage is taken to the plant by private citizens and waste disposal contractors and is deposited onto a tipping floor, which can hold 450 tons of garbage. The separation process begins on a conveyor into the primary shredder, where steel hammers reduce the garbage to pieces around 1 foot in diameter. These pieces are then passed under an electromagnet to remove ferrous metals before being deposited onto a series of two disc screens to separate out smaller particles. A second shredder reduces the garbage to pieces around 2 inches in diameter, which are then sorted on conveyors by air knife into burnable RDF and heavier nonburnable rejects. Conveyors then take the RDF to the twin screwfeeders, which load the material into the pneumatic tube that sends it to the power plant.

The RRP also provides glass, car battery, and waste oil recycling (with only a minimal charge for waste oil over five gallons), as well as disposal of hazardous household materials (free) and appliances ($20 each). The glass recycling program was initiated in 2006 to divert glass from the RDF and landfill streams. Glass ending up in the RDF melts in the power plant furnace and solidifies into slag in the boiler tubes, necessitating expensive repairs, while glass being sent to landfill increases transportation and dumping costs, uses landfill space, and is a waste of resources. By 2009, the glass recycling program had diverted over 100 tons of glass from the landfill. The recovered glass is crushed to sand-grain size and used for landscaping, industry, and construction. Financial assistance for the Yard Waste Site also comes from the RRP, allowing five free days of seasonal disposal a year: one day in spring for leaves and brush; and four in fall for leaves and grass.

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See Also: Economics of Waste Collection and Disposal, U.S.; Farms; Incinerators; Recycling.

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Iran

One of the world's oldest civilizations, Iran is a Middle Eastern Islamic republic on the border of Eurasia and is an important power in the world economy because of its large oil and natural gas reserves. Oil was nationalized in Iran in 1953, and the industry is entirely state owned and operated by the National Iranian Oil Company. The national economy is a mixture of state-owned industries (mainly oil), central planning, rural agriculture, and small private endeavors, including companies in the biotechnology and nanotechnology industries. In the Middle East, Iran is a leading manufacturer of vehicles, construction materials, appliances, pharmaceuticals, and petrochemicals. Oil contributes significantly to the economy, though not as greatly as in even more oil-dependent countries like Saudi Arabia. Oil revenues constitute a little less than half of the government's budget, compared to about one-third from taxes and fees. Unemployment, inflation, and budget deficits are

ongoing problems, the latter ascribed to state subsidies for food and gasoline. Energy subsidies alone cost the government close to $100 billion annually, and a 2010 economic reform plan calls for gradual reductions of subsidies and replacement with more focused social assistance, as the country attempts to move toward a more free market by 2016 while still maintaining a concern for social justice.

Oil and Natural Gas Production and Consumption

Iran has the third-largest oil reserves (10 percent of the world's proven oil reserves) and the second-largest natural gas reserves (15 percent of the world's reserves) in the world, and the country is the fourth-largest oil exporter. Output has been constrained by the country's inefficient technology; the 21st-century average output is only two-thirds the peak of six million barrels per day, which was reached in 1974, and the drilling of exploratory wells has slowed considerably. Like much of the Middle East, a dilemma in 21st-century Iran has been the combination of plentiful petroleum resources, yet vast inefficiencies and steadily rising demand in domestic energy usage. Iran's per capita energy consumption is 15 times that of Japan and 10 times that of the European Union. Even relative to the rest of the Middle East, the country's energy intensity (units of energy used per unit of the gross domestic product) is two and a half times that of the regional average. In gasoline consumption, Iran ranks behind only the United States in per-vehicle consumption. The subsidies that have kept prices low have encouraged wasteful consumption, and an illegal sub-industry has developed to smuggle cheap, subsidized gasoline from Iran into Iraq, Pakistan, Afghanistan, and Turkey, where local prices are high enough to make smuggling profitable.

Oil and natural gas combined account for about half of the country's energy consumption. Coal power plants continue to be an important contributor and have recently been streamlined for greater production. To help meet its energy demands, the country has been building new hydroelectric power plants since 2004, along with its first wind-powered and geothermal plants. The first solar thermal plant came online in 2009. There have also been tentative experiments with generating electricity from waste and sewage as well as assessing Iran's tidal power potential, which is believed to be considerable on the Persian Gulf coastline.

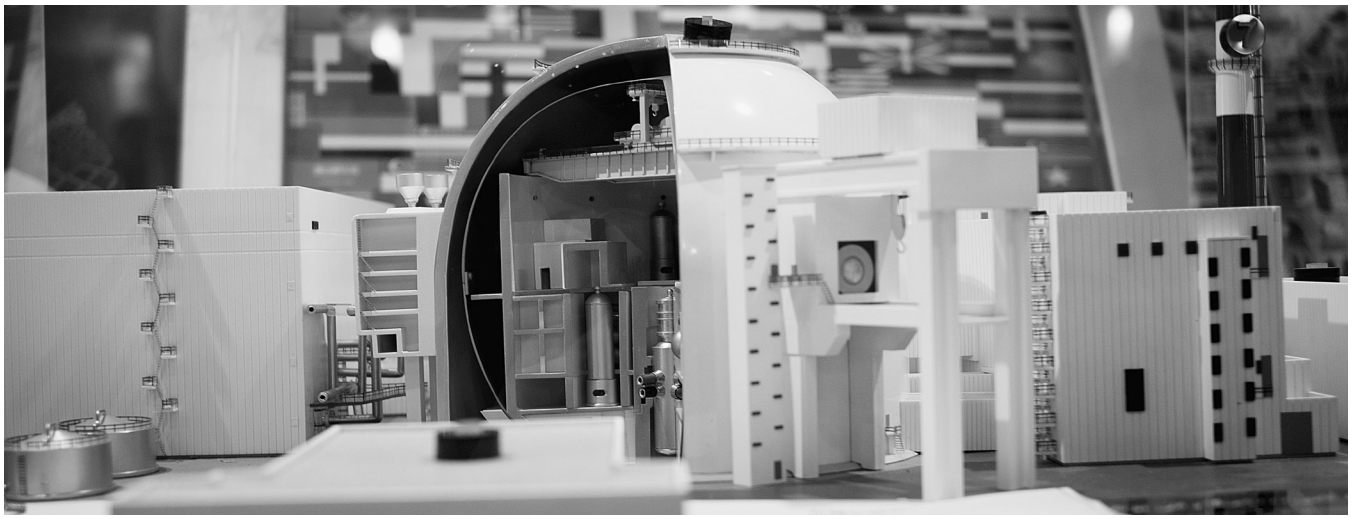
Despite Iran's vast amounts of oil, oil imports actually rose in the first decade of the 21st century, increasing from 30,000 barrels per day in 2000 to 180,000 barrels per day at the start of 2005, and originating mostly in India. The issue is the country's refining capacity. Imports shrank in 2010, and the Iranian government claimed in September 2010 that imports had stopped entirely—but because only months before, imports had supplied 30 percent of the country's domestic consumption, that announcement was met with skepticism.

At least some of the reduction in domestic oil consumption can be ascribed to the increased use of natural gas; reserves were largely untapped until 2005. The government has subsidized natural gas prices to encourage natural gas consumption in the interest of reducing oil imports. By 2010, Iran had the third-largest natural gas consumption in the world, after the United States and Russia, and the highest growth rate.

Electricity consumption has risen steadily since the 1980s and is heavily reliant on oil- and coal-burning energy, with a small but growing number of hydroelectric plants and the recent additions of alternative sources. Because of technological problems and inefficiencies, about 18.5 percent of electricity produced in Iran is wasted before it is consumed, lost on the way from generator to consumer.

Nuclear Power

Iran's nuclear program was launched in the 1950s when the country was an important ally of the United States and the West. Because of the withdrawal of Western support after the 1979 Iranian Revolution, which deposed the shah the Westerners had helped put in power, elements of the nuclear program were temporarily disbanded. Nuclear research in Iran stagnated for a long time; gestures toward working again on nuclear power were frequently met by suspicion from the West that the country was interested in developing nuclear arms. As a signatory to the 1968 Nuclear Non-Proliferation Treaty, Iran's nuclear program is subject to verification and inspection by the International Atomic Energy Agency (IAEA), which it has not only accepted but also on occasion invited



The Iran Bushehr Nuclear Power Plant (scale model depicted above) was fueled and officially launched on August 21, 2010, and hailed as a major coup by the Iranian government, igniting concern from many Western governments. Because of the controversial nature of Iran's leadership and its provocative political statements, it is difficult to accurately interpret the legitimacy of Iran's stated ambitions to use nuclear technology only as a source of energy and medical radioisotopes. Currently, the Bushehr plant is staffed by Russian specialists.

in order to dispel these nuclear weapon rumors. Both Iran and the IAEA have denied reports of Iran's blocking IAEA inspectors.

In the 21st century, reporting its activity to the IAEA as required, Iran has constructed two nuclear-material enrichment facilities, which are necessary to produce fuel for nuclear power plants, since it considers foreign sources of such fuel unreliable due to politics. Iran has produced enriched uranium contrary to a series of United Nations Security Council resolutions forbidding it from doing so, resulting in sanctions being imposed on the country, culminating in a complete arms embargo on Iran starting in the summer of 2010. The purpose of the sanctions is to limit Iran's ability to turn nuclear technology into nuclear weapons.

Iran has explicitly declared itself a nuclear state, and it intends to produce enriched uranium both for a medical reactor (to produce medical radioisotopes) and for a nuclear power plant. Iranian president Mahmoud Ahmadinejad went so far as to declare, "If we wanted to manufacture a bomb, we would announce it," and implied that the country had the ability to do so. Given the president's controversial nature and previous provocations of the West, it is difficult to know how much credence to give either half of the statement.

The Bushehr Nuclear Power Plant was fueled and officially launched on August 21, 2010, and hailed as a major coup by the Iranian government, prompting tentative retroactive support from many Western governments that stressed that their concerns were over illicit nuclear arms, not legal nuclear power. The plant is operated by Russian specialists, fueled for the time being with Russian fuel, and the spent fuel will be sent back to Russia for storage. The plant was expected to meet 2 percent of Iran's national electricity demand upon connection to the grid in early 2011.

Waste

Solid waste in Iran is primarily landfilled. Iran's capital city Tehran had a population of over 8 million people and generated 2,626,519 tons of solid waste in 2005. Most of this went to three municipally operated landfills in the city, although some was scavenged through informal channels. In the western Kurdistan province, unsegregated collection and open dumping of municipal solid wastes is common, and material reclamation goes through scavengers, rather than formal mechanisms.

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See Also: Africa, North; Gasoline; Middle East; Nuclear Reactors; Saudi Arabia.

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Iron

Iron is one of the building blocks of industrial society. An element found beneath the Earth's surface, the extraction of this material scarred the land and killed many people who harvested it. Once above ground, the pliability and strength of ferrous metal allowed it to structure modern life, from skyscrapers to automobiles. The properties of iron have allowed its users to remelt and refashion it over and over, making it one of the most recycled materials in history.

Iron (Fe) ore is abundant across the planet, the fourth most common element in the Earth's crust. Artifacts containing iron (such as spear tips and beads) exist from human societies as early as the Paleolithic Age more than 30,000 years ago. Intensive mining and smelting (in which iron oxide is separated from the ore to form metallic iron) of iron to fashion tools and weapons developed throughout civilizations in China, India, and the Mediterranean between 1200 and 500 B.C.E. Biblical verses refer to the remelting and reshaping of old iron implements for agriculture and warfare, converting plowshares into swords (Joel 3:10) and swords into plowshares (Isaiah 2:4 and Micah 4:3). Iron and the alloys made with iron were vital to the rise of the Islamic world (including the development of the legendarily strong and flexible swords made of Damascus steel) and the guns and agricultural implements leading to the rise of nations in Europe.

English and colonial blacksmiths used old iron for horseshoes and other goods in the early modern period, getting the metals mostly from local sources. The American colonies produced iron from ore as early as 1645; by 1700, American iron accounted for almost 2 percent of world production and about 10 percent of British production. Due to restrictions from the mother country, the colonists could not establish new ironworks to produce finished products, limiting most of the colonial blacksmith's work to mending existing goods.

Iron was crucial to the fighting of the U.S. Civil War; the U.S. system of rifle manufacture (a precursor to modern mass production) depended upon the malleability and durability of iron. As the United States industrialized in the decades after the war, iron—and its harder, lighter alloy, steel—allowed cities to rise vertically, supplying the skeletons for skyscrapers. Iron formed the trains and the rails they rode on from coast to coast. Iron revolutionized naval and cargo ships. Demand for this ferrous metal spurred the digging of more mines, the opening of more foundries to turn iron into steel, and more scrapyards to reclaim disused metals.

Changing production techniques led to increased recycling of iron and steel. The Bessemer process, used widely in the late 19th century, used a limited amount of scrap iron, up to about 10 percent of the charge in order to regulate temperature. Open-hearth furnaces operated at higher temperatures than Bessemer converters, and they burned off phosphorus and impurities found in scrap that Bessemer converters could not remove, allowing for use of more scrap iron. The change was important because steel producers coveted ways to reuse old iron and steel, rather than mining virgin ore. Mining incurred great costs in capital and labor to extract ore from under the Earth's surface, and the hazards involved led to frequent injuries, deaths, and labor disputes. Environmental effects of mining range from the creation of sinkholes to the release of toxic chemicals into the groundwater, and mining remains one of the most dangerous occupations in industrial society.

Iron and steel producers with access to ore had great advantages over their competitors. The interests that controlled the Iron Range in northeastern Minnesota effectively controlled the virgin ore market in the United States, and Carnegie Steel

monopolized the vast ores of high-phosphorus iron in Minnesota in the 1890s. This advantage catalyzed the transformation of the firm into the gigantic U.S. Steel, which then built the world's largest steel mill in northwestern Indiana. The Gary Works built several open-hearth furnaces between 1908 and 1920, and many of U.S. Steel's smaller competitors switched over from Bessemer furnaces to open-hearth furnaces in order to survive. The transition to open-hearth steel combined with expanding markets for steel to trigger new demands for scrap iron and steel.

Scrap and Recycling

With production techniques that could use more scrap, steelmakers could rely upon the discarded ferrous metals found in industrialized society. Dumps, independent junkyards, and demolition sites all became sources of scrap metal; instead of digging into the Earth thousands of miles away, a mill could find its materials in scrapped ships, railroads, and automobiles on the Earth's surface. Railroads acted as suppliers and customers of scrap iron on the open market. Old tracks and engines were made of heavy iron and became valued commodities for railroads. Steel mills collected in-house scrap (also known as "prompt industrial scrap" or "home scrap") in order to eliminate waste and use the cheapest-available materials for production.

Scrap collection and sorting is hard, dangerous work. Scrap metal does not come in neat, symmetrical sizes and shapes; it comes in whatever form it was in when it was discarded. In order to sell these materials, dealers have to convert them into portable shapes and sizes of material free from impurities. Ship hulls may be encased in rust that has to be scraped or cut off; potentially valuable cables have to be separated from worthless refuse. Processing scrap involves cutting it with shears or acetylene torches, either of which could easily maim a man. Sharp or jagged edges of scrap metal can cut flesh; if rusty, they can cause tetanus. Like mining, scrap processing was—and is—a dangerous occupation.

Thousands of workers engaged in this work because it was profitable. By 1917, *Scientific American* reported that the annual business in scrap iron increased from $100 million to $1 billion. The Great Depression stunted demand for iron and steel, but the United States consumed more ferrous metal than ever during World War II. Mines and scrapyards were mobilized for the war effort, and citizens' groups conducted scrap drives to maximize the amount of metal put into military production.

Scrap drives ended with the war, but U.S. consumption of iron and steel did not abate in 1945. Military use of the metal continued as the United States mobilized for a cold war that expanded the peacetime military and its purchase of weaponry and vehicles. The domestic economy grew substantially between 1945 and 1965, and with it came greater metal consumption. Iron and steel continued to shape new buildings, as well as the millions of new automobiles sold every year. It shaped consumables ranging from cans of food to air conditioners, as the material remained integral in modern conveniences.

Innovations

Further changes in steelmaking, including the advent of the electric arc furnace and continuous casting, reshaped the industry in the late 20th century as giant steelworks gave way to smaller minimills in both the United States and abroad. Another change in technology worked to counter iron's influence. The rise of plastics after World War II produced new, flexible materials that often matched or surpassed the malleability of ferrous metal but weighed less. A person drinking soda would be as likely to sip from a plastic bottle as from a steel can at the end of the 20th century. Even automobiles began to contain growing amounts of plastics in their bodies and interiors. While iron remained a widely used material in daily life in the United States, the age of plastic meant that petroleum's influence extended well beyond fuel to power vehicles once made primarily of iron and steel. Despite these changes, iron remains a crucial building block of industrial society, and its properties make it one of the most recycled materials on Earth.

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See Also: History of Consumption and Waste, U.S., 1850–1900; History of Consumption and Waste, U.S., 1900–1950; History of Consumption and Waste, World, 1800s; Industrial Revolution; Junkyard; Recycling.

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Italy

Bordered by the Mediterranean and the Alps, Italy is a 116,346-square-mile peninsula with limited space and natural resources. In addition, it is one of the European countries with the highest population density (517.4 people per square mile). The national territory also includes several islands, the largest being Sicily and Sardinia. This Mediterranean country has the fourth-largest economy in Europe by 2010 and experienced rapid industrial growth after World War II. The natural environment and rapid social and economic change have had an impact on Italian attitudes toward waste and environmental management. Not unified into one country until 1861, in many ways Italy remains regionally divided in both cultural and economic perspectives. The largest division is the north from the south. The north has developed a strong industrial economy and modern infrastructure, while the south remains largely agrarian with pockets of high poverty. When discussing Italian attitudes and approaches to consumption and waste, these divisions must be taken into consideration.

World War II Era

Since the 1940s, Italy has come nearly full circle when it comes to dealing with waste. Prior to and immediately following World War II, the average Italian experienced a life of great scarcity. Almost nothing, from water to manure, was wasted. Everything was reused until it could be used no more. For example, Italian pig slaughtering and processing used every part of the animal, from the snout to the tail. Italian culinary culture developed to make efficient use of the pig, from blood sausage to be consumed immediately after slaughter to long-aging hams that would be consumed the following year. Meat was scarce and often only a small piece of fat would be used to flavor a dish of pulses. Popular Italian cuisine, particularly in central and southern Italy, was referred to as *cucina povera* (meaning "poor or frugal cuisine"). Scarcity during times of war also led Italians to forage for wild foods such as mushrooms, chestnuts, and tubers. Scarcity was most felt when it came to subsistence, but the same frugality carried through the rest of Italian consumption patterns.

Italy manufactured very few consumer goods until the second half of the 19th century. As an agricultural economy, most farms were organized in the south, mainly as large shareholder farms, and in central Italy, a sharecropping system called *mezzadria* existed. This meant that the majority of Italians produced most of their own food and consumed very few consumer products. It was Benito Mussolini's dream to make Italian agriculture self-sufficient.

Postwar Economic Growth

Production and consumption changed drastically after World War II as Italy began to industrialize rapidly in the north. Helped along by funds from the U.S. Marshall Plan, Italy rapidly went from being one of the least to one of the most developed countries in Europe. There was a great wave of migration from south to north to the growing factories in cities like Turin, Genova, and Milan. The period from the mid-1950s to the 1970s is often called the "economic miracle." In particular, car manufacturing took off as one of the main industries, drastically changing Italy's economy.

The Turin-based company Fiat came up with a design for a small economic vehicle, the 500. The Fiat 500 was produced from 1957 to 1975 and was a car that even working-class Italians could afford. Previously, cars had been strictly luxury items to which only the privileged few had access. With the growth of the automobile market, Italians could

now travel longer distances. They were no longer limited to the range of a bicycle or the limited network of railways lines. Cars like the 500 offered Italians a new autonomy and outlook on their country. Owning a car was also a major status symbol and public display of upward mobility. By the 1960s, Italy was moving from a culture of poverty and scarcity to a culture of consumption, thanks to the rise of manufacturing and heavy industry.

Much Italian consumption was focused on the domestic sphere. Italy manufactured domestic appliances such as washing machines, clothing, shoes, food products, and other consumer goods. Along with industrialization came urbanization, and this also contributed to Italy's growing consumption. Once people moved off the land, they were no longer able to produce their own food or fuel. During the second half of the 20th century, there was also a great desire to modernize and move away from "backward" rural ways. Shopping in supermarkets, rather than tending a garden or going to an open-air market, was one of the ways in which "modern" families could display their growing prosperity. Women began to enter the workforce in larger numbers by the end of the century, increasing the average family budget. Consequently, women had less time to devote to household chores, such as cooking and cleaning, but innovations such as vacuum cleaners, washing machines, and prepared foods helped lift some of the domestic burden from women's lives. Women's entry into the workforce had serious repercussions for social and gender roles in the family: women were no longer economically dependent on men, which caused tension as the power dynamics shifted in households. Many women stopped preparing elaborate dishes except during holidays because there was not enough time in the workday. Italian cuisine was affected by the introduction of mass-produced foods and the homogenizing experience of the supermarket. In the 21st century, groups such as Slow Food are attempting to protect Italian culinary heritage by encouraging Italians to turn back to traditional forms of agricultural production and a more meaningful form of consumption.

Waste

With the growth in urbanization and the rapid expansion of consumer culture, Italians began to produce more garbage and use more fuel. The largest polluting factor in Italy in the 21st century is heating fuel, and Italy is struggling to meet its goals for the Kyoto Protocol because of the expense and challenges of moving to greener fuel sources. Italy has banned nuclear power production and must buy electricity from neighboring countries, such as France.

From a waste perspective, many Italian municipalities have adopted effective recycling programs and sustainability programs that feature the composting of organic waste. Waste management programs vary widely from town to town. There is once again a north-south divide in popular attitudes about waste and municipal management of this issue. In 2008, the city of Naples and the surrounding areas experienced a terrible garbage crisis. The media revealed that the local Mafia, the Camora, controlled garbage disposal in all of the area and had been dumping the city's waste in illegal, unauthorized sites. Landfill sites were full, and there were no modern incinerators in the area. The Mafia opposed the building of more incinerators because it did not want to lose control of its waste disposal enterprise. The local government also feared that the Mafia would take control of newly built incinerators and would start disposing of toxic waste from northern Italy, a practice that they had historically engaged in.

The crisis culminated when garbage stopped being collected and began to pile up in city streets, and citizens began burning the refuse piled up in the streets. The national government and armed forces had to step in to restore order, and many municipalities in the north offered their incinerators and trucked waste north from Naples. By 2010, the issues affecting Naples and other municipalities in southern Italy had not been concretely addressed or resolved.

Italy's rapid industrialization and urbanization have made it into one of the largest consumer cultures and economies in Europe, and the waste that this type of economy produces must be dealt with. On January 1, 2011, the Italian Environmental Ministry began enforcing a ban on polythene shopping bags in an attempt to reduce plastic waste. Italians, particularly in the north, are beginning to come full circle in the early 21st century in their search for more sustainable consumption. Italy struggles

to protect its natural resources, which are essential to some of its major industries (fishing, agriculture, and tourism). Without strong national or local government control, environmental catastrophes cannot be averted and abuses often go unchecked. With the serious disparity that exists between north and south, Italy has serious challenges to confront in the 21st century as it tries to manage its waste while maintaining economic growth.

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See Also: Capitalism; Consumerism; Culture, Values and Garbage; Economics of Consumption, International; Food Waste Behavior; Fuel; Grocery Stores; Home Appliances; Household Consumption Patterns; Incinerator Construction Trends; Incinerator Waste; Politics of Waste; Recycling; Slow Food.

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Japan

This island nation of some 127 million people (the 10th-largest population in the world as of 2010) was a rising power at the beginning of the 20th century. It turned into a major power in World War II; from defeat, it rose to prominence as a global economic player. As such, it was considered by some to be the exotic "Japan, Inc.," which was difficult for Westerners to understand (but had to be emulated and engaged with). It experienced economic decline beginning in the 1990s from which it had yet to recover as of 2012. Japan is a highly industrialized, urbanized, and consumptive nation with land scarcity, and a detailed discussion of waste management practices in a separate entry focuses on incineration rather than landfill. Environmental constraints, including severe urban air pollution in the mid-20th century and continued exposure to extreme seismic activity, shape life in Japan.

Culture, Production, and Consumption

Located at the eastern fringes of the Eurasian landmass, part of the "Ring of Fire" that circles the Pacific Ocean, Japan consists of four major and thousands of smaller islands, with an interior dominated by volcanic mountain ranges. Japan's development has been strongly influenced by its natural environment and location. Traditional culture even sees the world as animated. Especially in Japan's native religion, Shinto, every object is seen to be imbued with spirits. These do not reside only in nature but are also to be found in man-made objects.

Nature is prized most highly when it is cultivated, and human behavior is seen as the most highly cultivated when mastering learning to such an extent that it becomes the seemingly natural way of doing things. This blurring of the natural and artificial is often used to explain why there is a deep appreciation for nature and its beauty and power in Japan. However, a desire to intermingle these two aspects of the world—in ways that seem mutually exclusive in Western cultural terms—creates an attitude very open to novelty, not least in technological innovation. Such an inclusive view of human activities as a part of nature also influences the consumption of natural resources, for example, when it is argued that whaling should be allowed as a normal part of human activities, especially as whales' supposed overconsumption of other fish needs human intervention (to create harmony in nature).

Both traditional and modern culture have been shaped by the scarcity of resources that accompanies Japan's geography. The islands that make up

Japan offer forested, mountainous interiors and proximity to the resources of the Pacific Ocean surrounding them but few industrial resources and comparatively little land suited for agricultural cultivation and human habitation. These geographic factors help explain why Japan's population is especially concentrated in rather few areas. The human domination of these areas is also particularly great. Green areas in these conurbations are often times left only in the environs of Shinto temples because their association with these religious buildings gives them spiritual meaning and thus protection. The Greater Tokyo Area, also known as the "Tokyo-Yokohama urban corridor," is particularly noteworthy. It contains over 35 million people—28 percent of the country's total population. This makes it the world's largest metropolitan area, and it is increasingly merging with other coastal cities.

The rural population, in contrast, declined to only 21 percent of total population in 2000, and the agricultural sector, although strongly protected by government measures, only makes up 4.4 percent of total employment (according to International Labour Organization statistics from 2002). This is not to say that Japan's natural environment had been outside human colonization of nature; there have been ecological crises due to deforestation and remediated by active reforestation efforts.

Japan's geography is also one of the reasons (besides the large population and the highly developed economy) why Japan was the fifth-largest importer in the world and the third-largest importer of agricultural products by 2010. Agricultural imports had a value of over $40 billion in 2009 and constituted some 60 percent of the calories consumed in the country. The trade balance also shows this effect, as agricultural products made up 12.3 percent of Japan's imports in 2009, but only 1.4 percent of exports (according to the World Trade Organization trade profile of Japan).

Japan, in spite of its economic problems, achieved a 2010 estimated nominal gross domestic product (GDP) of over $5 trillion (or over $4 trillion by purchasing power parity), making it the world's second- or third-largest economy after the United States and China. Thus, it is also one of the world's largest consumers of raw materials because of its economic activity. It is also a major exporter of manufactured products. For example, in 2009, fuels and mining products constituted 34 percent of Japan's imports but only 4.4 percent of exports, and manufactured goods made up 51.8 percent of imports and 87.5 percent of exports.

Ecological Impact

Japan's economy grew rapidly after World War II, and intensive industrialization produced acute air, land, and water pollution problems relating to heavy metals, sulfur dioxide, and nitrogen dioxide. Public complaints in the late 1960s led the government to develop several environmental protection laws, with varying levels of success in abating pollution concerns. Comparing between major economies, Japan is still something of an outlier among industrialized countries. Its ecological footprint (the balance between national productive area and in-country ecosystem's capacity to absorb pollution, on the one hand, and resource use and concomitant emissions and pollution, on the other hand) is above the worldwide average of 1.8 to 2 global hectares of productive land available per person, standing at 4.73 global hectares per person in 2007. However, considering the relationship between ecological footprint and economic productivity, as measured by the Human Development Index (HDI) for Japan (which is at 0.884 points for 2010, putting Japan in 11th place), the country is highly effective at converting consumption of resources into value. The United States, in comparison, has an HDI of 0.902, a rank of fourth, but with an ecological footprint that is much higher at about 8 global hectares per person.

Japan ranked third among the world's nation in electricity production in 2008, trailing only the United States and China. Japan has relied upon nuclear energy to power industry and households since the 1960s, having 53 active reactor units in 2009, again ranking third worldwide behind the United States and France. The nation's vulnerability to earthquakes and tsunamis has shaped architecture and safety standards throughout Japanese society, including some of the most stringent building codes on Earth. Existing safety measures, however, have not prevented accidents at nuclear plants. To date, the most severe of these was the catastrophic meltdown at the Fukushima Daiichi power plant following the March 11, 2011, earth-

quake and tsunami. That disaster spread radioactive cesium hundreds of kilometers into the Pacific Ocean and forced tens of thousands of nearby residents to abandon their homes. The continuing environmental damage from the meltdown brought into question the nation's reliance on nuclear power, with public opposition soaring, and Prime Minister Naoto Kan stating "We will aim at realizing a society which can exist without nuclear power." It remains unclear whether Japan can replace nuclear energy for its considerable energy demands.

At least part of Japan's declining impact on the world can be explained by the stagnant economy, but there is also a distinct focus on greener technologies and more efficient production. Japan's lack of resources is credited with raising awareness of the need for a shift to less-consumptive practices (which are, therefore, less dependent on outside inputs). It is also a factor in the Japanese approach to wastes, which sees them very much as potential resources and aims to ultimately achieve a "zero waste society."

Japan, as a part of east Asia, also belongs to the region heavily influenced by Chinese culture. Its contemporary society intermingles aspects of traditional culture and global consumer culture in ways that are at the forefront of modernity, and it has increasingly exerted an influence on other societies. At the same time, Japan, in its economic development from postwar rise to feared economic dominance during the 1980s and on to stagnation, serves as an example of how economic and social dynamics interact, sometimes shift quickly, and may also change in other countries. This is all the more so as Japan's population development toward declining total numbers and rising numbers of seniors shows a path that other developed countries, and the rest of the world, will follow if world population to reaches a high point in the latter half of the 21st century and declines afterward.

Consumption patterns, both industrial and individual, have shifted and will shift in parallel with these economic and social developments. First, total fertility rates have been close to or below replacement level since 1957, meaning that Japan is now at the forefront of the global "silvering of society" (rapid aging) and showing an inverted population pyramid in which dependency ratios (of children and mainly retirees to economically active population) are increasingly high. This is particularly pronounced as the Japanese have the highest average life expectancy in the world. As a result, consumption declines along with population, increasing age, and perceived need to save for one's support in old age. In Japan, this challenge—and reduced productivity and consumption—is further exacerbated by the economic stagnation that has been near-continuous since the boom of the 1980s ended. One effect of it has been that the current young generation has only known a stagnating Japan and worrisome personal prospects (along with deflation) and has shifted its consumption habits accordingly, away from luxury brands to a concern with quality and, particularly, price. On the other hand, there is a concurrent trend toward urban living in single (or at least, smaller) households, which typically drives up consumption and production of waste per person.

Japan (as opposed to China) has the advantage of having become a rich, developed economy before becoming a society in which old people increasingly dominate. It also has cultural traditions valuing quality and aesthetics. In an aging world having to move toward less consumptive ways of life, these traits put it in the forefront of development—whether for better or worse will, of course, remain to be seen.

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See Also: China; East Asia (Excluding China); Economics of Consumption, International; Incinerators in Japan; High-Level Waste Disposal; Osaka, Japan; Sustainable Development; Tokyo, Japan.

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Junk Mail

Junk mail, sometimes referred to as direct mail or advertising mail, is unsolicited mail that is sent to people through the postal system. Junk mail may include letters, catalogs, and flyers from companies; credit card applications from banks; CDs and other forms of merchandising materials; and correspondence from politicians, candidates, and other organizations. In the United States, junk mail has been a facet of the postal system since the 19th century, but its popularity rose dramatically in the late 20th century, in part due to bulk mail permits.

Junk mail accounts for 100 billion pieces of U.S. mail per year, or approximately 848 pieces per household, weighing 41 pounds per year. U.S. junk mail accounts for 30 percent of all the mail in the world. The U.S. Postal Service estimates that advertising mail went from 35 billion pieces of mail sent by companies in 1980 to 64 billion pieces in 1990, to 90 billion pieces in 2000. Junk mail is received less than half as much by families making $35,000 or less per year than families making $100,000 or more. The rate of receiving junk mail also increases as the number of adults in the household increases. An additional factor is education.

Waste and Disposal

An estimated 44 percent of all junk mail goes to landfills unopened, and the estimated response rate to junk mail is less than 2–3 percent. Credit card companies report that a response rate of 0.25 percent is acceptable. Because of the acceptability of such a low response rate, environmentalists point out the immensity of the impact of junk mail. Some studies report upward of 100 million trees to produce all of the junk mail in the United States in a given year. Compounding this, the greenhouse gas effect of all of this junk mail is over 51 million metric tons of greenhouse gases. According to the Environmental Protection Agency, less than 50 percent of the junk mail received is actually recycled.

Direct Mail

A new phenomenon is the emergence of direct mail. Through the use of databases, direct mail is customized and individualized and sent to specific consumers. Direct mail may involve products beyond the paper that is commonly used in junk mail. Plastic bags, catalogs, mailings that resemble paperback books, and even small boxes are examples. The potential environmental impacts of direct mail are large considering the volume of mail that is sent to consumers and the types of products used for the mailings. Nineteen billion consumer catalogs, including those printed on glossy paper, are sent on average to U.S. consumers. The environmental effect of catalogs printed on materials that are less easy to recycle is substantial.

Reduction Efforts

Consumers have called on politicians and advocacy groups to curb the expansion of junk mail. The city of San Francisco called on the state of California to create a statewide Do Not Mail Registry; other states, including Florida and New York, have brought forward similar legislation. In the United States, consumers are often unable to opt out of mass junk mailings because of the postal service's insistence that it is providing a service for companies that pay to send their messages to consumers. Thus, the economic motivations of capitalism can be attributed to the challenges faced by consumers and advocacy groups that wish to curtail the junk mail phenomenon.

A small number of consumers use techniques of resistance and transgression, including sending back reply cards with false information, as a response to the problem of junk mail. On the Internet, a number of free and pay-for-service organizations offer opt-out options for consumers who wish to limit the amount of junk mail that they receive. A number of these organizations have raised public awareness about the environmental impacts of junk mail, to which other organizations, including those representing direct mail companies, argue that they have minimized their

environmental impacts by printing many of their mailings on recycled paper.

Internet Spam

Junk mail is also a growing phenomenon on the Internet. Although this form of mail is sent through the electronic means of the Internet, environmental impacts do exist. A study by McAfee Avert Labs concluded that 62 trillion spam messages are sent each year, with each e-mail associated with 0.3 grams of carbon dioxide released as greenhouse gas. The combined spam emissions of all e-mail users around the world accounts for 17 million metric tons of carbon dioxide per year, or 0.2 percent of total greenhouse gas emissions. The total energy used to transmit, process, and filter spam is 33 terawatt hours, or the amount of electricity used in 2.4 million homes. Much like junk mail sent through the postal system, those who receive spam messages report negative effects of annoyance, decreased work productivity, and in some cases, crime and identity theft.

Popular Culture

Junk mail has also impacted public popular culture. The television comedy show *Saturday Night Live* also once featured a parody of direct mail advertisers. In 2007, artists Barbara Hashimoto and Nancy Spiller produced the artistic piece *Reverse Trash Streams: The Junk Mail Project*. The piece was shown at the LA Contemporary gallery. The artists produced the piece in response to concerns related to junk mail, including the impact on global warming, deforestation, and injuries to postal carriers. The piece featured hundreds of pounds of shredded junk mail that the artists arranged in a heap at the rear of a gallery.

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See Also: Consumerism; Material Culture Today; Paper and Landfills; Paper Products.

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Junkyard

The junkyard is an iconic symbol of waste in industrial life, and it is one of the more complex spaces devoted to post-consumer materials. Instead of simply being an end-stage sink for materials like a landfill, it offers the potential for returning materials to production through recycling. At any one time, a yard may host materials at the end of their lives or near the beginning. Messy and complex, even the term *junkyard* is contested, belying the battles for identity and respect that these businesses have fought for decades.

History of Junkyards

Yards with scrap materials such as copper, iron, or silver have existed as long as markets for those metals. In the American colonies, Paul Revere kept a yard of scrap metal for his work as a metalsmith. The number of such yards, and the name *junkyard* increased with the Industrial Revolution. Shipbuilders and railroads kept salvage operations on their own sites, and independent yards containing rope, rags, metals, and any other materials desired by industrial producers became common by the end of the 19th century, containing the detritus of farm machinery, household tools and appliances, scrapped vehicles, and retired industrial machinery. A consumption ethic based on

style rather than functionality spurred disposal of durable goods in the late 19th and early 20th centuries, increasing the volume and variety of objects found in junkyards.

In the United States, thousands of junkyards—most found in industrialized areas of growing cities—welcomed millions of mass-produced metal goods that could be resold as secondhand appliances or processed as scrap. Many yard owners started as junk peddlers. In the United States, a common path to ownership during the period of growth between the Civil War and World War I was to emigrate from Europe, become a peddler, and with the money raised, rent or purchase land to create a junkyard. Demand for secondary materials fueled the growth of junkyards, especially for materials containing iron and steel. The number of yards listed in city directories in Detroit, New York, Philadelphia, and Boston almost doubled between 1880 and 1921; in Chicago, the total listed in the annual *Lakeside Directories* increased from 140 in 1890 to 471 in 1917.

The trade in junk became an organized industry during this period, as yard owners created trade publications such as the *Waste Trade Journal* and professional associations such as the National Association of Waste Material Dealers (NAWMD) and the Institute for Scrap Iron and Steel (ISIS) in the first three decades of the 20th century. These institutions reflected the pervasiveness of yards in modern life and their role in both housing scrapped materials and reintroducing them to industrial production. In the 1920s, the automobile graveyard became a new, specialized junkyard, where customers could purchase obsolete automobiles for scrap or purchase individual parts off junked automobiles in order to repair other automobiles.

Technology

Junkyard technology changed over time. In the early 20th century, workers sorted and processed materials by hand or with small shears or acetylene torches. By the late 1940s, common technology included conveyors, dust-collecting systems, forklifts, hand trucks, rag-cutting machinery, rag shredders, shears of various sizes, torches to reduce items into manageable sizes, balers to turn scrap into symmetrical cubes, cranes and magnets to move heavy materials, and a variety of other tools to process materials. With the mass disposal of the automobile in the 1950s, several yards adopted specialized automobile shredders that disassembled a car within minutes, allowing yard owners to harvest No. 1–grade ferrous scrap. The torches and shears used in yards were too slow to profitably separate steel from the rest of an automobile, but by 1960, machinery designed to quickly harvest scrap metal from automobiles evolved to hammer and shred automobiles, using magnets to separate the ferrous scrap from other materials. The automobile shredder became a staple of the junkyard by the late 1960s, as its ability to hammer down an automobile and quickly separate light iron and steel from the many other materials found in automobiles gave operators the ability to process a massive source of consumer-generated scrap. Larger yards adopted other devices such as balers and cranes to process and transport materials. Smaller yards focused on securing goods. Among the tools to provide security were barbed wire, electrical fences, and intimidating junkyard dogs.

Social Conceptions

Despite the role junkyards play in returning disused materials to industrial production, cultural and social perceptions of junkyards have been consistently negative, associating them with disease, dirt, dangerous dogs, and blight. Progressive reformers at the turn of the century saw junkyards as blights upon urban neighborhoods; advocates such as Jane Addams and Jacob Riis warned of the dangers of junkyards to children's moral and physical health. Police worried about the difficulty of finding stolen goods in yards. Due to these concerns, several cities established zoning regulations after World War I that barred junkyards from residential areas. In fact, yards often moved to areas where police did not enforce zoning regulations. By 1956, geographer Gerald Gutenschwager found that most of Chicago's scrap iron and steelyards were located in majority African American residential neighborhoods, revealing environmental inequalities based upon race decades before the term *environmental justice* was first used.

Regulation

State and federal governments began to take an interest in regulating junkyards in the late 1950s.

As consumers in the late 19th and early 20th century shifted their focus from the functionality of household goods to the style and degree of modernity, the volume and variety of discarded durable goods found in junkyards increased. The junk trade became an organized industry, complete with trade publications and professional associations. Over time, technological advances in sorting and processing increased the usability and value of scrap. As such, the industry sought to redefine its image and promoted titles such as "salvage yard."

The Highway Beautification Act of 1965, however, was the first federal law regulating the scrap industry on aesthetic grounds. It sought, according to President Lyndon B. Johnson, to eliminate or screen unsightly, beauty-destroying junkyards and auto graveyards along U.S. highways. During the battle over the legislation, representatives of the scrap industry complained about the name *junkyard*, insisting that the materials they contained were valuable secondary materials and not worthless junk. Industry leaders promoted alternate names like *salvage yard* and *scrapyard*, with limited success. After the act passed, the Department of Transportation estimated that over 3,300 illegal junkyards were removed or screened from view by 1979.

Federal regulation of junkyards in the late 20th century focused more on environmental hazards than aesthetic blight. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), better known as Superfund, yard owners could be held liable for any hazards caused by the materials they contained. This was true of hazards both brought to the yards, such as rusting cans of petroleum, or hazards produced by the yards. Yards that shred the bodies of junked automobiles, computers, refrigerators, or other complex machinery produce residue that might contain a variety of carcinogenic, flammable, corrosive, or otherwise hazardous materials. Junkyards are at once areas containing both valuable recyclables and hazardous wastes, revealing the dangers of production techniques that do not include designs to promote full recycling of products.

Despite regulatory attempts to limit its presence, the junkyard remains a common and iconic presence on the landscape as yards containing automobiles, appliances, industrial machinery, and other scrapped artifacts remain common in industrialized society. They will remain as long as society designs and purchases disposable commodities.

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See Also: Automobiles; History of Consumption and Waste, U.S., 1900–1950; History of Consumption and Waste, U.S., 1950–Present; Iron; Recycling.

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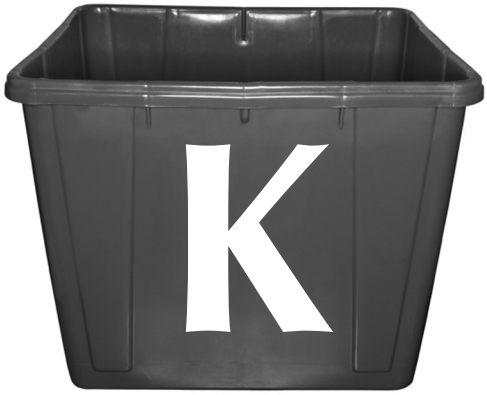

Kansas

Named after the Kansas River and, ultimately, the Kansa Native American tribe, the U.S. state of Kansas is located in the midwestern region. Until the first European settlement in the 1830s, the state's inhabitants were a variety of Native American tribes, settled agriculturists in the east, and semi-nomadic hunter-gatherers in the west. The state emerged from a chaotic period of political wars over the slavery issue in 1861 to join the Union and grew rapidly after the Civil War as immigrants turned the prairie into farmland. The state remains one of the most agriculturally productive in the 21st century.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Kansas had an estimated 4,089,591 tons of municipal solid waste (MSW) generation, placing it 30th in a survey of the 50 states and the capital district. Based on the 2006 population of 2,755,817, an estimated 1.48 tons of MSW were generated per person per year (ranking 12th). Kansas landfilled 3,271,773 tons (ranking 24th) in the state's 52 landfills. The state exported 140,939 tons of MSW, and the import tonnage was 770,650 tons. Kansas was ranked eighth out of 44 respondent states for number of landfills, but it had no plans to increase its landfill capacity and no waste-to-energy (WTE) facilities. Only whole tires were reported as being banned from Kansas landfills. It recycled 817,818 tons of MSW, placing Kansas 26th in the ranking of recycled MSW tonnage.

The historic disposal methods of pig-feeding and open burning ceased between the 1950s and 1970s as U.S. life became more urban and trash became an increasing problem in Kansas as well as elsewhere. The first statewide solid waste regulations were not passed until 1970 in Kansas, although the same is true for many other states. The nationwide garbage crisis was also felt in Kansas with a 1969 *US News & World Report* article describing 770 paper cups, 730 cigarette cartons, 590 beer cans, 100 whiskey bottles, and 90 beer cartons being found dumped on one mile of a two-lane Kansas highway.

Quindaro

Situated on the south bank of the Missouri River in Wyandotte County in what is now Kansas City, Quindaro was a short-lived (1856–62) community established after the Kansas-Nebraska Act to create a free-state port of entry into Kansas. Originally

Wyandot Indian land, the town's founders were former members of the tribe who chose to remain in the area and become U.S. citizens when the tribe disbanded. The town was named after one founder's wife, Nancy Quindaro Brown Guthrie, whose husband was a European American adopted into the tribe on marriage.

Close to the Missouri River, the town was an active part of the Underground Railroad, helping slaves escape to freedom. A boomtown with a population that peaked at 600, the town's fortunes declined when a nationwide economic depression hit and efforts to attract a railway line to the town failed. Much of the male population left to fight in the U.S. Civil War, and those who remained continued farming while the town drifted into abandonment. Freed African American slaves settled in the area after the war and buildings of Freedman University (later Western University) occupied the bluff over the site of the old town. These buildings would also become ruined within a century.

In the late 1980s, a projected landfill on the site was countered by the Kansas Antiquities Commission Act. As Kansas City owned part of the site and was a permitting authority, an archaeological evaluation had to be conducted. Two years of archaeological work uncovered a cistern, three wells, and the remains of 22 buildings. The level of archaeological remains raised a public outcry, which halted the landfill development, but this had the effect of removing the funding source for the site archive's storage and analysis. An agreement was eventually reached, which transferred the archive to the Kansas Historical Society.

Bill Compton and Kansas Pyrolysis

During the late 1960s and early 1970s, the U.S. government funded various resource recovery technologies in the hope that the crises of garbage accumulation and oil shortage could be alleviated by WTE facilities. Pyrolysis (which cooks trash, rather than incinerating it, to release oil, carbon, and gas, was seen as the most promising method of disposal, but it was also the most expensive, technologically complex, and heavily funded method. Even with federal funding, the hope of creating a pyrolysis plant remained beyond the financial and intellectual capabilities of most communities. Many of the resource recovery programs established by the 1970 Resource Recovery Act and the 1976 Resource Recovery and Conservation Act failed, and federal research was dropped when the energy crisis threat waned in the early 1980s. Loss of government interest made it seem less likely that technology could combat the garbage accumulation problem.

Bill Compton, a former World War II fighter pilot from Wichita who used the GI Bill to obtain chemistry and physics degrees, designed, built, and operated his own small pyrolysis plant in his yard from 1992 to 1998. Running the plant for 350 hours converted 700 pounds of trash into usable oil, carbon, and gas. Compton and his supporters constantly petitioned the government to consider building full-scale pyrolysis plants, without success. Compton's supporters place the blame for their initiative's continual knockbacks on bureaucracy, politics, apathy toward resource recovery, and bad publicity from the Baltimore Pyrolysis Plant affair. Compton's supporters continue their campaign into the 21st century after Bill Compton retired due to advanced age and health problems.

Project Salt Vault

Another controversial waste management program vaunted for Kansas was a plan formulated in the early 1970s to use an abandoned salt mine in Lyons as a disposal site for high-level radioactive waste from the nuclear weapon program and commercial nuclear power plants. The Atomic Energy Commission (AEC) reacted swiftly while under pressure to establish the Lyons site's suitability and, in doing so, provoked a backlash from Kansas's scientists and politicians. The AEC sought to find a way to contain the most hazardous form of nuclear waste, the highly radioactive liquids that were by-products of reprocessing uranium fuel to recover plutonium. It was suggested that salt formations were the best geological siting for radioactive liquid waste, being dry, impervious, and having a plasticity that sealed itself around fractures or anything deposited in it. Salt formations were also abundant, found in areas of low earthquake risk, and cheap to mine. The depth, size, and thickness of the central Kansas salt deposits were thought ideal.

The AEC began preliminary experiments in a disused section of the Carey Salt Company mine

in Hutchinson. Between 1959 and 1961, scientists injected nonradioactive liquids into cavities bored into the mine floor to simulate the heat produced by nuclear liquid waste. The results of these tests were inconclusive but deemed encouraging. A second battery of tests was announced in 1963, which were to be conducted between 1965 and 1968 at another Carey salt mine in Lyons. Called Project Salt Vault, this test used solid radioactive waste as the test substance. In 1970, the AEC was ready to move forward with construction, but ambivalence toward the project became a sensitive political issue in the upcoming gubernatorial election. As the debate simmered, relations soured, and political support for the project was lost as Kansas' officials tired of the political blundering by the AEC. The incident generated bad press nationwide and made finding the solution to the nuclear waste problem an even more arduous problem for the AEC. A major stumbling block had been the AEC's eagerness to press onward while overlooking serious concerns of the Kansas Geological Survey and American Salt Corporation about the risks posed by earlier workings nearby.

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See Also: Atomic Energy Commission; High-Level Waste Disposal; Radioactive Waste Disposal.

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Karachi, Pakistan

As one of the world's largest and rapidly growing cities with a population exceeding 18 million in 2007, Karachi has high levels of consumption and waste. Given the financial constraints typical for a developing country as well as limited systematization and control, the waste management system is inefficient, with at least half of the waste remaining uncollected and untreated. As is the case with most of the urban waste generated in Pakistan, a large part of the garbage is sorted and recycled by street scavengers and trash pickers. This often amounts to improper treatment of waste, which increases the city's pollution levels. Landfills and open dumping remain the primary means of disposing all kinds of solid waste, exacerbating the issue. Water is not only contaminated by the leachate from landfills but also by the open discharge of industrial waste in drains, canals, rivers, and the sea. For a rapidly and somewhat haphazardly growing city like Karachi, where shantytowns appear intermittently, there is the additional problem of increasing pollution encroaching on residential areas and further endangering the health of inhabitants.

Known since the times of Alexander the Great, Karachi is named, according to the most popular legend, after Mai Kolachi, one of the earliest settlers in the fishing village, who established a matriarchal regime over the area. In the 21st century, the city sprawls over 2,192 square miles and contains Pakistan's two main ports. Serving as Pakistan's capital from the country's independence till 1960 and currently the provincial capital of Sindh, Karachi is the most developed region in the country, attracting immigrants from rural areas and abroad—particularly Afghanistan since the Taliban occupation of Kabul in the mid-1990s.

Consumption

In spite of the difficult economic conditions and the low standard of living, with the majority of the population situated below the poverty line, the

transition toward a consumer culture is evident in the densely populated urban region of Karachi. Indicating the country's lax import policy, extensive varieties of foreign goods are easily available in stores throughout the city, ranging from cosmetics and clothes to food items. Franchises of many multinational fast food chains crop up frequently and, as a result, Karachi had seven McDonald's restaurants as of 2010 and an even larger number of Pizza Hut branches. The kinds and varieties of products marketed have affected eating and living habits and, ultimately, the kind of waste generated. Subsequently, a general shift from organic to inorganic substances is discernible in garbage composition, combined with an overall rise in packaging material, particularly plastics. In 2001, around 40 percent of the waste was biodegradable, roughly 10 percent was paper, and the amounts of metal and glass as well as textiles and leather were even less.

Waste Management

In accordance with its size, Karachi produces more than 10 times the waste generated in the Punjabi cities of Islamabad and Multan combined, and this amount has an annual growth rate of 2.4 percent. Varying between 6,000 and 7,000 tons daily per person in 2001, the city's waste production is almost double that of New Delhi and is among the highest in south Asia. From this, according to the country's environmental department, less than half succeeds in reaching a landfill site, even though more than 1 billion Pakistani rupees are spent annually by the city on solid waste management.

Karachi's waste collection is divided among the municipal councils of its five districts for the south, east, west, and center of the city, as well as Malir in the north. From these, the districts of southern and central Karachi, which encompass Karachi's most commercial and affluent regions, generate the largest amount of waste. The district municipal councils are responsible for transporting the waste to one of the two landfill sites located within the northern limits of the city. These sites are operated by the Solid Waste Management Department of the Karachi Metropolitan Corporation (KMC) and have the collective capacity of around 2,000 tons of waste per day for two decades, consequently lacking the capacity for absorbing all of the city's waste.

As Pakistan's main port city, Karachi's waste management also involves tasks specific to harbors and beaches, such as collecting and disposing of seashells on the beach. The Karachi Port Trust and the Port Qasim authorities are involved in the solid waste management of their respective ports. Similarly, industrial areas, including Pakistan Steel Mills, Sindh Industrial Trading Estate, and the Export Processing Zone, have almost autonomous control over the management of their waste. The newest port, Port Qasim, generates approximately six tons of waste per day, which is the same as the amount produced by Karachi's Jinnah International Airport. The pre-independence Ports Act from 1908 still governs the discharge of waste at the ports. While oil is frequently discharged from the ports into the sea, a considerable proportion of industrial waste from the Export Processing Zone as well as other industrial areas on the coast, like Korangi and Landhi, is still dumped in the sea. Since Landhi contains the Bhains or Landhi Cattle Colony, one of the five cattle colonies in Karachi and the largest buffalo cattle colony in the world, the majority of the waste emptied into the Arabian Sea is animal dung. In 2007, a waste-to-energy plant was opened in Landhi, funded by New Zealand Aid, with the original initiative taken by the International Union for the Conservation of Nature (IUCN). Converting the waste into biogas provides up to 30 megawatts of energy and simultaneously produces 14,000 tons of organic fertilizer.

Medical Waste

The city has more than 200 hospitals, which is the highest concentration of hospitals in the country; in contrast, the entire province of Punjab contains approximately 250 hospitals. In addition, Karachi houses about 1,400 healthcare units (HCUs), which include establishments like laboratories or small clinics. These generate more than 3,000 kilograms of waste per day, of which at least one-sixth is hazardous. Owing to limited concern and awareness, as well as the absence of strict rule enforcement by the Sindh Environment Protection Agency, less than one-tenth of the HCUs send their waste to the incineration plants set up, like the landfill sites, by the Karachi City district government. The incineration plants were only installed in 1996, and both of

Karachi, Pakistan, is one of the world's largest and rapidly growing cities, with a population over 18 million in 2007. As such, it has high levels of consumption and waste. In the shantytowns that appear haphazardly within the city (left), street scavengers and trash pickers (right) sort through trash, leading to improper treatment of waste and an increase in the city's pollution levels. Solid waste is primarily disposed of via landfills and open dumping, from which tainted water finds its way into drains, canals, rivers, and the sea.

them are located in Mewa Shah in the west. Thus, most of the hospital waste is mixed with municipal waste. Given that dumping is usually open and frequented by trash pickers and stray animals, which can also include cattle, the health risks of such disposal practices are extensive.

Organic Waste

Two of the city's largest markets, namely, the Vegetable Market and the Empress Market, generate 70 and 100 tons of waste per day, respectively, a considerable proportion of which is biodegradable. The possibility of composting such waste has triggered several initiatives. On the other hand, Karachi's high temperatures also reduce the amount of moisture in green waste that is necessary for composting. Given the scarcity of water in the city, the reduced moisture can also pose problems. Karachi's sole composting plant, the Farooq Compost Fertilizer plant, was set up during the 1980s in the northern part of the city. Because of its inefficiency and the high costs procured, the plant was eventually shut down. In 2010, one of the prominent nongovernmental organizations (NGOs) in Karachi that aimed to collect and reuse organic waste was Gul Bahao. Also functioning as a research institute, Gul Bahao buys organic waste and other items that cannot be sold to *kabaris* (the local waste dealers). This waste has been transformed into a variety of items, including fertilizer, animal feed, possible fuel for power plants, and even low-cost houses (as part of the Chandi Ghar, or Silver House, project), which have been made out of plastic waste. In addition, the Pakistan Environment Welfare and Recycling Program (PEWARP) concentrates on collecting organic waste from the vegetable market and converts the vegetal solid waste into pesticide and liquid fertilizer.

The waste from high-income housing areas contains a large amount of food remains, which is rarely the case with low-income areas. Garbage from affluent residential areas also contains a larger proportion of garden waste, like dry leaves.

Organic waste from well-off areas can amount to almost 22 percent of total waste, whereas in poorer households it can be less than 9 percent.

Household Waste

Due to the lack of awareness and means, household waste is rarely sorted. Only one-tenth of domestic garbage—usually paper, plastic, and metal—is separated in households and sold for recycling to neighborhood dealers, who then sell it to recycling plants for processing. Since many of these plants are located in the neighboring province of Punjab in the north, much of Karachi's sorted waste is sent there. A lot of plastic material, for instance, is processed in Gujranwala, and it is usually converted into lower-quality plastic products. Only one-quarter of the recycling industries are located within the city's industrial zone, the majority of which make cardboard out of wastepaper. However, such factories are ill equipped and have the drawback of causing heavy pollution.

Waste from houses is usually brought to the nearest municipal garbage containers, which are known as *katchra kundi*. Since these are almost always open, they attract trash pickers and scavengers like crows or stray dogs. While litter around the container is common, and usually the result of careless throwing, some containers overflow since they are not emptied regularly. Both trucks as well as bull or donkey carts are used for collecting the waste, none of which are covered, causing some of the garbage to fall out during the transportation process.

Scavenging

Trash pickers, who frequently live near the waste disposal sites or along the garbage transportation route, scour the garbage for metal, recyclable plastic, and glass, which is then sold for further recycling. To separate metals from other components of the waste, the trash pickers often burn the garbage, thereby polluting the air. While the total number of trash pickers in Karachi has not been calculated, approximately 100,000 are Afghans. Furthermore, a large number of children are also involved in trash picking, and it is estimated that in Karachi alone, more than 20,000 children work as trash pickers. Street sweepers are also involved in waste separation but, in contrast to the trash pickers on the landfills, they usually separate and sell paper and cardboard collected from the streets and garbage containers.

Although proposals have been made to incorporate trash pickers into the waste management system—most prominently by the Karachi-based NGO Shehri—these were yet to be implemented as of 2010. However, the success of private initiatives shows that with more widespread motivation and support, the waste management issue can be resolved in such a way as to contribute to ameliorating some of Pakistan's economic and energy issues.

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See Also: Composting; Developing Countries; Medical Waste; Open Dump; Organic Waste; Pakistan; Street Scavenging and Trash Picking.

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Kenilworth Dump

From the time it opened in 1942, Kenilworth Dump (KD) served as the waste management center for residential and commercial waste generated within the Washington, D.C., metropolitan area. In 1968,

following an incident that resulted in the death of a young boy, KD was effectively shut down, and in the early 1970s, it became a recreational area and continues as such into the 21st century. When considering the social process of consumption and waste, KD is an important discussion point because its entire history epitomizes the complexities involved in the seemingly simple practice of throwing something away.

For 26 years, the land along the eastern shoreline of the Anacostia River in northern Washington, D.C., was used for the disposal and burning of municipal waste. At the time of its construction, no physical barriers had been included to protect the river from the waste products that would migrate from KD and subsequently contaminate both the soil and water. Furthermore, by the time the Resource Conservation and Recovery Act (RCRA) was signed into law in 1976, the landfill was officially closed; KD operated without a permit for its entire existence.

Operations and Problems

The primary feature that negatively affected KD was its operation as an open burning dump site. An open dump is an uncovered space that serves as a repository for refuse, with all waste material exposed. As an open-burning site, KD created two main problems: sanitation and air pollution. Without capping a layer of soil atop the rubbish piles or using a lining system to act as a barrier between the refuse and ground—both of which are consistent with sanitary landfills—KD became a breeding ground for vermin and other pests. Additionally, the uncontrolled incineration of waste material released vast amounts of contaminated ash into the air. By 1967, roughly 80 percent of all the refuse produced in the Washington metropolitan area was being burned, while the remaining 20 percent was buried in landfills. Of approximately 1.5 million tons of refuse produced each year, an estimated 1.2 million tons were burned; and of this amount, roughly 160,000 tons were burned in open dumps, most of it at KD.

Residents had been complaining about KD for several years when the U.S. Surgeon General convened a conference on solid waste management in 1967 to address the growing problems at KD. One important conclusion drawn from the conference was that processes for dealing with safe and sanitary solid waste disposal were mainly political and economic in nature, rather than technology based. In other words, the inability to develop technology that could safely dispose of waste in a permanent manner was not the primary reason waste management practices were fraught with issues and challenges. Rather, it had to do with the lack of—and thus, essential need for—jurisdictional cooperation. For example, by 1967, Washington, D.C., disposal systems were overwhelmed by increasing amounts of solid waste—a result of both the growing population and the single-use disposability mentality that gained a stronghold directly following World War II—so simply shutting down KD without a replacement site would have been extremely difficult. Herein lies the political problem: for KD, jurisdictional cooperation was predicated on the understanding that regardless of whether one experiences the smoke from KD directly or not, everyone in the Washington community was involved because everyone breathed the same air, drank the same water, and, most importantly, everyone contributed to the accumulation of waste, most of which was burned at KD. However, deciding which existing site would take on the waste, how the materials would be transported (what routes it would be allowed to follow and through which communities it could travel), and other costs created a challenging atmosphere in which to make a decision.

Closure

Consensus held that KD needed to be closed, but translating that into reality was not so simple. To help solve the problem, the short-term solution of reincarnating KD from an open-burning dump site into a sanitary landfill was suggested and approved. However, because of various delays in the process, open burning continued past the set deadline of January 1, 1968. Then, in February of that same year, a young boy was playing in KD (KD was often referred to as Landfill Mall because it was commonplace for local residents to search through the piles of waste in search of items they could find useful) when a change in the wind pattern abruptly altered the course of a fire that had been burning

waste material that afternoon. Unable to escape the flames, the boy was killed. As a result of this incident, Mayor Walter E. Washington agreed to shut down KD. By 1970, the new sanitary landfill was nearly filled and was closed and capped with clay and topsoil. At this time, the landfill, which was owned by the U.S. government and administered by the National Park Service (NPS), comprised about 145 acres and contained roughly 4 million tons of raw refuse, incinerator ash, and other burned residue.

Continuing Contamination

In the 21st century, the KD landfill site is known as the Kenilworth-Parkside Recreation Center and features a gymnasium, swimming pool, soccer and baseball fields, and basketball courts. However, despite the goal of turning KD from something negative into something positive, the land space continues to suffer environmental damage. By May 1980, KD had successfully been turned into a park. However, in 1997, NPS permitted two companies, Driggs Corporation and Barrett Tucker Corporation, to deposit on the Kenilworth park space excavation and construction debris from their work sites. In 1998, when it had been determined that neither company had an official permit for such activities, the Environmental Health Division of the district's Department of Health issued a Notice of Violation to the NPS. A year later, additional concerns arose that the companies had dumped asbestos, polychlorinated biphenyls (PCBs), and other hazardous waste in violation of their contract. The Environmental Protection Agency, under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, Superfund), subsequently performed inspection tests, but preliminary sampling found no presence of PCBs. Despite the Superfund findings, however, issues related to remediation of contaminants in the underlying dump and questions of soil quality throughout the park continue to exist into the 21st century and have slowed the development of proposed recreational field projects.

By serving as evidential proof that open burning systems are both unproductive and unsafe, KD made an important contribution to waste management practices in the United States by catalyzing a movement away from utilizing open burning facilities. On the surface, waste seems a self-evident truth: when an item is no longer useful, it becomes waste and it is thrown away. While this is a simple process in theory, KD demonstrates the complex nature of simply throwing something away.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); District of Columbia; Incinerator Waste; Landfills, Modern; Solid Waste Disposal Act.

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Kentucky

Bordered to the north by the Ohio River, Kentucky is a state with natural amenities ranging from the Mississippi River to the west and the Appalachian Mountains running through most of the eastern half of the state. In 2010, 4,339,367 residents lived in Kentucky, with the bulk of the population clustering in the metropolitan areas on the shores of the Ohio River. Louisville is the largest city, and Kentucky is also home to Cincinnati, Ohio's southern suburbs. Kentucky's consumption and waste issues vary widely depending upon the region of the state. With such diversity, be it in Louisville or Lexington, at the University of Kentucky, or in the southeastern Appalachian coalfields, the issues facing this state vary largely depending upon location. While cities like Lexington and Louisville are making headway in recycling programs, the rural areas with industry continue to have major problems because of industrial waste. Consumption and waste problems in Kentucky are closely related to the coal mining industry. With large-scale coal min-

ing in the southeastern part of the state, Kentucky has easy access to abundant local coal. This has led to low coal prices, which in turn has resulted in cheap electricity for Kentucky residents from coal-fired power plants.

Kentucky is one of the most coal-dependent states in the United States. Kentuckians spend the same percentage of their income on electricity as residents of any other U.S. state, even though they are paying a lower rate. This means that Kentucky residents use more electricity per person than residents from other states. The cheap access encourages irresponsible energy use. Other than coal-fired power plants, the remaining electricity generation within the state is mostly provided by petroleum-fired and hydroelectric power plants. Kentucky is one of just a handful of states remaining that uses no nuclear power. With their resource-laden mountains, Kentuckians use a lot of energy with little cost and care, leading them to confront significant consumption and waste issues.

Energy From Coal

After Wyoming and West Virginia, Kentucky is the third-largest producer of coal in the United States. Kentucky is also sixth in the nation in coal power generation, with 56 operating coal-fired power plants in 21 stations across the state. In total, the state produces 16,510 megawatts (MW) of energy from coal-fired power plants.

Energy produced at coal-fired power plants is dirty business. Contributing significantly to air and water pollution, both locally and globally, Kentucky's production and consumption of coal has had destructive effects on both the environment and the health of local residents.

Coal-fired power plants are recognized as some of the heaviest-polluting forms of energy production, causing major pollution of air quality. When coal is burned for energy, a harmful pollutant gas, sulfur dioxide, is released into the atmosphere. Coal naturally contains sulfur, but when the coal is burned, the sulfur combines with oxygen to form harmful emissions. These emissions far exceed safe or natural levels of production and contribute to significant health and environmental problems in Kentucky, as well as to the growing crisis concerning global warming.

Coal in eastern Kentucky is widely considered to contain less sulfur than coal from the western part of the state. This means that the coal from eastern Appalachia is increasingly sought after, as regulations begin to further restrict the amount of pollutants that can be legally released when coal is burned. While less environmentally damaging when burned, all burning of coal emits harmful pollutants and contributes to local and global environmental problems.

Once coal is burned to make energy, large amounts of waste are left behind in the filters at coal-fired power plants. Increasing environmental standards, particularly the Clean Air Act, have regulated power plants to catch coal ash before it is released into the air during the coal burning and energy-producing process. This is beneficial to the public, as fewer pollutants are released into the communal air. However, this waste is now caught in filters at the power plants and needs to be disposed of. Known as coal ash, this waste contains extremely large amounts of dangerous toxins. In Kentucky, coal ash is generally stored near power plants or recycled for use in highway building. Some power plants store their coal ash in liquid form in man-made lagoons.

Surface and Underground Mining

Water contamination is one of the biggest waste problems associated with both strip coal mining and underground coal mining in Kentucky. While mountains naturally contain high levels of minerals, these minerals, like selenium, for example, only become harmful when the mountain's rock is detonated in order to mine coal. When the rock explodes, the contaminants and minerals are disturbed and exposed. As a result, runoff from the mining location can carry this toxin to the local water source. While there are regulations in place to try to prevent this sort of water contamination, regulations are not always followed, and dangerous contamination happens. Water contamination, in the 21st century, continues to adversely threaten the health of residents who use water affected by mining.

As coal is processed—from hard rock in a mountain to burnable fuel—more toxic waste is accrued. Some minerals are removed to increase the coal's power-burning potential. The removed mineral then becomes mining waste and is mixed with water. The

resulting mix, known as coal slurry, is a cement-like paste. Slurry is primarily stored in man-made sites near mining sites. Also referred to as coal waste or coal sludge, slurry is filled with dangerous toxins, including mercury, lead, arsenic, copper, and chromium. Coal companies generally dispose of this waste by constructing dams from the solid mining refuse to store the liquid waste. Slurry impoundments are generally located in the valleys near coal processing plants and are tenuous at best. Life threatening disasters have occurred in Kentucky because of problems with coal slurry impoundments.

On October 11, 2000, 306 million gallons of liquid slurry came pouring out of an impoundment at the abandoned Massey Energy mine site in Martin County, Kentucky. The slurry polluted hundreds of miles of the Big Sandy and Ohio rivers. Over 27,000 residents were unable to use their water, and all aquatic life in the nearby waters was killed. Heavy metals were found in the water supply, and, according to the Environmental Protection Agency, the spill was 30 times larger than the *Exxon Valdez* oil spill. As the Martin County disaster makes clear, Kentucky's relationship with the coal mining industry and their waste has led to some devastating environmental problems.

Mining waste continues to affect the region long after an active mine site has closed down. The coal-producing regions of the United States are not only forced to deal with mining waste while the mine is active but also continue to face the long-term reality of living near toxic slurry impoundments and the destroyed mountains. There may not always be a disaster or waste spill to mark the issue, but the threats of water contamination and the long-term risks of large amounts of toxic chemicals are a concern for all Kentuckians. A form of surface mining, referred to often as mountaintop removal mining, is a popular and cheap form of coal mining in Kentucky in the 21st century.

The cheapest and fastest way to get at seams of coal, mountaintop removal mining literally removes the tops of mountains in order to access the coal. These large-scale mining operations create significant amounts of waste. As the mountaintops are removed, the blown-off rock is dumped into the valleys and headwaters of streams nearby. Known as valley fill by regulators, the former mountaintops become waste material. Now laden with harmful minerals that have become exposed during the explosion process, this rock is dumped in valleys next to the mountain where mining occurred. When blasting, the technique changes the chemical composition and the physical structure of the ore or mineral. This waste then resides at the heads of streams and disrupts the local water flow and source.

Consumption and Waste Management

Kentucky's per capita consumption of residential electricity is among the highest in the United States. In Kentucky, the cheap price of coal makes coal-fired power plants the most popular form of energy for electricity. The U.S. Energy Information Association (ETA) claims that coal accounts for more than 90 percent of the electricity produced in Kentucky. This makes Kentucky one of the most coal-dependent states in the United States. According to the ETA, the remaining electricity generation within Kentucky is mostly provided by petroleum-fired and hydroelectric power plants. Kentucky's per capita energy consumption is ranked seventh in the United States, making the 462 million BTUs of per capita energy consumption a large part of the country's dependency on fossil fuels.

Waste management in Kentucky is regulated by the Waste Management Department within the state's Department of Energy. The Waste Management Department is the largest department in the state. All counties across the state claim to offer universal collection of residential solid waste. Counties are given the freedom to contract with private waste management companies, allowing county governments to have leverage in the costs associated with pickup.

Individual energy consumption rates in Kentucky are high, and Kentuckians also produce a lot of garbage. This is in many ways linked to the mining industry. Kentucky's extremely cheap garbage disposal costs are kept low because of the 35 years of already-permitted landfill space awarded to the Waste Management Department. The availability of landfill space on former strip mines continues to keep prices low. Permitting for landfills at former strip mining sites is generally much less difficult than on previously undamaged land. The land has

already been disturbed and deemed "worthless," and officials are unlikely to challenge permits.

Recycling efforts in Kentucky continue to grow. Increasing from 29.5 percent to 34.6 percent in 2008 for common household items, the government sees recycling as an important area for improvement. Many Kentucky counties have been receiving help from state grants to invest in the capital-intensive machinery required for recycling centers. Kentucky was above average in per capita household recycling rates as of 2010. The state is continuing to facilitate the further development of recycling infrastructure into the 21st century. Kentuckians must recognize that if the per ton cost of garbage continues to remain as low as it was in 2010, the recycling effort will remain ineffective.

Kentucky is a state confronting many of the contemporary evils associated with an economy and population heavily dependent on fossil fuels. As a state with diverse regions with very diverse needs, it is important to think about the way Kentucky can move forward in more sustainable ways. Because of low electricity rates in the state, Kentucky has encouraged energy-intensive practices by producers, consumers, industries, and residents. In order to reduce consumption of energy, preserve the undamaged landscape, and begin to restore the already environmentally devastated areas, the state government needs to take leadership. Regulations are changing, and Kentucky will continue to be at the center of this conversation because of its vast coal resources and irresponsible consumption and waste practices.

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See Also: Clean Air Act; Clean Water Act; Coal Ash; Mineral Waste; Pollution, Water.

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Kolkata, India

Kolkata (Calcutta) is the capital of the Indian state of West Bengal. Kolkata was once the wealthiest and most opulent city in India, the center of the British East India Company, and the second-largest city in the British Empire after London. In the 21st century, with some of the worst air pollution in the world, Kolkata epitomizes the popular image of the third world city, ravaged by industrialization, overpopulation, large-scale poverty, agricultural stagnation, political instability, and weak environmental regulations. At the same time, the city is a bustling hub of revolutionary politics, literature, arts, and film. Kolkata has been an industrial center since its foundation, from jute production in the mid-1800s to 21st-century information technology, electronics, and petrochemicals.

History

Kolkata is situated on the east bank of the Hooghly River and serves as an important global seaport. Located on a vast wetland, the small Bengali village of Kalikata was occupied sequentially by French, Portuguese, and British traders. In 1690, Kolkata became a trade settlement for the British East India Company. By 1698, the East India Company bought Kalikata and two adjoining villages from a local landlord and began developing Calcutta. In 1772, Calcutta became the capital of British India, and the Crown relocated all administrative offices to the new city. In 1912, after several nationalist uprisings, the British colonial government moved its capital to Delhi, which is still the capital of postcolonial India. Calcutta was the center of revolutionary politics during the movement for Indian independence, and it continues to have active leftist and trade union movements. The city is also home to the longest-running, freely elected communist government in the world. In 2001, the city was renamed "Kolkata" to break with colonial heritage and better reflect Bengali pronunciation.

Once the center of British opulence and oppression, Kolkata still provides a sensory overload for visitors. Kolkata is often described in the pejorative: a corrupt, dying, and decaying city. Thousands of people live in the streets, fixing their tarpaulin ceilings to the iron gates of colonial-era villas. Popular

literary representations of the city, including those of Claude Levi-Strauss, Dominique Lapierre, and Günter Grass, describe Kolkata as an urban disaster, filled with street-dwelling, emaciated bodies teetering at the edge of survival. Kolkatans attribute the popularization of this negative stereotype not only to Western authors but also to the work of Mother Teresa and her Missions of Charity, whose Nobel Peace Prize brought global attention to the destitution of Kolkata. Despite the protests of many of Kolkata's residents, contemporary press accounts of life in Kolkata draw Western audiences' attention to the poverty, chaos, and disease of the city.

In the mid-1800s, the areas surrounding Kolkata were described as jungle with a few intermittent villages. In 1855, the first Indian jute mill was founded in Kolkata, and by the early 1900s, Kolkata jute production surpassed European production. Since jute was used to make gunny sacks, burlap bags, and other packing materials, jute production in Kolkata expanded along with other British export enterprises such as opium and tea. The jute boom continued through World War I, after which additional industries such as tanneries, glassworks, ceramic factories, chemical plants, and textile mills began to dot Kolkata's periphery.

A hand-pulled rickshaw carries a customer through the streets in Dalhousie Square South, Kolkata. Many migrants have sought employment in Kolkata. While some have found industrial jobs, others struggle as rickshaw pullers, ragpickers, or street sweepers.

These factories were constructed to the north and south of the city, particularly along the Hooghly River. West Bengal's rural coalfields fueled Kolkata's growing industries.

After India's Partition in 1947, refugees from East Pakistan (now Bangladesh) fled to Kolkata and sought work in the factories of the city. According to official censuses, Kolkata's population grew from 4.4 million in 1961 to over 15 million by 2010; however, since many migrants from within West Bengal maintain ties to their ancestral rural villages, these population estimates neither adequately account for these migrant populations nor properly represent migrants who live in small informal settlements, know as *bustees*. Migrants from other economically depressed Indian states, particularly Bihar and Orissa, come to Kolkata in search of employment and are also not counted in official censuses.

Many argue that Kolkata's industrial areas have changed little since the British-led industrial boom of the late 19th century. Bustees in the industrial areas that surround the city have little ventilation, open drains, few toilets, and minimal municipal facilities. Continued political strife and the decline of traditional smallholder agriculture in rural West Bengal have driven people to the city to find food and work. While some find employment in the industrial sector, others work as rickshaw pullers, street scavengers, or informal "sweepers." Responding to the protests of wealthier Kolkatans who resent the influx of migrants, city officials have organized the demolition of bustees in or near the city center. As a result, many bustee residents often become pavement dwellers.

Waste Disposal

There is little formalized solid waste management in Kolkata. Waste is carted to open pits, or "dust bins," which also double as public toilets. For pavement dwellers and bustee residents, street scavenging in and around these bins has become a common way to make a living. Street scavenging also helps the municipality, which permits the practice because of the amount of waste scavengers remove. The same officials that drive bustee residents into the streets rely on them to help contain municipal waste.

Kolkata's only sewer system lies in the city center. The bustees surrounding the city are not attached to

the sewer system. During the monsoon, the city center floods when drains and sewers overflow, forcing Kolkatans, rich and poor, to wade through waist-high contaminated water. Kolkata is surrounded by marshland, which acts as the city's primary sewage treatment facility. In the 21st century, both government and nongovernment agencies have begun to develop and support wastewater-fed aquaculture within fisheries in the wetlands. If successful, feeding wastewater to fish could simultaneously solve the sewage problem and provide local people with seafood, which is a staple in Bengali cuisine.

Pollution and Health Problems

Many Western accounts of Kolkata focus on the air and noise pollution caused by the fleets of yellow Ambassador taxis (remnants of colonial-era transportation) or the speeding municipal buses. Air pollution caused by cars, buses, and auto-rickshaws is significant; however, local Kolkata development workers and environmentalists argue that while the danger posed by transportation is great, the municipality is ignoring the pollution caused by the city's numerous coal-fired power plants and factories. Coal mining is a major industry in India and West Bengal, and there is minimal national or local government initiative to place environmental controls on these factories and power plants.

A study by a prominent Indian research organization, the Chittaranjan National Cancer Institute (CNCI), highlighted the alarming incidence of lung cancer in the city and tied this directly to air pollution. The rates of suspended and respiratory particulate matter (SPM and RPM) in Kolkata are high, even compared with other Indian cities, often exceeding safe levels (140 for SPM and 60 for RPM) by two to three times. Street dwellers, hawkers, and scavengers are the worst sufferers, as they spend most of their days in congested intersections where the air pollution is most concentrated. The CNCI study claims that close to 80 percent of street dwellers have deteriorated lung function or damaged lungs.

Kolkata's lung cancer incidence is far higher than that of Delhi, the country's capital and largest city. In Kolkata, the rate is at least 18.4 cases per 100,000 people, compared to Delhi's 13.34 cases per 100,000, according to the CNCI study. In the 21st century, Indian cities have felt strong pressure from government agencies and the High Court to reduce air pollution; however, unlike Delhi, Kolkata had not been able to significantly reduce its air pollution bys 2010. In May 2005, the Indian government ordered all vehicles in Kolkata manufactured before 1990 to convert to greener fuels such as liquid pressurized gas (LPG). Had the government followed through on this directive, nearly 80 percent of the city's buses, many of which are city owned, and nearly 50 percent of taxis and auto-rickshaws, would have been taken off the streets. Arguing that the ban would cripple the city's transportation system, the Kolkata High Court quashed the central government's mandate.

It was not until August 2009 that the municipality began to crack down on polluting vehicles. City managers and activists are using initiatives like the curbs on vehicle emissions to improve infrastructure and sewage and join other Indian cities such as Delhi and Mumbai in rectifying decades of unregulated consumption, waste, and urban expansion.

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See Also: Automobiles; Delhi, India; Developing Countries; Emissions; India; Mumbai, India; Noise; Power Plants; Public Health; Slums.

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Laidlaw, Inc.

Laidlaw, Inc., was a multifaceted company providing tour and transit passenger services, healthcare transportation, and waste transportation in the United States and Canada. Traditionally a waste management company, Laidlaw, Inc., divested itself of waste collection in the 1990s and served this sector through a 35 percent ownership of Safety-Kleen Corporation (formerly Laidlaw Environmental Services). Safety-Kleen was involved in collection and recovery services, treatment and disposal services, and landfill services. In 2007, First Group plc., the United Kingdom's largest surface transportation company, acquired Laidlaw International, which had become one of North America's largest providers of school and intercity bus transport services and a leading supplier of public transit services with companies including Laidlaw Education Services, Greyhound Lines, Greyhound Canada, and Laidlaw Transit.

Laidlaw Transit was named after Robert Laidlaw, who started a small trucking company in Ontario, Canada, in 1927. In 1959, Michael DeGroote purchased Laidlaw Transit for $300,000, keeping the established and respected Laidlaw name and turning it into a multiservice transportation firm. In 1969, Laidlaw, Inc., went public, and by the time it was sold in 2003, it was Canada's number one growth stock for 17 straight years. Laidlaw was North America's largest solid waste disposal and hauling, chemical and hazardous waste management, school bus, and public transit transportation industry. The owner, Michael DeGroote, a self-made millionaire twice over, has been involved with all of the major waste haulers, including Republic Waste Industries, Allied Waste, and Browning-Ferris Industries. It is impossible to discuss the emergence and challenges of modern solid waste management without discussing Laidlaw, Inc., and DeGroote.

1970s and 1980s

In the 1970s, increased environmental awareness and subsequent environmental regulation coupled with a declining economy to create the rise of the modern solid waste industry. The era of the trash crisis was initiated as stricter landfill regulations and governmental oversight precipitated the closing of many municipal dumps, opening the market for competition among waste transportation companies. In the United States, stricter regulation, including the 1976 Resource Conservation and Recovery Act (RCRA), fostered a situation whereby municipalities could no longer afford to upgrade or build

new facilities to meet the more stringent standards. Concern over a lack of landfill space further opened the market for private corporations to turn waste into an economic commodity through interstate commerce and transportation.

Laidlaw, Inc., was at the forefront of waste transportation because DeGroote saw trash disposal as a basic need, making it a "recession-proof" industry. Laidlaw became one of the first vertically integrated solid waste companies by handling waste hauling, landfills, hazardous waste, and other methods of disposal. Laidlaw grew through acquisition of smaller companies, drawing criticism for aggressive takeovers, instead of using partnerships. By 1978, Laidlaw, Inc., had become a major player in the U.S. solid waste industry and the U.S. school bus and public transportation industry. By 1988, when DeGroote sold his controlling stake in Laidlaw to Canadian Pacific, it had become a world leader in several industries. DeGroote went on to become the head of Republic Waste Industries, a competitor to Laidlaw, Inc.

1990s

In 1990, Laidlaw, Inc., was listed on the New York Stock Exchange, where it continued to grow by acquiring school bus, public transit, security, emergency, and solid waste contracts, including Mayflower; National Bus Service; Greyhound Lines' U.S. operations; Safety-Kleen; and Attwoods, a UK waste management company. Like the small municipalities and haulers before them, Laidlaw, Inc., and other solid waste corporations were impacted by increasingly tougher environmental laws and oversight. However, Laidlaw, Inc., had the added burden of acquiring too much debt along with companies and, in 1999, started to take corrective action, including getting out of the solid waste industry.

2000s

In 2000, Laidlaw was the key player in two precedent-setting legal actions. In these lawsuits, Laidlaw has been said to represent the problems of the solid waste industry at the time. In *Friends of the Earth, Inc. et al. v. Laidlaw Environmental Services, Inc.*, the U.S. Supreme Court held that residents in the area of South Carolina's North Tyger River could sue Laidlaw Environmental based on the fact that the residents alleged they would have used the river for recreational purposes but could not because of pollution. Despite the fact that Laidlaw Environmental claimed the case was moot because they had closed the factory responsible for the pollution, the court agreed with Congress that civil penalties in Clean Water Act cases do more than promote immediate compliance by limiting the defendant's economic incentive to delay its attainment of permit limits—they also deter future violations.

In 2002, Laidlaw defended securities fraud class action litigation that alleged the company and the other defendants disseminated false and misleading financial statements and press releases concerning the company's financial condition. In 2003, Laidlaw settled a class action lawsuit that alleged that Laidlaw's corporate officers had misrepresented the financial condition of the company. Soon after, Laidlaw declared bankruptcy and became Laidlaw International.

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See Also: Browning-Ferris Industries; Canada; Clean Water Act; Mega-Haulers.

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Landfills, Modern

Next to incineration, the disposal of solid waste by landfilling in quarries or via artificial hills constitutes the oldest form of disposing of waste. The Romans created the Monte Testaccio in Rome, a 35-meter-high hill created by the shards of containers that were used to merchandise goods such as

wine, oil, and grain. Albeit grown in dimension, modern landfills will similarly last as memorials of the 20th-century consumption culture. The Fresh Kills Landfill of Staten Island, New York, which from 1948 to 2001 absorbed New York City wastes and was then briefly reopened to handle the debris of the World Trade Center after the September 11, 2001, attacks, was said to be the world's largest landfill and can be considered to be the largest human structure ever built.

Modern landfills, conceived as controlled, hygienic, and applying modern engineering principles, accompanied the rise of modern mass-consumer society, but the wild, crude, or uncontrolled dump also proliferated. At first placed in the urban periphery, landfills served to absorb the growing waste amounts produced by urbanites. Although landfills for a long time were considered to reclaim land, their placing also was an issue of environmental injustice, when poor areas were chosen to absorb other people's trash. When ruralists turned into consumers in the postwar boom years, landfills also encroached into rural areas, in particular, in their crude form. Seen over the course of the 20th century, the changing discourse on and the changing practices of landfilling reflect major turning points in the history of city–periphery relations, of public health and hygiene, and in the history of environment and consumption.

Beginnings of Modern Landfills

Disposing of leftovers and street cleanings on dumping sites for a long time resembled a natural process. As long as wastes consisted of organics and minerals, dumped in small piles, they would turn into a sort of "waste humus," which local farmers would then use as dung or soil conditioner. The distinctions between dumping and producing this so-called waste soil were vague, as long as both practices were devoid of specific methods and the fermentation process was yet unexplored. Moreover, in many regions, ancient landfills were exploited to retrieve the fermented soil and fresh waste was used to reclaim land, for example, by filling it into previously idle wetlands or by creating artificial hills for sports and recreation. The engineering method of modern landfilling was rooted in such practices, even though the 19th-century sanitary movement had hinted at the hazards of water and soil contamination by waste piles.

In the 1920s and 1930s, the "sanitary landfill" and "controlled tipping" were developed in the United Kingdom and United States, and France developed the *dépôt contrôlé*. These novel landfilling concepts were supposed to modernize tipping, which became considered as unhygienic or wild. The main alterations between the traditional and the modern landfill initially consisted of (1) the use of mechanical traction for transport, tipping, and planning; (2) the method of dumping in compacted layers; and (3) the regular—at best daily—covering of the wastes with soil, ashes, or dirt in order to reduce vermin, smell, fires, and wind-blown litter. In addition, some forms of waste compaction were practiced, and scavengers were increasingly banned from the landfills' territory.

While up to the 1960s, the trenching method was often undercut, the regular covering with dirt finally constituted the chief distinction between control, hygiene, and engineering principles versus disorder. Because modern landfills were assumed to feature hygienic conditions (which, however, never existed and were approached only by the adoption of insecticides, among them DDT), they were sometimes sited next to residential zones. The main advantages ultimately lay in cost-effectiveness, low investment costs, and the possibility to run a landfill with just a few workers and an excavator, or, later on, a bulldozer. Besides, modern landfills were used to gain land, for example, in Robert Moses's 1930s sanitation, reclamation, recreation plan for New York.

European Landfills

Controlled tipping was pioneered in 1915 by the city of Bradford, England. In United Kingdom (UK) cities, incineration was largely in place, but the new method promised to provide a cheaper means of disposal. During the following three decades, it would turn into the dominant method of UK municipal waste disposal. State regulations described its modes of operation, ruling, among other things, that the waste layers should measure less than 1.8 meters (about six feet), the covering was to be applied at least every 24 hours, and the covering should measure about 0.25 meters (0.8 feet). Each waste layer

should rest for some time to let it ferment and sink down before the next waste layer was to be spread on top of it. Later on, inclined layers were applied. French engineers and hygienists visited the Bradford landfill just before siting the first French *dépôt contrôlé* in Liancourt-Saint-Pierre in 1935. It received waste from the capital of Paris, roughly 37 miles away, for which additional and less-distant landfills were soon installed. On French controlled tips, the new waste layer should be applied only after the temperature of the old waste layer had declined to that of the surrounding soil, thus indicating that fermentation had reached its peak. Other continental European countries—or, more accurately, their cities—did not implement modern landfilling until the 1960s, or even later. European engineers studied the site of Bradford and, to a lesser degree, that of Liancourt, but not the U.S. model. Some European waste experts assumed the European model to be superior, since it was said to guarantee an aerobic fermentation process. The latter was a centerpiece in interwar UK and postwar European landfill concepts, for it would destroy pathogen germs and render putrescible matter into harmless, even valuable soil.

U.S. Landfills

In the United States, the first sanitary landfill opened about three miles away from Fresno, California, in 1937. The landfilling site was closed in 1987 and subsequently designated a National Historic Landmark. The concept soon was also used in New York and San Francisco. During World War II, the method was practiced and improved by the U.S. Army. Members of the military's Corps of Engineers, as well as the U.S. Public Health Service, spread this knowledge throughout the country. After then, and similar to the United Kingdom, sanitary engineers praised the sanitary landfill as the universal solution of the waste problem. In the 1950s, the first manuals and guidelines were formulated by organizations such as the U.S. Public Health Service, the Sanitary Engineering Division of the American Society of Civil Engineers, or the American Public Works Association. These would describe the method as a safeguard for public health, since it was said to avoid all the nuisances produced by wild tipping. In retrospect, the U.S. sanitary landfill method and its appraisal were similar to the UK or French cases. What distinguished them was mainly the waste. Since U.S. waste contained more packaging and paper, landfilling applied more compression, which became an issue in Europe only after the 1960s.

Alternatives

Even if French engineers were among the pioneers of modern landfilling, in the postwar decades, incineration and composting were the two primary engineering methods of waste disposal until the early 1960s. The same is true for the West German waste experts' discourse. By then, because of an exponential increase in waste volumes and changing waste contents, there was a wide understanding that modern consumer societies were in need of modern landfills, since incineration and composting also left behind leftovers such as slags and nondegradable rests. Novel plastic wastes yielded problems in incineration, but they were seen as inert—and, thus, as innoxious as glass powder or stones—for landfills. Detached from the waste experts, the daily practice of municipalities was predominantly mere crude dumping.

Modern Landfill Challenges

Since the 1960s, waste experts and politicians have advocated modern landfilling, mainly as a tool to limit wild tipping and to site new landfilling space, which had become a problem due to a shortage of space and citizen resistance. European cities had experienced a shortage of close-by dumping space for some time already, and, in the United States, siting became problematic during the 1970s. In the long run, a decreased number of large, centralized landfills substituted for the many small, wild landfills, which resulted in longer transport distances, or, in the case of the United States, in interstate waste transport. Modern landfilling was further regulated, while applied treatment technologies had hardly been advanced. The regulations—in West Germany by means of sanitary guidelines, in France by means of a 1963 Circulaire, and in the United States in connection with the 1965 Solid Waste Disposal Act—resulted from previous legislation on water protection. Accordingly, a controlled landfill mainly meant to choose a site under geological and hydrological considerations so as to exclude potential contamination of water sys-

tems. Spontaneous fires, smoke, dust, vermin and flies, and wind-blown drifts of waste were normal occurrences on controlled landfills. Nevertheless, landfilling still was considered an issue in urban planning, greening, and recreation.

A further challenge of modern landfilling lay in compacting and homogenizing the solid waste. Household waste was less dense than in the 1930s. The latter had consisted mainly of ashes and humid organic leftovers, while paper usually had been burned in domestic fireplaces and scrap had been given to ragmen. Together with the arrival of the so-called throwaway society and its packaging, such as the one-way glass—and later plastic—bottle, waste volumes were rising at a faster rate than waste weights. In addition, municipalities began to entomb bulk waste, car tires, and industrial wastes. Industrial waste was turning into a major municipal concern, and waste became classified according to potential hazard levels, with special landfills for toxic wastes.

To compact and homogenize the heterogeneous waste masses into the desired layers of the average sanitary landfill, mills and successively specialized compactor engines were introduced in landfilling. Despite the substantial change of waste contents and despite known accidents caused by methane emissions stemming from anaerobic decay, the intractable paradigm of an aerobic fermentation that would prevail in the guts of modern landfills still persisted.

New Technologies

In contrast to its naming, until the 1970s, modern landfilling was lagging behind the scientific and technological progresses realized in the production, distribution, and consumption of those goods it would absorb. Both crude and modern landfills had never been closely studied over time, and no scientific scrutiny had been conducted on their inner processes or long-term effects.

Modern landfilling can be interpreted as a genuine experiment that was conducted under real conditions and that carried unknown results. Only since the 1970s were science, technology, and professionalism applied to landfilling. The beginning ecological era came along with a rise in environmental awareness. Besides, next to municipalities, the state became a main actor in landfilling and funded research and data collection or issued waste abatements. In the United States, for instance, the 1976 Resource Conservation and Recovery Act imposed criteria for groundwater protection and landfill gas migration control. As a consequence, in many countries, the 1970s constituted a crucial era of retooling modern landfilling. Recent explorations of ancient landfills had indicated slow degradation processes and the importance of anaerobic fermentation. Decade-old paper was conserved, while plastics showed signs of disruption. Hence, waste experts became aware that modern landfills represented long-term storage, rather than transient reactors—a fact that anthropologist William Rathje explored from the late 1980s onwards in his archaeological surveys (or *garbology*) of modern landfills.

Landfill engineering now included mineral as well as plastic liners, diverse containment structures, leachate collection, and drainage systems. Eventually, the concept of the perfectly isolated landfill was developed that would physically encapsulate the waste and thus inhibit any contact with the circumjacent water, air, or soil. As a reaction to leakage water occurrences, multiple barriers were used to hermetically seal the bottoms of landfills; to seal the top, among others, plastic foams were tested.

Retooled in such ways, the modern landfill was said to resemble the most environmentally friendly disposal method, since no interaction between waste and its environment would occur. This proved to be an illusion, and sanitary engineers soon realized that landfills needed decade-long aftercare procedures due to ongoing interior reactions and the need to extract methane. Many modern landfills that operated at the end of the 20th century had been installed before these new paradigms gained influence, and they thus lacked a coherent avoidance of pollution by leachate. Next to aftercare plans for current landfills, the remediation of old landfill sites has turned into a further field of waste management.

Due to its simplicity and cost-effectiveness, landfilling—both wild and controlled—remains the most common way to treat waste in the early 21st century. Meanwhile, its adversaries have added its

methane emissions to the long list of potential environmental hazards, while its adherents keep alluding to the need for sinks to hold unavoidable leftovers. Or they envision—in line with the previous exploitation of waste earth from old dumps—landfills as mines for future exploitation, for the recovery of gas, or of materials such as plastics and metals. In the beginning of the 21st century, the United States landfilled more than half of its municipal waste. In developing countries, most waste is landfilled, often with interposed scavengers who sort out recyclable materials. In European countries, where European Union (EU) politics put recycling on top of the five-stage waste hierarchy (reduce, reuse, recycle, recovery, and disposal), the percentage of landfilled waste differs greatly, amounting to more than 70 percent in Greece, the UK, or Portugal and to less than 20 percent in the Netherlands, Denmark, Belgium, and Sweden.

The EU hurried to find a coherent waste treatment regulation, and, in 1999, the European Landfill Directive was issued. This directive asks the member states to apply strict requirements for future landfilling, such as aftercare plans or the pretreatment of waste before its tipping to destroy any organic content. High landfilling taxes are supposed to provide compliance incentives for the favored waste policies. Europe's largest and oldest open landfill in Entressen, in the French Crau plains, measuring about 80 hectares of dumping surface and emerging from an agrarian reuse of waste as humus that Marseille had begun there in 1912, only closed in 2010.

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See Also: Composting; Garbology; Packaging and Product Containers; Paper and Landfills; Trash to Cash.

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Lighting

The introduction of artificial light has allowed humans to extend their ability to perform tasks. This basis became externalized in urban building patterns that gave rise to the street light as an organized system of lighting.

Ancient Lighting

Lamps have existed from ancient times. An example is the Inuit oil lamps, admired for their wide range of heat and light, a by-product of the relationship between hunter and prey that provided critical fuel for heat and light for people living beyond the Arctic Circle year-round.

As early as 5,000 years ago, architecture became formalized for a significant section of cities, and the desire and need for rooms to have lighting after nightfall led to a market for early candle factories. This also extended to fine oils for lamps. Resources for these lighting products are examples of early biofuel use and came from cattle and other animals as tallow, a waxy fat, and from certain plants from which burnable oils were pressed. Waxes were learned about over time and incorporated as the major component by many candle makers, along with scents and specialty wicks from certain fibers.

Candles can be made in sizes that burn in tens of days, or are gone in minutes, and, while ancient

in technology, are still preferred for the atmosphere they deliver as they illuminate for an intimate meal or other gathering.

Industrial Age

Candles were not very practical for the steam-powered Industrial Age. Cities have long been susceptible to fires that spread catastrophically. The Industrial Age brought new fuels, including gases, and also brought many refinements. These improvements came in the form of woven wicks, reflectors, glass globes and lamps with control of both oil and air, and, most important, with lenses, a practical way to control beams of light. Light physics is tied to lighting and illumination, and lenses became a way to amplify the effectiveness of the lumens by defining the focal length and shape for a desired purpose.

Early Industrial Age light physics produced focusing and diffusing lenses and mirrors, then the Fresnel lens design. This lens is so efficient in the parallelization of light from an oil lamp or candle that it quickly became a standard in lighthouses to extend their feeble flame into the night. Good use can be made with this design today in solar collectors, concentrating the light and producing 1,315 degrees Celsius/2,400 degrees Fahrenheit temperatures on a clear day from a thin plastic lens of 2 square meters, with output about 750 watts at the focal point, 2.5 cm in diameter.

With early direct current (DC) came the solution lab battery, then a damp mixture called a "dry-cell," a self-contained battery in a casing common as a 6-volt size, so reliable and efficient that even today they are used globally. These early batteries, and others that ended up powering the electric hand torch in sizes from AAA to D, supplied an eager, growing industrial society where electric lighting allowed processes to continue through the night. But these needed a bulb.

Thomas Alva Edison is a name still known for electricity, and his development of the incandescent light bulb was the major event in modern lighting. His lightbulbs soon became widespread for a variety of uses, from room lights to street lights, replacing the gas lamps of the era, and then made into small hand torches.

Soon the "electrical" world became politicized, and in the battle for networked power, Nikola Tesla's alternating current (AC) became the standard on transmission lines. Today, nearly all generation systems have been built for AC. By losing less power over distance, AC allows generators to be miles away from where the current is needed, but is not very energy efficient when the end use is to heat something.

Over time, lighting has taken many forms for many uses: from lighting for photography and movies to industrial lighting for machine automation and control. Lights are used to add energy to a scene, and to fulfill illumination requirements whether to set a mood or to see a can on a conveyor.

Heat Pollution

From the point of view of sustainability, the present use of power for lighting is the main concern as it relates to waste, in this case defined as "heat pollution," "heat not used in a process and released to the environment," or "entropy." Entropy comes from not using the heat as it moves from the source to the end use, so any heat not used is lost forever from the system. Incandescent bulbs release a lot of energy as heat for the amount of illumination that is returned.

What this means, in terms of heat pollution or waste heat, is significant on a large scale, because lighting uses a massive amount of energy. To reduce both heat emissions and the amount of electricity needed for lighting, it becomes important to look at using fluorescent tubes, modified to be usable replacements for standard bulb sockets and uses. Their trace mercury is the drawback, but their lumens per watt efficiency, along with a long life expectancy versus incandescents, are benefits.

Efficiency

Lighting a home using electricity suffers losses in terms of wasted heat at every transformation, generator, or inverter. There are massive losses in original heat output to create that much electricity per hour from a process 50 percent efficient at best. Converting power to lumens is costly, and while an offshoot of solid-state products has been the development of a practical light-emitting diode (LED), their costs are a concern.

These devices turn amperes into lumens at much higher rates than ever thought possible and part

of their importance is that they light a home using photovoltaic-battery systems very well and so are very appropriate to use in a macroeconomic view. The LED, if it can be made for significantly less per unit, is ready to eliminate the need for an antiquated and expensive system developed a century ago when resource management and energy efficiency were not yet conceptualized.

The greatest advancement in lighting came with solid-state materials that led to the LED, which greatly reduces the watt-per-lumen ratio. This is an ongoing field, and as organic LEDs (OLEDs) have become feasible, any of these can be integrated into products for assorted lighting needs. The speed of development in off-the-grid illumination products for housing is advancing quickly within the LED industry. Many nations have initiatives for innovation and progress in energy-conserving products, and using renewable processes and methods is becoming an economic advantage over the ever-increasing costs of using nonrenewable resources or thermodynamically wasteful processes in the marketplace.

Lighting in the future may well be based on quantum physics and solid-state developments in materials and manufacturing methods to deliver even more lumens-per-watt-per-unit-cost, so that photovoltaics (PVs) will more easily supply home lighting. New LED lightings that run on rechargeable batteries are pragmatic and cost-effective for homes never wired for electricity, as is the case in most of the world's housing. For existing homes, luminaires—LEDs arrayed to act as standard lightbulbs—are being worked on in practical sizes, and reducing costs is the priority.

Today, industrial designers and architects are faced with the choice of energy status quo in their work or the move to far less costly ways of providing light. This can be from physical sun ports or openings in the roof to light hallways, the placement of windows and doors, anything that can supply energy-neutral modern living. Because of this and from the push for hybrid vehicles, new lithium batteries will end up in many household items. These fast-charging batteries are replacements, and, with

Luminaires, LEDs arranged to function like standard lightbulbs, are being developed for practical use. LED lights requiring only rechargeable batteries to run are pragmatic and cost-effective for homes that are not wired for electricity, which is common in most of the world. Fast-charging lithium batteries are projected to become more commonly used in household items, and when used with LED technology will enhance the usability and cost effectiveness of both products.

LEDs, become even more effective for the people depending on them. Product lines that are helping this transition are replacements for common lightbulbs with LED models, a critical issue in sustainable product design and where high costs prevent the technology from filtering down to where it can have a statistically significant impact on thermal emissions reductions globally.

The percentage of power used only for lighting would be hard to estimate, from oil lamp and candle to industrial assembly lines, yet all of it is thermally expensive to produce. As a recent U.S. National Aeronautics and Space Administration (NASA) Earth Observatory image at night of the Nile Delta artfully captured, some lighting is so intense that it can be easily seen from space, a huge expenditure of energy pointing to why lighting is a primary energy conservation issue. Nearly half of all energy use can be associated with lighting and illumination.

Conclusion

An electricity grid sprawls over thousands of kilometers, involves capital expense and ongoing costs of all that infrastructure, and has effects on sedimentation and runoff. In contrast, an onsite system in the home collects, stores, and uses solar power for much of its electricity, along with microgeneration for high-current needs. An important issue with respect to lighting is the true return per lumen for an original watt of power used to create it, and the impact to the environment in the delivery of those lumens to where they are being used.

Like Telsa's AC versus Edison's DC, from a cost standpoint, the LED-battery system is far better, and the realistic ratio in cost-per-watt-per-lumen is 100 times more for watts over-the-wire than a simple PV-battery system, once refined. While lighting is not the primary use of power worldwide, eliminating the need for over-the-wire power for residential use will mean a great gain in thermodynamic efficiency to conserve heat.

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See Also: Economics of Consumption, U.S.; Household Hazardous Waste; Industrial Revolution; Sustainable Development.

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Linen and Bedding

Linen and bedding make up a large component of the textile industry. Household textiles, or soft furnishings, are fabrics used in the home. The term *linen* is also used to classify bath towels, dish towels, table linens, sheets, pillowcases, mattresses, blankets, comforters, and other bedding. These materials are not only used in private residences but are also found in vast quantities in hotels, hospitals, office buildings, restaurants, nursing homes, and countless additional commercial establishments. The textile industry is one of the largest industries in the world.

The volume of textiles produced to support 21st-century society has a large impact on the environment. The processes and materials used to create and eventually destroy these fabrics require a great deal of resources, energy, and space.

Environmental Impact

The production of textiles releases several forms of pollution into the environment. Unconverted raw materials, by-products of the manufacturing process, and shipping of the finished products release solid, liquid, and gaseous pollution into the water and air. Textile manufacturing consumes water, fuel, and chemicals in a complex sequence of processes that vary depending on the type of fabric being produced. The main environmental problem during the production phase involves contaminated water, but air pollution and excessive noise or odor also impact the health and safety of workers.

Textiles undergo a series of processing steps, and different products create different waste streams. The variation in type of fiber used to create the product, the dyes and chemicals used, and the technology of the facility producing the material all

impact the amount and type of waste generated. In the case of linen and bedding, cotton and polyester are most commonly used, but bedding incorporates many different fabrics.

Natural fibers have the greatest environmental impact during the growth and harvesting of the raw materials. Synthetic fibers have the greatest environmental impact during processing, when large quantities of chemicals and energy are being used. There are many stages in the life cycle of both natural and synthetic fibers.

Growing the crops to create household textiles is resource intensive. Cotton plants are the most pesticide-intensive crop in the world, but any plant used to create textiles uses agricultural land that could be used for food. Fertilizers, herbicides, and pesticides applied to crops of cotton, jute, bamboo, and flax (for linen) contaminate soil and groundwater. Animals and insects are also exploited to harvest wool, fur, leather, and silk.

Harvesting the raw materials uses additional chemicals in the application of defoliants to the plants and the exploitation of cheap labor or use of fuel-powered machinery to gather the materials. Production cleaning of the raw fibers uses detergents, soaps, or bleaches and creates waste by-products that are shipped to a landfill, and the machinery to perform these tasks uses fuel or electricity. Noise and dust are frequently health issues with employees in the plant.

Additional processing to create fabric from the fiber results in toxic fumes and by-products from dyes and finishing chemicals. Heavy metals used to fix dye to fabric or solvents to seal waterproofing to material also contaminate wastewater, which often flows into local rivers. Virtually all polycotton (polyester/cotton blends), especially bed linen, and any garments labeled "wrinkle resistant," "easy care," or "permanent press" are treated with toxic formaldehyde to give them that quality. Much of this industry has been shipped overseas, where labor and resources are less expensive and environmental health and safety regulations are often lax.

Synthetic fibers consume finite resources such as petroleum, coal, and oil in their creation. The by-products eliminated during the production process are often toxic and require extensive treatment before being released into the waste stream. Air pollution is especially prominent when these substances are in use. After the textiles are created, there is additional waste and pollution generated as the linens, garments, and other household products are fashioned. Packaging and shipping the finished products by land or sea uses additional resources and fuel.

Sustainable Product Development

Steps are being taken by the textile industry to minimize harm to the environment. There is much written in the media in the early 21st century about the "greening" of the industry. Ecofashion is a movement to take the health of the environment and consumers into account. Fabrics are made using organic raw materials. Chemicals and bleaches are not applied when dying the material. The industry is taking steps to reduce wastewater. The careful selection of fabric and dye combinations can maximize dye effectiveness. Separating wastewater streams allows selected by-products to be reused. Using biodegradable enzymes in place of chemical agents, where possible, improves wastewater quality and reduces treatment costs. Design and production are being reconfigured to reduce energy use. Simple changes, like insulating boilers and pipes or using cold-temperature dyeing and finishing, improves efficiency and reduces cost.

Recycling or Reusing

There are many obvious benefits to recycling or reusing textiles. It reduces the need for landfill space. Textiles discarded in the 21st century are more problematic because of the development of synthetic fabrics, which do not decompose. Reusing textile products reduces the pressure on finite raw materials and reduces pollution and energy needed to process them. Medical facilities and the hospitality industry are heavy users of textile products. Many hospitals, hotels, motels, and restaurants have implemented recycling programs for linens.

Textile recycling encompasses reusing or reprocessing used clothing, linens, fabrics, manufacturing scraps, and other textiles. The Environmental Protection Agency (EPA) estimates that 12.4 million tons of textiles were generated in 2008, approximately 5 percent of total municipal solid waste generation. There are a growing number of textile recycling companies that divert these products

from the municipal waste stream. These operations recover good-quality clothing and linens that can be resold in secondhand outlets. More than half of the clothing recovered for resale is exported to foreign countries. Damaged textiles can be converted to rags and industrial wiping cloths. Used textiles can also be broken down into fiber that is refashioned into new products. Fiber reclamation mills sort incoming materials by type and color, then shred and blend the fibers into new yarn for weaving or knitting. The fibers can also be compressed into filling material for mattresses, insulation, roofing felts, and furniture padding. Synthetic fabrics can be cut into small pieces that are granulated into pellets that can be melted and spun into new polyester fabrics.

Regardless of their final destination, used textiles have a relatively stable and high price. They remain a valuable commodity, even after heavy use. Revenue generated by resale is enough to cover the processing costs. The textile recycling industry in the United States employs nearly 20,000 workers, and primary and secondary processors of these products account collectively for annual gross sales of $700 million.

Educating the public about the value of reusing and recycling their household textiles from clothing to linens is critical. Good publicity and outreach will help to increase participation and the quality and quantity of textiles collected. Textile recovery programs are effective and can be easily replicated around the country. Each individual must use and reuse these valuable resources responsibly.

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See Also: Consumerism; Floor and Wall Coverings; Hospitals; Recycling.

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Los Angeles

From a precolonial population of 5,000 native Californians, Los Angeles (LA) has mushroomed into an urban giant of more than 6 million people. Demand for water and resources in a desert-like environment presents significant challenges to engineers and planners and has generated its share of political scandals. Strategies to cope with the enormous shift in the volume of waste over that span have tested the ingenuity of city residents. In the 21st century, although LA is a leader in recycling and energy generation from waste, rates of consumption are soaring, and many households are overwhelmed by the profound effects of runaway consumerism.

Early History

The LA area was for millennia the home of the Tongva and Chumash and their ancestors. Their uses of the landscape helped to shape the actions of the earliest Europeans and have continuing impacts in the 21st century. The Chumash lived at the western edge of LA and along the Santa Barbara Channel to the northwest. Their important coastal village, Humaliwu, lent its name to the famed celebrity colony of Malibu. The Tongva people occupied the

LA basin and San Fernando and San Gabriel valleys. Both tribes had many villages along the coasts, estuaries, and rivers where the food resources were richest. Even so, their collective ecological footprint over some 10,000 years was exceptionally modest by 21st-century standards.

Native Californians utilized many calorically desirable and easy-to-acquire resources and may have at times driven local animal populations to precarious levels. Some paleontologists argue that early hunters precipitated the extinction of Ice Age fauna (such as mammoths), but others disagree. In some periods, sea mammals vulnerable due to sustained, land-based breeding seasons at local rookeries were likely overhunted, forcing villagers to pursue other species. For the most part, however, precolonial people were effective stewards of the sea and land.

Virtually all plant and animal species present at the start of the Holocene were still around when the missions were built. Many plants important for basketry or food were regularly pruned and tended (although the people were not farmers), and there was a long precolonial history of controlled burns to stimulate the production of seed-rich native shrubs and grasses. Plant species adapted to fire thrived under these land management practices, attracting deer and elk. The era must not be romanticized, but the archaeological record suggests that people did not wastefully use most resources.

Although communities across ancient southern California were judiciously spaced and rarely reached 300 people (most had 75–150 residents), the cumulative effect of thousands of years of food and toolmaking waste at settled villages is impressive. Before highways and other construction destroyed so much unwritten history, the LA–Santa Barbara coast was a necklace of shell midden sites as deep as 5 meters, each with the barest remains of circular thatch houses surrounded by discarded shells; bones of fish, seals, rabbits, and deer; acorns; stone tools; soapstone bowls; and metates. In these societies, food and manufacturing trash was tossed near houses—there were no toxins to concern them. The most physically dangerous waste was sharp-edged stone from making projectile points, but these too were absorbed into middens. Other resources consumed in the LA region include asphaltum from the La Brea tarpits, which was widely used as an adhesive. The distribution of native villages affected where important nodes of colonial activity took place, such as where missions were positioned, and still deeply impacts where urban construction happens in the 21st century, since the remaining sites are protected by local and federal laws.

Missions

The native population in the LA area was about 5,000 at contact. The San Gabriel Mission was the first colonial building in these lands. Established near Tongva villages in 1771, it moved to the current location in 1774. El Pueblo de Los Angeles (the northern core of the modern downtown) was founded in 1781 on the banks of the Los Angeles River, close to Yaanga and three other Tongva villages. The founding group consisted of 11 families recruited from Sonora and Sinaloa, Mexico. The pueblo took five decades to reach a population of 1,000. Meanwhile, the San Fernando Mission was established in 1797 on the north side of the valley. All three locations were soon surrounded by cattle, agricultural fields, and human and animal waste. The Tongva who crowded around these locales (peaking at 1,700 persons at the San Gabriel Mission in 1817) suffered poor health and high mortality because of European diseases and unsanitary conditions. The governor of Alta California deeded large ranchos, usurping tribal lands. Tongva laborers built and provided food to the missions and herded at the ranchos. Ten millennia of practices marked by low-impact consumption of wild resources and the generation of little waste vanished in a few decades.

Growth of Modern Los Angeles

The growth of LA was slow until 1870–1890, when its population spurted from 5,730 to 50,395. By 1900, it surpassed 100,000, and by 1930, the population surged to 1.2 million. At nearly 2 million in 1950, Los Angeles had become the nation's fourth-largest city. By 2010, the city officially has about 4.1 million residents, second most in the United States, and the core urban area had over 6 million of the county's 9.9 million residents. It is such a megalopolis that few realize it was California's second-largest city (well behind San Francisco)

until the 1920s. The core LA urban area consists of more than 100 contiguous neighborhoods from Sylmar to Long Beach, as well as dozens of embedded cities such as Beverly Hills, Santa Monica, Burbank, Manhattan Beach, and Inglewood. This roughly 800 square miles of contiguous urban development supports about two-thirds of the LA County population. Another 3,261 square miles of the county encompasses more sparsely populated mountain and desert land to the north and dense urban areas to the east, including Pasadena and Arcadia.

Three Major Aqueducts

Most water is piped in from distant sources. William Mulholland, superintendent of the LA City Water Company during the early 1900s, famously negotiated land purchases and water rights for the first of three major aqueducts that still sustain the city. The aqueduct from Owens Valley was built in 1908–13, and stretches 233 miles from the eastern Sierra to Los Angeles. The 300-mile Colorado River Aqueduct was constructed during the 1930s, and the 140-mile aqueduct from the Mono basin was added in the 1960s. LA sanitation operations were founded in 1923, when rapid expansion of the city meant that waste was becoming a major problem. In the 21st century, a vast infrastructure of facilities provides solid waste and wastewater disposal for millions of households at a 2010 cost of nearly $1 billion. According to Sanitation Bureau documents, more than 6,650 tons of material generated by commercial and residential sources is collected and recycled or buried daily, including refuse, recyclables, and plant trimmings.

Some 6,500 miles of sewer pipes handle 550 million gallons of wastewater each day. It is estimated that at least 5,000 restaurants, hundreds of schools and hospitals, 12 colleges and universities, 700 grocery stores, 20 club megastores, 1,100 convenience stores, 15 malls, and untold numbers of industrial enterprises and small businesses contribute to the daily consumption of resources and generation of waste in LA.

Portions of LA waste go to three landfills; the largest, Puente Hills, reclaims energy through gas collection networks. The district also operates refuse-to-energy facilities in Commerce and Calabasas. Several enormous dumps used for decades are filled and closed, and others are reaching capacity. A "Waste-by-Rail" program that moves refuse to the remote desert locality of Mesquite near the Salton Sea is permitted to accept 20,000 tons of LA's waste per day through the 21st century. Another distant waste locus for LA trash is proposed for Riverside County. Some Angelenos improperly dispose of household hazardous wastes, although the city has established hazardous-material collection sites. Dumping into storm drains, roadsides, and bins meant for regular trash is common. Trash of all kinds winds up in coastal waters. A one-day coastal cleanup event in September 2010 generated 50 tons of trash collected by 14,131 volunteers.

Waste is not confined to solids and water. With at least 16 million cars registered in the core LA area (26 million in the county), the county's roadways are handling 12 million cars per day, and 18.6 million tons of carbon dioxide are emitted into the atmosphere each year. The crux of the problem is the job commute: when Angelenos travel to work, 70 percent of them drive alone.

Water Recycling

LA administrators are rapidly expanding various recycling programs. Persistent droughts signal the need for more frequent water rationing. In the early 21st century, six water reclamation plants recycle sewer water for agriculture, groundwater recharge, and park, golf course, and landscape irrigation. "Toilet-to-tap" water recycling is on the horizon. Most biosolids from wastewater are converted to electricity and fertilizer. Huge recycling centers recover more than 240,000 tons of paper, glass, plastics, and aluminum annually. From nearly 500,000 tons of plant material, mulch and compost are produced. More is diverted from landfills than is mandated by AB939, a California law requiring reduced flow to landfills. *Waste & Recycling News* reports that of the 10 largest U.S. cities, Los Angeles ranks at the top in recycling rate, at nearly two-thirds of material collected.

A society accustomed to throwing out 80 percent of what it buys needs to stop and take stock of the heavy toll such actions have on the land. Compared to the disposed waste per capita of the Tongva people, the waste produced by the LA population occupying the same patch of land is astounding. Among

the Tongva, the population of 4,000 or so in the LA basin/valley region (another 1,000 lived on the nearby islands and in the San Gabriel Valley to the east) disposed of an estimated 1 pound of waste per person daily, primarily in the form of shell, bone, and stone. This amounts to 1.5 million pounds of waste per year. On the other hand, the roughly 6 million people in the LA urban core—at the U.S. norm of 4.5 pounds of waste per person daily—produce 27 million pounds of garbage per day. This is equivalent to 1.13 million pounds hourly, meaning that LA's population disposes of the same amount of waste in about 80 minutes as the precolonial population tossed out in one year. Stated another way, what Los Angeles dumps in two months equals what it took the Tongva 1,000 years to throw out.

Consumption at Home

Los Angeles, like other urban locales, is filled with busy families, many with two jobs and children to raise. The behavior of people as consumers and disposers, as it plays out in their homes, has a major effect on the trajectory of life in the city. From 2002 to 2005, the UCLA Sloan Center on Everyday Lives of Families documented the material worlds of ordinary, middle-class LA households. Archaeologists enumerated possessions, measured rooms and yards, recorded activities, took nearly 20,000 photos, and gained an unparalleled, systematic picture of what people have and do in their homes. Ordinary working families have thousands of possessions tucked into every available space, including crammed garages that no longer accommodate the family car in 75 percent of homes studied.

As documented in *Life at Home in the Twenty-First Century*, the United States in the 21st century is the most materially saturated society in global history. For decades, the consumption of increasingly cheap yet expendable goods such as toys, phones, and electronics has occurred at astounding rates. Clutter overwhelms many families, and measurable physiological stress arises from trying to cope with it all. Only economic declines seem to encourage typical families to rethink frenetic consumption habits.

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See Also: Archaeological Techniques, Modern Day; California; Material Culture Today; Recycling.

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Louisiana

Louisiana is one of the southern states of the United States; Baton Rouge is its capital, and New Orleans is its largest city. Louisiana is the only U.S. state to refer to its political subdivisions as parishes instead of counties. Named after Louis XIV (king of France 1643–1715), the state was once part of the French colonial empire. The state consists of an upland region and an alluvial region of low swamp, coastal marsh, beaches, and barrier islands, which lie principally along the Mississippi River and the Gulf of Mexico. The state is frequently subjected to tropical cyclones and vulnerable to major hurricane strikes. The New Orleans area was devastated by Hurricane Katrina in 2005 when the federal levee system failed, the worst civil engineering disaster in U.S. history. Over 1,500 people died, and 80 percent of the city was flooded. New Orleans remains one of the largest and busiest ports in the world, the region is key to the U.S. oil refining and petrochemical industries and is a corporate base for onshore and offshore petroleum and natural gas production. Concerns over water contamination from the petroleum industry produced regulations ranging from

a state law in 1910 to forbid discharges of oil that might damage rice crops to coordinated efforts by several federal agencies in 2010 to remediate damage to the state's coastline by oil spilled in British Petroleum's Deepwater Horizon disaster. The state's main agricultural products include seafood (Louisiana supplies most of the world's crawfish) and other land-based staples—the seafood industry directly provides around 16,000 jobs.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Louisiana had an estimated 6,051,158 tons of municipal solid waste (MSW) generation, placing it 23rd in a survey of the 50 states and the capital district. Based on the 2006 population of 4,243,288, an estimated 1.43 tons of MSW were generated per person per year (ranking 15th). Louisiana landfilled 5,551,158 tons (ranking 19th) in the state's 27 landfills. The state exported 168,341 tons of MSW; the import tonnage was not reported.

In 2006, Louisiana was not increasing its landfill capacity, which was then 71,721,948 tons. It was ranked joint 19th out of 44 respondent states for number of landfills. Whole tires, used oil, lead-acid batteries, and white goods were reported as being banned from Louisiana landfills. Tipping fees across Louisiana averaged $32.35, where the cheapest and most expensive average landfill fees in the United States were $15 and $96. Louisiana has no waste-to-energy (WTE) facilities, although plans have been put forward for a controversial Sun Energy Group plasma gasification plant in New Orleans. Louisiana recycled 500,000 tons of MSW, placing the state 31st in the ranking of recycled MSW tonnage.

Landfills

Since the late 1980s, Louisiana's waste management has undergone a complete upheaval. In 1980, there were over 800 landfills; by 2010, this has been reduced to 24 by new federal and state regulations governing landfill design, construction, and operation. Act 189 of 1989 reduced MSW being sent to landfill by 25 percent and emphasised the recycling and composting of MSW and other waste. Prior to this act, there was little organized recycling of MSW and up to 25 percent of waste received at landfills was yard waste. Nearly all sewage sludge was being landfilled without consideration of alternate methods of disposal. In rural areas, open dumping and backyard burning persisted as they had done throughout U.S. history. In similar age-old patterns, industrial waste was left in open pits and waste from forestry and agriculture was burned or piled up to rot away. In 1990, more than 11 million tons of nonresidential waste was being landfilled.

The construction of landfills to modern standards and their operation cost much more than the outmoded landfills, but afforded much greater protection to the environment. Increases in tipping fees and increased MSW transportation costs made many municipalities study ways of reducing the cost of waste disposal; this factor, along with Act 189, stimulated the recycling of paper, glass, plastic, and metal. Yard waste began to be separated from the general waste stream and recycled into compost or mulch, and state regulations promoted the use of treated sewage sludge as a fertilizer replacement. Between 1990 and 2000, recycling in Louisiana went from near zero to 15 percent—around 570,000 tons of material. The amount of landfilled MSW decreased to 3,800,000 in 2000, from 5,797,320 tons in 1990. Industrial waste now goes into environmental protective landfills, recyclable streams of waste are separated out, and waste reduction programs have been implemented in many workplaces.

Agricultural, Forestry, and Livestock Waste

One of the largest waste streams in Louisiana is the residue from primary processing of crop harvests and felled timber. Estimates vary, but in most years this can exceed 10 million tons of bagasse (sugarcane stalk), filter press cake, cotton gin trash, rice hulls, bark, wood chip, and paper mill waste (fibers and ash). Some sugar plants and paper mills now burn their residues to provide power and steam. In 1993, best management practices (BMPs) introduced by the Louisiana Department of Agriculture and Forestry (LDAF) allowed agriculture and forestry wastes to be reused under exemptions from the solid waste regulations. Most processors are now in this program, and some or all residues are reused as soil amendments, nutrients, or a source of lime. Often, this returns organics to the land from which

Sugarcane is harvested and loaded into high dump trailers in Bunkie, Louisiana, for transport into trucks for shipment to a sugar mill. Residue from primary processing of crop harvests is one of the largest waste streams in the state; an estimated 10 million tons of residue, including bagasse (sugarcane stalk) and filter press cake, is produced every year. Some sugar plants and paper mills burn their biomass as an energy source under a state program that allows agricultural and forestry waste to be reused for energy, soil nutrients, or a source of lime.

the same crops were harvested, reducing costs, preventing soil exhaustion and reducing the need for manufactured fertilizers.

While residues remaining at the site of their harvest are now exempt from Louisiana Department of Environmental Quality (LDEQ) and LDAF regulations, the burning of these residues onsite remains highly controversial. The routine burning of timberland to control litter and competition has similarly been problematic. All burning must now be carried out by a trained and LDAF-certified burn operator.

Animal waste is not a major issue in Louisiana as livestock farming has been reduced since the mid-20th century. In 1950, the state produced 1.5 million market hogs; in 2001, only 70,000. The majority of Louisiana's animal waste is chicken litter from the 2,000 broiler production houses. This is a mixture of chicken manure and rice hull or sawdust litter, and it is routinely spread on fields, being a high-quality fertilizer that also adds organics to the soil. However, this use has been concentrated in areas around poultry farms, creating concern about accumulating phosphorous in the soil. Safe practices are being implemented in the early 21st century to address this problem, and education and testing programs for soil and litter have been put in place.

Agriculture Street Landfill

A 95-acre area of swampy low ground in the Upper Ninth Ward of New Orleans began to be used as a dump in 1909, becoming known later as the Agriculture Street Landfill. It became one of the main dumps in the area for residential and industrial waste. Fires were common in the dump, and it received the local nickname of "Dante's Inferno." First efforts to close the dump were in 1952, but it remained in use as a sanitary landfill until the end of the 1950s. In 1965, the debris of Hurricane Betsy necessitated reopening the landfill for another two years before it was officially closed again. The site was then sealed with

compacted incinerator ash. In 1976, redevelopment began, and the site was covered with sand and soil and a neighborhood was built on top of part of it. Morton Elementary School, some small business units, and three residential developments—Press Park, Gordon Plaza, and Liberty Terrace—were situated on the former landfill.

Residents complaining of health problems occasioned the first Environmental Protection Agency (EPA) investigations in 1986, which concluded that no remediation was necessary. Old trash continued to be found just below the surface, and anecdotal evidence of health problems, such as an abnormally high cancer rate, persisted. Local people petitioned for retesting, and, in 1994, the Agriculture Street Landfill site was added to the National Priorities List (NPL) and became a Superfund site. The undeveloped part of the landfill was declared a public health hazard and was fenced off. Contamination was found in samples of soil, dust, air, and garden produce, which contained metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and pesticides. Further investigations revealed that the actual amount of soil deposited in the landfill prior to redevelopment was significantly thinner than had been claimed.

The remediation operation involved closing Morton Elementary School and, in the residential area, removing two feet of soil, putting down a barrier layer, and then replacing the soil with clean material. The project was completed in April 2002, but many homeowners have since petitioned to be rehoused elsewhere—a petition backed by Congressman Bill Jefferson. As of 2010, they were unsuccessful in their attempts. The remediated landfill was disturbed in 2005 by flooding from Hurricane Katrina, which is believed to have freed toxins from the landfill. Press Park, a residential address consisting of 56 townhouses nearby, has been found to have levels of benzopyrene, a carcinogenic petroleum by-product, that were 50 times greater than the normal level.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Farms; Toxic Wastes.

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Love Canal

Love Canal is a chemical waste disposal site located in a small neighborhood of Niagara Falls, New York, just north of the Niagara River. Although Love Canal was neither the first nor the last hazardous-waste dump site in the United States, it has become a symbol of governmental red tape, corporate accountability, and grassroots organization. It spawned new legislation and awakened the world to the effects of industrial waste on human health. It took over two years of battling government agencies and staying in the headlines, but the Love Canal Homeowners Association eventually achieved the relocation of nearly 900 families from the Love Canal neighborhood.

History

Love Canal's history is long and intricate. The name of the canal comes from William T. Love, a 19th-century entrepreneur who envisioned a canal that would connect Lakes Erie and Ontario and harness some of the hydroelectric power capable of being produced by the Niagara River. The canal was 3,000 feet long, 60 feet wide, and 10 feet deep when Love had to abandon the project because of an economic depression in the late 1890s that resulted in loss of funding. From 1942 to 1953, Hooker Electrochemical Company dumped between 20,000 and 22,000 tons of industrial wastes into the canal. When Hooker sold the 16-acre site to the Niagara Falls School Board for $1 in 1953, the deed contained a disclaimer relieving Hooker of any future liabilities that may result from the chemical wastes buried in the canal. The 99th Street Elementary School opened on the site in 1955 with 400 students. The next 20 years saw the neighborhood

grow, with many homes and the accompanying new infrastructure built. The construction of streets, sewer lines, and utility lines meant that the canal's clay walls were breached, and soil from the surface of the canal was excavated and reused elsewhere in the neighborhood. Reports of fumes, sludge in basements, and holes in the surface of fields and school playgrounds began in the 1960s. Finally, in 1976, the New York Department of Environmental Conservation (DEC) began investigating materials that had been disposed of in the Love Canal site. During the DEC's investigation, the story of Love Canal and litanies of complaints began appearing in local newspapers.

Inspections and Relocations

The canal's many changes in ownership serve as an appropriate precursor to the metaphorical "hot potato" it became among several government agencies, beginning with the DEC in 1976. Shortly after the DEC investigation began, the Environmental Protection Agency (EPA) began collecting air and soil samples, the results of which would later be handed to residents as lists of chemical names with numbers next to them. The commissioner of the New York State Department of Health (DOH) visited the site in April 1978, declared it a public health hazard, and ordered Niagara County to begin health studies. The DOH would figure most prominently in the Love Canal disaster area because it was conducting the health studies and would make many of the announcements of evacuation throughout the next years. A pattern of miscommunications quickly emerged, and residents were often confused by what the DOH told them and the unorganized fashion by which the DOH collected residents' blood samples: many were lost, some expired before being tested, and the DOH labs were overrun with the samples.

In the span of six months, two successive New York State health commissioners delivered orders for pregnant women and children under age 2 to be relocated, first in the inner ring of houses, followed by those in the next few rings of houses. Each time the DOH made an announcement, other government agencies scrambled to find funding to enforce the order, while residents grew ever more confused, outraged, and afraid as a result of information provided without interpretation and the DOH's refusal to ever reveal or publish all data from the health studies. New York governor Hugh Carey promised to buy the inner two rings of houses and created an interagency task force onsite comprised of the DEC, DOH, Department of Transportation, and six other agencies. This task force had the job of overseeing home purchases, resident relocation, health and environmental studies, and the remedial construction project that would hypothetically remedy the Love Canal site's leaching chemicals.

The grassroots organization credited with eventually winning relocation for all 900 families in the Love Canal area was the Love Canal Homeowners Association (LCHA), run by Lois Gibbs. After her son began attending the 99th Street School, he developed asthma and seizures. When Gibbs read an article about Love Canal in the *Niagara Gazette* in June 1978, she feared a connection between the canal and her son's health. What began as a concerned mother knocking on doors to collect signatures on a petition to close the 99th Street School, grew into a community movement that would keep Love Canal in the news.

The LCHA organized protests, put pressure on politicians while cameras were rolling, testified at local and federal hearings, and lobbied for legislation to approve tax exemptions and rebates after property values tanked. Because this was a blue-collar neighborhood and the property values had plummeted due to the news of the Love Canal chemical waste site, residents could not afford to simply pick up and move. Eventually, the LCHA took two EPA officials hostage for several hours in order to protect them from a mob that had gathered outside LCHA headquarters and to get U.S. President Jimmy Carter's attention after 11 of 36 residents tested positive for chromosome deformities.

Leading up to the presidential election of 1980, several members of the LCHA—including Lois Gibbs—and the mayor of Niagara Falls appeared on the *Phil Donohue Show*. The LCHA followed this media appearance by arriving at the Democratic Convention in New York City with signs demanding action from President Carter. Following an appearance on ABC's *Good Morning America*, the president visited Niagara Falls to sign an agreement with New York State that provided $15 million of federal funding to purchase the rest of

the Love Canal homes. The president's signing the agreement in September 1980 meant that residents could finally escape the chemicals they had been living with for years.

Effects

Love Canal was a battle won by a grassroots community organization. Despite many of the reported governmental misses, its legacy had some positive results. On December 11, 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), better known as the Superfund. Funded by taxes on the chemical and petroleum industries, the Superfund remedies other hazardous waste sites like Love Canal. After the EPA managed the fund for a few years, the Superfund Amendments and Reauthorization Act (SARA) passed on October 17, 1986, providing for permanent remedial actions at sites and increased state involvement. Lois Gibbs now heads the Center for Health, Environment and Justice, an organization that helps other grassroots organizations like the LCHA.

After nearly all the Love Canal residents relocated—some chose to stay behind—by 1981, and after the 239 homes closest to the canal site were demolished in 1982, the DOH declared the areas north and west of the canal habitable for residential use in September 1988. After years of remediation work and continued environmental studies conducted by the EPA, the site was removed from the Superfund's National Priorities List of sites requiring remediation in 2004. Occidental Chemical Corporation, the parent company of Hooker Electrochemical Company, eventually had to pay $129 million in reimbursements to various city, state, and federal agencies that had financed the cleanup, as well as $1 million to establish the Love Canal Medical Fund.

In the 21st century, when one drives down Colvin Boulevard Extension, the northern perimeter of the canal, on one side of the street a grassy knoll rises behind a sturdy green cyclone fence. On the other side of the street, a resettled neighborhood lies in what used to be known as Emergency Disaster Areas 4 and 5.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Environmental Justice; Environmental Protection Agency (EPA); Industrial Waste; Landfills, Modern; Politics of Waste; Pollution, Air; Pollution, Land; Pollution, Water; Public Health; Public Water Systems; Toxic Wastes.

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Lynch, Kevin A.

Kevin A. Lynch (1918–84), a U.S. architect and planner, is best known for his practical and theoretical contributions to the psychology of place. His keystone concept of place legibility refers essentially to the ease with which people understand the layout of a place. According to Lynch, the city can be considered text to be read by every individual. The particular organization of place components determines how easy it is to read the urban configuration in order to create an adequate mental map to navigate the city. For Ethan Sundilson, "mental maps of a city are mental representations of what the city contains, and its layout according to the individual."

Along with his studies on perception of city form, Lynch inquired about the different meanings given

to waste. In his posthumous book *Wasting Away*, he went beyond the material definition of waste as "a deteriorated collection of things," exploring the more symbolical side of wasting that includes temporal and spatial dimensions of the process of consumption. Besides being "all a nasty business," Lynch described waste and loss as the dark side of change, a repressed and emotional subject to be redefined. Every human being regards death and most change as tragic and confusing, fearing the sense of loss. Following the same logic, Lynch described waste as a signal of loss, of growing old. Waste is both a result and the process of loss. The common words for filth are generally tense with emotion. They are not neutral. Waste is an impurity to avoid or to wash off.

Though the process of waste production was conceptualized by Lynch as a continuum with very diffuse limits, he contended that wasting is, for the sake of simplicity, normally described in polarized ways. Going back to his concept of legibility, Lynch explained that, where customary boundaries are lacking, people lose their grip on things. That is the very reason to dichotomize the idea of waste: useful or useless, front or back of buildings, efficient or wasteful, saving or spending, growth or decline, produce or consume, succeed or fail, alive or dead. Nevertheless, those dichotomies sometimes lead to absurd behavior. Cultural, economical, and ideological reasons sustain the oversimplification of terms like *waste* and *garbage*. For example, some chicken farmers complain that they cannot feed unsold market produce to their birds because it is legally defined as garbage. Dirt is an idea bound to context and culture. It is matter out of place, particularly, matter that is unpleasant, dangerous, and difficult to remove. One's style of handling dirt is a way of establishing one's character and social position. Both the pathologist and the butcher work with "living matter in fresh decay," but the social meaning of their jobs defines a very different status and recognition.

For Lynch, defining waste as something that is out of place immediately posed a question on the definition of place as a culturally defined term. As stated by Lynch, ". . . in our urgent need for order and clarity, we find change and gradation hard to bear…." Waste is omnipresent, but the need for order and simplicity decrees that ". . . People, things, and places must be one or the other (waste–not waste), there to remain not shifting, not in-between, not partly so and partly not. . . ." Accordingly, Lynch also saw a dilemma: permanence, as opposed to declination, is stagnation and illness. The production of waste is a synonym of change and growth. Waste was visualized by Lynch as a necessary part of the continuum of life and death, a prime process in the spiral of change of things, living creatures, and systems. Lynch situated waste in a new, honest dimension. It is conceptualized as a normal process of the cycle of life, neither something obscure nor abject. In fact, Lynch criticized that most definitions of waste in the English language are negative. He also discussed the Latin *vastus*, which means "unoccupied" or "desolate." Lynch asked if something without human presence deserves to be treated as trash, since life normally thrives in those spaces. They were not considered waste at all by Lynch.

Waste and the City

The image of the city is also composed by waste. For Lynch, spaces devoted to waste can also be magnets for adults and children as places for free imagination and search for fascinating vestiges of a recent past beyond the reach of the regular whereabouts. They could be conceptualized as learning places where children connect with adults by investigating their material traces. In Lynch's words, many waste places "have these ruinous attractions: release from control, free play for action and fantasy, rich and varied sensations. They are characterized as places for pleasure precisely because of their rich form, freedom, and a sense of continuity. Thus, children are attracted to vacant lots, scrub woods, back alleys, and unused hillsides." Regrettably, the range of free movement—and therefore the amount and quality of exploratory behavior—in children has been severely restricted since the beginning of the 20th century. A car culture, television, and video games at least partly explain such restriction.

More than a meticulous explanation about waste and its different methods of treatment, Lynch questioned the multifaceted nature of this phenomenon. He posed disturbing, yet contemporary questions, such as: "Can we forsake our automobiles, a con-

tingency that is at least thinkable? What will happen then to the suburbs? to vacation areas? to industries whose employees commute by car? to the entire apparatus of making and maintaining those beautiful machines?"

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See Also: Archaeology of Garbage; Archaeology of Modern Landfills; Sociology of Waste.

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Magazines and Newspapers

Magazines and newspapers are two different categories of mass media with distinct histories, functions, and futures in the globalizing world. Similarities include high circulation, the structure of article content and periodical character of publications, subscription opportunities, as well as a strong impact on society.

Consumption: Newspapers

Newspapers were the first medium for formal distribution of mass information, the roots of which date to ancient Rome. After a period of handwritten proto-newspaper medium in the 17th century, printed newspapers gradually became the most important source of political, economic, sport, and cultural information during the 19th and 20th centuries.

Newspapers developed from periodical to weekly to daily. In the United States, the first newspaper was published in 1690 in Boston. The first U.S. daily came out almost 100 years later, in 1783 in Pennsylvania. In the 21st century, 216 of 260 countries or territories publish newspapers (83 percent of all countries). Japan, Norway, Finland, Sweden, and Switzerland are the top five countries for newspaper sales per capita, while Mozambique, Uganda, Armenia, Zambia, and Botswana are the bottom five. Twenty-nine countries publish only non-daily titles. However, the advance of technological information and electronic media has resulted in the decline of printed newspapers as a leading information source.

Traditional consumers of newspapers over the centuries have been adults. Improvement in literacy on a global scale has been steadily increasing the numbers of readers. Globalization in the later 20th and early 21st centuries has also stimulated the popularity of newspapers and the emergence of many new titles in a period when the meganewspapers have been reducing their circulation and publishers have been closing or filing for bankruptcy.

The early 21st century is a particularly volatile period for newspapers worldwide, with established titles in the United States and western Europe in deep crisis. Several newspapers ceased publishing or scaled back their editorial operations due to declining revenues or issues particular to each paper's operation. In July 2011, the United Kingdom's best-selling Sunday newspaper, the *News of the World*, closed after 168 years when allegations of illegal telephone surveillance jeopardized the satellite television interests of its publisher. From 2001 to 2005, circulation increased by 7.8 percent (including free daily). So-called narrowcasting has

splintered audiences into smaller and smaller slivers. Ranked at the top by circulation is *Yomiuri Shimbun* (10,021,000), Tokyo, Japan, Yomiuri Shimbun Group. The *Wall Street Journal* and *USA Today* are the most distributed U.S. newspapers (20th and 22nd, respectively, on the world list). In 2008, approximately 48.6 million copies were sold every weekday by the 1,408 daily U.S. newspapers. On Sunday, 902 newspapers sold 49.1 million copies, averaging 2.5 readers per copy. According to some prognoses, by 2017, printed newspapers will become insignificant in the United States.

Australia presents an exemplary case study of consumer interest in daily and weekly newspapers. There are 48 daily newspapers with a total circulation of 3,030,000, and 196 newspapers circulated per 1,000 people. The number of nondaily newspapers is 233, with total circulation at 374,000, and 24 newspapers circulated per 1,000 people. Newspaper consumption (minutes per day) is 35.6 percent of global daily newspaper circulations, including the free daily newspapers.

Surveys point to four characteristics of printed newspapers that keep them a part of social life: navigation, convenience, informationality, and entertainment.

Consumption: Magazines

In the United States, the approximate number of published magazines is 19,500, with a 2008 circulation of almost 370 million copies. Approximately 74 percent of all magazines go to subscribers, 11 percent are single-issue sales, and 15 percent are returned unsold. Nearly half of the single-issue sales occur in supermarkets. Nineteen billion catalogs were mailed in 2007, a one-third increase in a decade. Consumers of magazines are of all ages because of the variety of the topics—from children's comics to publications about aging for the elderly. Pornography is also a part of the magazine industry, with enormous circulations and profits. Electronic media will most likely not replace magazines because the parts of the culture that use and value printed, visual materials have extremely high numbers and strong market share.

Waste and Recycling

Newspapers and magazines belong to the nondurable goods category, together with other sorts of paper and paper products. Traditionally, newspapers and magazines have been reused as paper for packing; covering different surfaces, such as windows and furniture; and even as toilet paper.

In many countries, there are special services that pay by weight for submitted printed media, or systems of special recycling bins. As of 2004, the recycling rate for newspaper (73.4 percent) led all recycling rates in the paper products category in the United States. In 2008, newspaper generation was 1.7 million tons higher than in 1960, but newspapers' solid waste market share decreased by 56 percent. Newspaper recycling increased by 5.92 million tons and the recycling rate increased by 243 percent during this same period.

Unique, clay-coated paper makes magazines more difficult to recycle, but a fair number of these are also recycled in the United States. Catalogs also are primarily printed on coated, ground wood paper and are more difficult to recycle, but, like magazines, they are also recycled.

Despite various recycling programs, the amount of newspapers and magazines produced outnumber the amount recycled. The Institute for Scrap Recycling Industries (ISRI) estimated that recycling all morning newspapers read in the United States could save 41,000 trees per day and reduce 6 million tons of waste deposited in landfills.

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See Also: Household Consumption Patterns; Paper and Landfills; Paper Products; Recycling.

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Maine

Maine, with a 2009 population of 1.318 million and 35,387 square miles, which is slightly smaller than the rest of the five New England states combined, has evolved into one of the leading states with regard to pioneering innovative municipal solid waste (MSW) management policy. Maine adopted the first extended producer laws in the nation on mercury-containing products, electronic waste, and fluorescent lights, and it adopted the country's first product stewardship framework law. In addition, Maine is one of the first bottle bill states and has banned the creation or expansion of new commercial MSW landfills.

Based on 2009 U.S. Census Bureau estimates, Maine is ranked 40th in population and 38th in population density, with 42.7 persons per square mile. Maine has the oldest population in the United States, with a mean age of 42.2 years, and is ranked third with 15.6 percent of the state's population over 65 years of age. Maine is ranked 49th in mean household size (2.35), ranked 32nd in mean household income ($45,734 per year), and ranked 44th in population growth from 2000 to 2009 (3.4 percent). Maine's economy is ranked 43rd with $50 billion in gross state product in 2008.

Maine's taxable retail sales in 2009 were just below $16 billion. Of this amount, 88.1 percent ($14.1 billion) was attributable to consumer consumption and less than 12 percent ($2 billion) qualified as business operations. The categories of 2009 sales were general merchandise stores (21 percent), building supply stores (14 percent), restaurant sales (14 percent), food stores (11 percent), and lodging (4 percent). Total retail sales rose each year from 2004 to 2007, declined slightly for 2008, and fell to a level below the 2004 annual sales for 2009 because of the sustained economic recession. Food stores represented the only continuous annual increase in taxable retail sales for all years 2004–2009.

Waste Management

In 2007, Maine residents, businesses, and visitors generated 2,066,448 tons of MSW. Between 1993 and 2003, municipal solid waste generation in Maine increased over 55 percent. This equates to an annual per capita rate of 3,200 pounds of MSW per year, or about 7.5 pounds per person per day, which is 38.6 percent higher than the 4.6 pounds per person per day, reported by the Environmental Protection Agency. A dominant factor in the higher per capita rate is Maine's reliance on tourism. In 2008, there were 15.4 million overnight visitors and 16.5 million day visitors to Maine.

In 1989, Maine adopted its solid waste management hierarchy: reduce, reuse, recycle, compost, waste-to-energy, and then landfilling, which serves to guide Maine's solid waste management planning at the state level. Also in 1989, the Maine legislature established a state recycling goal of 50 percent to be met by January 1, 2009. By 2010, the state recycling rate was 34.8 percent, significantly less than the stated goal and a decrease from the peak of 42 percent in 1997. Maine does not have mandatory recycling at the state level, but municipalities representing approximately 25 percent of the state population have adopted mandatory recycling ordnances. Maine Recycling Week, which is intended to increase the public's awareness of the importance of reducing, recycling, and buying products made from recycled materials, is November 8–15 each year and is designed to include November 15, which is America Recycles Day.

The regulation of solid waste management at the state level is under the auspices of the Maine Department of Environmental Protection (Maine DEP), Bureau of Remediation & Waste Management, which is supported by four regional offices in Portland, Bangor, Presque Isle, and Augusta. Maine also has the Board of Environmental Protection, which is charged by statute to provide informed, independent, and timely decisions on the interpretation, administration, and enforcement of the laws relating to environmental protection and to provide for credible, fair, and responsible public participation in DEP decisions, including actions related to solid waste. Maine's Board of Environmental Protection is unique in that it provides the citizens of the state with a forum that fully opens up the licensing, rule-making, and appeals process to full public participation. Statewide solid waste planning is under the auspices of the Maine State Planning Office. Maine is a home rule state; by law, Maine's 488 organized municipalities are responsible for providing for municipal solid waste activities in their jurisdictions. Regionalization is not significant

in Maine, although many municipalities share solid waste transfer operations, as there are 240 public transfer stations for the 488 municipalities.

Maine is one of 11 states with a beverage deposit and refund system (bottle bill) and has one of the broadest programs in effect. In 1976, through a citizen referendum, Maine adopted its bottle bill. The original law established deposits on beer, soft drinks, mineral water, and wine coolers. In 1989, the program was expanded to include wine, liquor, water, and nonalcoholic carbonated containers (glass, plastic, and metal). The 2006 sale of beverage containers was estimated at 650 million containers. The return rate is approximately 90 percent, representing approximately 50,000 tons of waste diverted from disposal each year.

Maine's solid waste disposal facilities are one state-owned landfill, one commercial landfill, eight municipally operated landfills, 23 municipal construction and demolition debris landfills, and four waste-to-energy facilities. The state also owns a permitted "greenfield" site, known as Carpenter Ridge, outside the town of Lincoln that is reserved for future development of a landfill if needed. In 2007, 32 percent of Maine's waste was sent to the four waste-to-energy facilities. Although Maine had, as of 2010, about 12–15 years of landfill capacity, since 1989, Maine law prohibits the construction of new or expansion of commercial MSW landfills. In 2007, 456,580 tons of MSW were imported, while 60,491 tons were exported. Disposal fees for landfill and incineration ranged from $40 to $158 per ton in 2010. Maine also has 81 licensed compost facilities.

Mercury

Maine has focused on the elimination of mercury from its environment. A number of state laws and programs have been enacted to control specific products and to prevent disposal while maximizing recovery. These actions have since evolved into broader approaches to implement the waste management hierarchy and to shift costs and responsibilities onto producers.

The first mercury law was enacted in 1999, which banned the disposal of any products containing mercury as solid waste after 2002. This law was expanded to include household products containing mercury starting in 2005. Simultaneously, the sale of mercury thermometers was banned starting in 2002, which was followed by a series of additional mercury-containing product bans, including motor vehicle switches (2003), thermostats, (2006), miscellaneous meters (2006), and button cell batteries (2011).

In 2006, Maine passed the first law (LD 1792, An Act To Protect Maine Families and the Environment by Improving the Collection and Recycling of Mercury Thermostats) in the country that established a financial incentive to recycle out-of-service mercury thermostats to promote the recovery of mercury. To encourage mercury recycling, the law established a minimum bounty value of $5 per thermostat to be paid by thermostat manufacturers.

In 2009, Maine enacted a law designed to reduce mercury pollution from fluorescent lighting, the first in the nation. The law required fluorescent light manufacturers to share the costs and responsibility for recycling mercury-containing bulbs generated by households by establishing a free, statewide convenient collection system by January 1, 2011. The law requires the manufacturers' programs to include effective "education and outreach," including, but not limited to, point-of-purchase signs and other materials provided to retail establishments without cost. The law also established a maximum allowable mercury concentration in lighting sold in the state and directed the state to modify its procurement program to purchase lighting with lower mercury concentrations.

Electronics Waste

In 2004, Maine was the first state to pass an electronics waste law that integrated extended producer responsibility to ensure that products are recycled at the end of their lives. The law created a producer-financed, shared-responsibility collection and recycling system for household residents, which partnered with municipalities. On a per capita basis, Mainers recycled 3.2 pounds per capita in 2006, 3.61 in 2007, 4.06 in 2008, and about six pounds per capita in 2009. The Maine DEP estimated the capture rate for household computer monitors and televisions available for recycling in 2006 at 43 and 44 percent, respectively, which increased to 50 percent of computer monitors and 51 percent of televisions in 2008.

Producer Responsibility

In March 2010, Maine was the first state to pass an extended producer responsibility framework law (LD 1631), "An Act to Provide Leadership Regarding the Responsible Recycling of Consumer Products." The law applies the principle of extended producer responsibility for managing products at their end-of-life by establishing a process for creating product stewardship programs for hard-to-recycle products and packaging, moving the physical and financial responsibility for managing old products from the general taxpayer to producers, consumers, and others who benefit from products sold and used. The law establishes a three-step review and recommendation process. In step one, review and prioritization, the Maine DEP reviews existing product stewardship programs and conducts a prioritization process to identify potential candidate products for product stewardship status. In step two, report development, the DEP prepares an annual report to the Maine Legislature on the state of existing product stewardship programs, proposed changes to existing products stewardship programs, and recommendation of potential candidates for product stewardship. In step three, legislative review, the Maine Legislature's Joint Standing Committee on Natural Resources reviews the DEP report and has the authority to report legislation as necessary to modify existing programs or to list new products or create new programs. Following the committee's action, final approval is through the full legislature and then the governor.

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See Also: Household Hazardous Waste; Incinerators; Producer Responsibility.

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Malls

A shopping mall refers to a diverse collection of retail stores that is arranged on one or more levels and is typically augmented by one or more anchor stores, food and dining establishments, and entertainment venues. Malls may be open air or enclosed. Dating from 900 to 700 B.C.E., the Greek agora helped establish the idea of publicly presenting goods on rugs spread on the ground. In the 1st to 5th centuries C.E., Rome was the site of the first covered shopping space—an innovation that allowed shoppers to be protected from the elements. Medieval market halls and town halls (11–16th centuries) were examples of shops appearing in buildings designed for other uses, while the Eastern bazaars, including the Great Bazaar at Istanbul (1461), were revolutionary as

Climate-controlled malls, like the Mall of America in Minnesota (MOA), allow customers to shop in comfort despite inhospitable weather. MOA also features a theme park, movie theaters, video arcades, wedding chapels, and even a public aquarium.

districts within cities. The first walk-in shops with internal counters were established in Holland in 1695. In 1830, the Galerie de Orlean was the first arcade in Paris and featured an enclosed covered way to protect shoppers. In 1840, the invention of plate glass facilitated the development of shop fronts to showcase goods. In 1888, New Trade Halls opened in Moscow; it featured three arcade areas that allowed for up to 1,000 shopping units. The key factors in these early phases of the evolution of the shopping mall are the connection of the shops and the city, the inherent civic nature, the uses of technology, and the idea of an admixture of different types of shops.

At the end of the 19th century, the chain store was invented. Especially in the 21st century, chain stores often make up the majority of shops in malls. Similarly, the evolution of the supermarket would also lead to many of the traditions found in the shopping mall. In the 20th-century United States, cities were beset with population growth, congestion, and intense traffic; coupled with these facts were new technological developments in lighting and ventilation. These conditions were ripe for the first shopping mall—socialist Victor Gruen's Southdale (Edina, Minnesota, 1956).

Spanning 1 million square feet (sq ft) of shopping space, Southdale was revolutionary in that it was a fully enclosed shopping space. The use of climate control in the mall allowed customers to shop year-round in Minnesota's often inhospitable weather. In Victor Gruen's mind, Southdale would have become a master planned space including housing, hospitals, parks, and lakes among other features—essentially, an artificial, enclosed downtown. As the U.S. highway system developed in the years following Southdale, the shopping mall continued to emerge and eventually became an archetype repeated throughout the world.

Megamalls

One contemporary trend of shopping malls is increasing size. King of Prussia Mall (Pennsylvania, 2,793,200 sq ft of retail space, 400 stores), Mall of America (Minnesota, 2,768,399 sq ft, 520 stores), and South Coast Plaza (California, 2,700,000 sq ft, 280 stores) are examples of U.S. megamalls. In Canada, the West Edmonton Mall occupies 6 million sq ft (3,800,000 sq ft of retail space) and features more than 800 stores (eight anchors) and 20,000 parking spaces. Some of the largest malls exist outside North America: New South China Mall in China is 9.58 million sq ft and features space for 2,350 stores and SM City North EDSA in the Philippines is 8.68 million sq ft and offers 1,100 stores.

Other Types of Malls

In addition to the emergence of mega shopping malls and regional malls (malls designed to serve a large population and geographic area), there is the development of the outlet mall (a mall that features a number of name-brand retailers and that offers discount prices, such as Woodbury Commons, New York), the big box retailer (a major store, such as Walmart, that models the shopping mall concept by enclosing a variety of goods and services within one space), and the strip mall (a horizontal layout of stores arranged side by side, often accompanied by a large anchor store).

Socializing and Mall Culture

The contemporary shopping mall is the epitome of consumer society. People are encouraged to come inside a fully closed, protected, and controlled space that offers a multitude of consumer goods. Anchor stores like Macy's and Nordstrom offer name brands, while smaller specialty stores cater to people's perceived needs in fashion, home electronics, shoes, novelty items, books, video games, kitchen gadgetry, and arts and crafts. Because malls are self-contained, people are encouraged to spend the entirety of a day there. Many malls, including King of Prussia Mall and Mall of America, are designed as tourist attractions. People from across the United States, even from around the world, travel to spend days in a shopping mall. Food courts are a staple feature of malls. Many of the dining establishments in them feature nonorganic, nonlocal, and nonnutritious food.

People are also encouraged to spend their post-shopping time partaking in entertainment. Many malls, including Mall of America, feature small theme parks, movie theaters, video arcades, wedding chapels, and even ice rinks. The term *malling* not only refers to the act of building shopping malls

but also to the behavior of people who spend time at malls. Malling would seem to indicate that part of the problem with overconsumption can be connected to the prevalence of the shopping mall.

Criticisms

Santana Row, located in San Jose, California, is one example of the emerging trend of lifestyle centers. Santana Row includes numerous retail stores, on top of which are luxury condominiums. For some, the architectural and urbanist trends of malls like those at Santana Row are alarming. There is concern that outdoor spaces with parks, waterways, and forests are being replaced by the overwhelming shopping mall structures. Others express disappointment that traditional main streets and mom-and-pop establishments have given way to the shopping mall and its chain stores.

Similarly, critics have expressed that while shopping malls supplant previous public spaces—like the city park—they serve a different public function. People can frequent a park to stroll, take in a conversation, or just relax, but a mall is designed with one purpose in mind—consumption. Malls frequently establish stringent dress, behavior, and activity codes. In many cases, people cannot take photographs in malls, protest, or pass out political or other information. Malls often have the appearance of civic participation and social integration—many offer their spaces to the aged for morning walks before stores open—but these forms of civics and sociality are always geared toward the goal of consumption.

In addition to the concerns that shopping malls promote overconsumption and socially deviant behaviors in people, critics have argued that shopping malls pose threats to the environment. Unlike the vision promoted by Victor Gruen—people would come to the center of the city to shop—the contemporary mall is often located at the outskirts of cities, many of which lack viable public transportation options.

As a result, shopping malls promote the use of the automobile and this has a major impact on the environment. They also promote urban sprawl—a fact that Gruen himself noted in a 1978 interview in which he bemoaned the archetype that he had helped to create. Because of their increasing size, shopping malls use incredible amounts of natural resources, and even after they are built, they continue to require large amounts of energy for their day-to-day use. Shopping malls are also beginning to approximate theme parks. Wafi City Mall in Dubai features Egyptian themes that resemble a theme park or themed casino. Universal Studios CityWalk in Hollywood, California, merges theme park entertainment, traditional shops, and contemporary architecture in a form that suggests a new direction for shopping malls. Some critics charge that the uses of theming and other technologies designed for retail atmosphere amount to a further lulling of the consumer into patterns of overconsumption.

Closings and Alternatives

Many shopping malls have closed, are on the verge of closing, or have been unable to attract retailers to rent spaces. In 2008, over 150,000 individual stores closed within malls. In April 2009, General Growth Properties, a firm that runs 200 malls in 44 U.S. states, filed for bankruptcy. Like many industries, shopping malls have suffered from the economic downturn of the early 21st century, and many have closed. This has led to the term *dead mall* being used to describe shopping malls that are vacant.

When malls close, cities must deal with how to use the massive spaces once occupied by the malls. One of the most interesting cases is that of the world's largest mall, New South China Mall. As of 2010, nearly 99 percent of the stores inside the mall were vacant. Unlike the trend of bigger malls in many Asian nations, the trend in the United States has been moving toward the development of strip malls and big box centers. From 2006 to 2009, only one enclosed mall was opened in the United States. One alternative to the shopping mall is the online retail location. This movement from bricks and mortar to the virtual could result in major energy savings. In the case of a shopping mall bookstore, energy costs run $1.10 per sq ft, while an online bookstore has energy costs of $0.56 per sq ft.

Popular Culture

Because of their ubiquity, shopping malls have received significant attention in popular culture.

Films like *Paul Blart: Mall Cop* and *Mallrats* in part poke fun at the central role that malls play in everyday life, while *Dawn of the Dead* uses an emblematic scene of zombies going mindlessly up and down escalators in a shopping mall as an existential reflection on the nature of mall life. The parody newspaper the *Onion* once did a spoof feature on a shopping mall in North Dakota that spanned six different zip codes and had 4,700 stores and 240,000 parking spaces. While this story is parody, in the future, malls of this scale may not be out of the question.

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See Also: Consumerism; Home Shopping; Overconsumption; Supermarkets.

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Manila, Philippines

Metropolitan Manila is the formal name given to the 13 cities and four municipalities that comprise a rapidly growing megacity, one that is facing very serious problems of solid waste management, pollution, and associated threats to environmental health and sustainability. The estimated population of Metro Manila (as it is more widely known) is 12 million, though that comprises a commuting population of some 2–3 million during weekdays from surrounding regions.

Metro Manila's postwar growth has been phenomenal. In little more than six decades, it has grown from a population of a little over 1 million to a 21st-century megacity. In 2020, it is estimated Metro Manila's population will rise to around 18.5 million within 385 square miles, making it one of the most populated urban regions in the world.

It is, therefore, not surprising that concomitant infrastructure and institutional responses have lagged behind demand. Metro Manila's governance and planning has been hobbled by politics and intracity competition. Local government exercises considerable power in the Philippines, often at the expense of coordinated responses to shared problems. This is evident in solid waste management. Negotiations over access to landfills, which operate close to capacity, occur on a regular basis. Waste management and disposal is often an election issue. In 2000, Metro Manila's main landfill site, Carmona, closed, leaving several much-smaller sites to cope with demand. In actuality, most of Metro Manila's landfills do not meet international standards of sanitary disposal and can best be described as open dump sites.

Metro Manila has grown in enormous leaps in just over 60 years, from a population of just over 1 million to a massive megacity of 12 million. In 2020, it is estimated that Metro Manila's population will rise to around 18.5 million, making the city one of the most populated urban regions in the world. Total waste and per capita waste generation are also expected to increase substantially. Infrastructure and administration has not kept up with this growth, and local political negotiations determine the use of limited landfill space.

Waste Production and Composition

It is estimated that Metro Manila produced 7,000 metric tons of waste daily in 2010, a daily waste per capita rate of 0.66 kilograms (kg). Government estimates show that both total waste and per capita waste generation will increase substantially by 2020 (16,166 daily metric tons at 0.874 kg per capita). Between 65 and 85 percent of waste is collected, though coverage is said to be declining with the growing population and declining service coverage, particularly in poorer and informal settlements (informal, or "squatter," communities make up some 35 percent of Metro Manila's population). This results in substantial open dumping or burning of waste. Illegal dumping is estimated at around 25 percent of solid waste disposal. Much of what is openly dumped finds its way into the city's numerous *esteros* (estuaries) and has contributed to severe water pollution problems. The impacts of waste, then, have been considerable in Metro Manila. Consequently, given the environmental, health, economic, and political impacts of waste, much greater efforts have been made in the 21st century toward cleaner production (CP) and waste minimization. Solid waste is also estimated to make a significant contribution to Metro Manila's poor air quality, in the form of carbon dioxide from burning and methane gases from open dump sites.

Around 75 percent of solid waste streams in Metro Manila are derived from households. The composition of waste shows that most is recyclable, and a high percentage of waste is organic. Most studies of waste composition over the past decade have estimated that food waste alone accounts for nearly 50 percent of total waste composition in Metro Manila. Though the majority of solid waste is collected in Metro Manila, there are no designated collection points. This leads to "legal" dumping in front of households or on street corners. Scavengers are an important source of recycling and collection, though only for types of waste that have value. Scavenging can also contribute to problems of waste dispersal, as garbage without value is simply redumped in public areas.

Waste Management Programs and Problems

The enactment of RA9003, the Ecological Solid Waste Management Act, in 2000, was largely in response to the crisis in availability of landfill options and increased local government conflict over responsibility for waste. RA9003 encourages waste minimization in order to maintain a healthy and clean environment and has resulted in the setting up of solid waste management bodies at national, provincial, and municipal levels of government, which are responsible for establishing coordinated waste management plans. Though a National Ecology Center has been created in an advisory role, the act places emphasis on the role of local government to both lessen waste and to divert it from landfills (and finance such activities). A diversion target rate of 5 percent per year was given to local governments to encourage a shift away from landfill dependence. However, the realization of such targets is very uneven across Metro Manila, and it is important to note that most programs targeting waste segregation and recycling activities are limited to middle- and upper-class communities.

Though RA9003 encourages waste segregation, few households practice this unless it is to separate materials that can be sold or donated to scavengers. One study undertaken in the late 1990s noted that only 1 percent of waste was recycled, but this lowly figure has increased in recent years and does not take into account the role of informal scavenging and recycling, the scale of which can only be estimated. Still, efforts to encourage household waste segregation and recycling were considered to be as failing by 2010, despite the existence of penalties and the enactment of a number of regulations. Common reasons given for this indifference include the belief that government is responsible for garbage, that systems merely mix waste sources at a later stage, the opportunity cost of the time taken to segregate waste, and the lack of information or encouragement given to do so. It is widely observed as well that garbage trucks picking up segregated waste do not separate it, leading to the later mixing of waste. It is important to note, though, that waste is still most likely to be resorted, recycled, and used at the end disposal point by the thousands of families who live and work on the city's landfill sites, most notably Payatas.

Alternative Programs

Though Metro Manila as a whole has struggled to manage solid waste and create viable and effective alternatives to open dumping and landfill dependence, in part a result of the passing of the Clean Air Act in 1999 that bans incineration of waste (putting greater pressure on landfills), there are a number of successful initiatives at a local level.

Barangay Sun Valley, in Paranaque City, has since 1998 operated a "no segregation, no collection" program (the Total Segregation Approach to Ecological Waste Management program) in which segregated waste is collected in three phases and sent to different locations: biodegradable waste to composting centers, recycling materials to junkshops and recycling factories, and residual waste to landfills in standard garbage trucks. The initiative is based on three principles: segregation at source, segregated collection, and segregated destination. However, such programs remain limited in scope. Even households participating in the program continue to rely on informal collectors (for convenience and as a form of social support for the poor) and burning. This demonstrates the persistence overall of established patterns of waste disposal and systems and the difficulty of significantly shifting away from these behaviors and economies—at least in the short term.

Perhaps the best-known program in Metro Manila, which builds upon environmental, social, and economic systems of waste, is the much-heralded *Linis Ganda* (meaning "clean and beautiful") program. Nominated at the Istanbul Habitat II conference as a leading global practice for handling garbage, *Linis Ganda* is a privately run resource recovery and recycling program. The program's hundreds of recycling cooperatives collect, recycle, and process over 200,000 tons of garbage annually in a number of Philippine cities, but most are active in Metro Manila. An added attribute is that it encourages the development of recycling cooperatives and the establishment of junk shops. In particular, *Linis Ganda* seeks to lessen the stigma and increase the livelihood opportunities of door-to-door waste recyclers in the program,

known as "eco-aids," through establishing consistent routes and household and school collection systems and, therefore, income. As of 2010, there are more than 3,500 uniformed eco-aids who, through their organization into cooperatives, are able to access low-interest and collateral government business loans.

Conclusion

The development of such formal–informal partnerships and innovations will be critical in the future management of waste. As a growing megacity, Metro Manila faces considerable and difficult challenges in managing the substantial impact of development. The consequences are environmental, but waste management is increasingly becoming a political issue and raises questions over governance. There is also significant economic cost associated with waste production and management in Metro Manila.

This has been estimated by city mayors to be 10–20 percent of their overall budgets, a cost likely to rise significantly in the future. However, waste has provided an opportunity for enhanced livelihoods and social inclusions, as evidenced through the celebrated *Linis Ganda* program. The management of waste is intrinsic to the future of Metro Manila but these challenges remain largely unmet.

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See Also: Developing Countries; Open Burning; Open Dump; Organic Waste; Politics of Waste; Population Growth; Slums; Street Scavenging and Trash Picking.

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Marine Protection, Research, and Sanctuaries Act

Rachel Carson elevated public awareness about the long-term detrimental effects of pesticides widely used in the U.S. agricultural industry with her 1962 book, *Silent Spring*. Many credit Carson with launching the environmental movement of the 1970s, but few realize that she began her career as a marine biologist with the U.S. Bureau of Fisheries and wrote extensively about marine life and the undersea world.

During the 1970s, air and water pollution, as well as other environmental issues, commanded federal attention, resulting in the creation of new regulations and agencies. Congress passed the Marine Protection, Research, and Sanctuaries Act (MPRSA) in 1972 during the administration of President Richard M. Nixon. The newly formed Environmental Protection Agency (EPA) was granted authority to regulate and enforce MPRSA.

Ocean Dumping

As its name suggests, MPRSA initiated groundbreaking legislation designed to address all aspects concerning the safety, sanctity, and proliferation of marine waters. One of the most critical problems motivating the need for legislation was an alarming escalation in the amount of urban sewage and industrial waste being dumped into both coastal and deepwater marine areas. For this reason, MPRSA is also known as the Ocean Dumping Act. The EPA regularly monitored ocean dumping and made reports to Congress from 1973 to 1990. The Ocean Dumping Ban Act of 1988 amended dumping concerns outlined in MPRSA by prohibiting the dumping of sewage sludge and industrial waste after 1991.

One area particularly threatened by ocean dumping and targeted for specific protection under MPRSA is the New York Bight Apex, an area in the continental shelf waters of the Atlantic Ocean. The dumping of municipal sewage sludge at a site located only 12 miles from Sandy Hook, New Jersey, was phased out between 1983 and 1986. Beginning in 1986, permits for dumping were authorized in waters deeper than 2,000 meters (m), at a site designated 106 miles (mi.)

One of the most critical problems motivating the need for legislation protecting marine ecosystems is an alarming increase in the amount of residential sewage and industrial waste being dumped into coastal and deepwater marine areas. The Marine Protection, Research, and Sanctuaries Act of 1972, which was regulated and enforced by the newly formed Environmental Protection Agency, was designed to address the safety, sanctity, and proliferation of marine waters, including such areas as industrial waste disposal, ocean drilling, and research.

from shore. In 1995, the EPA and the National Oceanic and Atmospheric Administration issued a report to Congress concerning the effects of sewage dumping on the 106-mi. site and industrial waste disposal at a former site nearby, which was also called the 106-mi. site.

In accordance with the Ocean Dumping Ban Act of 1988, industrial waste disposal ceased in 1987, and the former site was officially de-designated in 1992. Dumping at the 106-mi. municipal sewage site also ceased in 1992.

Unlike the Rivers and Harbors Act, which regulates the release of refuse and waste so as not to impede the navigation of inland waterways and coastal harbors, MPRSA regulates ocean dumping with the primary purposes of protecting living marine resources, ensuring the viability of commercial fishing endeavors, and preventing potential health hazards to humans. To this end, MPRSA also includes provisions for marine research, especially regarding the effects of ocean dumping on the marine environment and the establishment of sanctuaries to preserve and protect marine ecosystems. Among the topics covered are regulations for coastal zone management, the administration of funding for research programs, the maintenance of standards for marine sanctuaries, and the enforcement of legislation. Several amendments were made to MPRSA from 1974 to 1996.

Ocean Drilling and International Waters

Ocean drilling, an industry established long before 1972, also comes under the scrutiny of MPRSA. In the wake of the 2010 British Petroleum oil rig disaster in the Gulf of Mexico, it is interesting to note that MPRSA cites the director of the Minerals Management Service as one of the key authorities with whom the EPA administrator must consult in developing and implementing MPRSA strategy. MPRSA legislation is not limited in scope to the

boundaries of U.S. territorial waters. Section 109 mandates that the secretary of state and EPA administrator seek to capture the attention and cooperation of the international community regarding the world's oceans. The Third United Nations (UN) Conference on the Law of the Sea was convened in 1973 and established precedents for negotiation and discussion regarding legislation for international waters, culminating in the 1982 UN Convention on the Law of the Sea. The 1982 convention codified commonly accepted principles and new concepts regarding the high seas, the continental shelf, fishing rights, pollution, marine scientific research, and other related topics.

As of 2005, the 1982 convention was accepted by 148 parties. Certain articles of the 1982 convention are worth highlighting. Article 56 proscribes jurisdiction over marine scientific research and the protection and preservation of the marine environment within the exclusive economic zone to the coastal state. Accordingly, other states with rights in the exclusive economic zone must defer to and comply with the laws of the coastal state. Article 94 defines duties of the flag state of a ship, including the adherence to international regulations concerning the reduction and control of marine pollution. Articles 116 through 119 outline the fishing rights and duties for the conservation and management of living resources of the high seas.

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See Also: Clean Water Act; Environmental Protection Agency (EPA); Pollution, Water; Rivers and Harbors Act.

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Marketing, Consumer Behavior, and Garbage

Poor societies produce less garbage than affluent societies. Although garbage has been problematic since people have begun forming settlements, industrialization has been credited with initializing large-scale environmental degradation. Prior to the creation and use of incinerators in 1885, refuse, garbage, and animal waste were left in the streets to be trampled upon or to be eaten by livestock, bringing health devastation such as cholera, in addition to environmental degradation. With industrialization came consumerism, and the remains of that consumerism have created heightened levels of garbage.

Although adapting to changing needs over time, marketing has been in existence since people have sought prosperity. By attracting a wider audience, producers (and marketers) could sell more and thus increase profitability. The use of mass media for advertising has created a monolith of spiraling overconsumption: the more products one has, the more space one needs to store the products, and the more waste that accumulates, eventually affecting landfills with packaging and products.

History of Consumerism and Garbage

While initial forms of advertising appeared as matter-of-fact statements in newspapers, marketing became more sophisticated with the onset of the Industrial Revolution. By the 1800s, advertisers began to adopt the persuasive techniques that Westerners are accustomed to seeing: graphics, language, and statements of grandeur. In the late 1800s, commercialization brought convenience and, with it, challenges. In 1879, Frank Woolworth

pioneered the idea of contemporary retail sales by openly displaying products on counters so that consumers could see and feel the merchandise, enticing them to purchase. Prior to direct access, customers looked at products from afar or required direct assistance. Woolworth's practice of hands-on salesmanship, novel and ingenious in its time, later made larger, antitheft packaging necessary.

Accompanying this higher demand for products was a call for convenience and affordability. This movement began in 1895 with Gillette's creation of the first razor with disposable blades, with the first fully disposable razors becoming available in the 1960s. Disposability meant that products became, in the short run, cheaper and less durable. The trend toward a disposable society grew exponentially in the early 1900s, as household products such as linens and mugs were replaced by paper towels, Kleenex, and paper cups. The creation of wax paper for cereal box liners and as bread wrappers meant that products could be manufactured and shipped for broader consumption. Over time, disposability became so rampant that only a century after its creation, the average U.S. worker used approximately 500 disposable cups per year.

Expanding on the hands-on, do-it-yourself merchandising success of Woolworth, Clarence Saunders opened the first supermarket in 1926. The introduction of prepackaged foods and self-service packaging increased food and product selection while decreasing the cost. Packaging was enhanced in 1928 when cellophane was invented, enabling protection of foods and other products, and in 1939 with the creation of precooked frozen foods. With the creation and widespread use of convenience foods and increasing consumerism came an increase in packaging. This packaging enhancement was both for product safety, so that foods would arrive to their destinations intact, and to increase product desirability. More than plain brown wrappings, the packaging became advertising in its own right, enticing consumers to purchase goods.

Produce and Sell More

In 1947, industrial designer Gordon Lippincott, working to capitalize on this trend toward mass production, stated, "our willingness to part with something before it is completely worn out is a phenomenon noticeable in no other society in history . . . it is soundly based on our economy of abundance. It must be further nurtured even though it runs contrary to one of the oldest inbred laws of humanity; the law of thrift." Producers, and thus marketers, focused on revenue generation and profitability to fuel further production. The objective in the industrial age is increased consumption, diametrically opposed to the value of thrift emphasized during and after the Great Depression.

From the drive toward increased consumerism, in the 1950s, the United States saw a vast growth in convenience foods accompanied by a surge in packaging waste that now needed disposal, including the ubiquitous television dinner. This trend continued when, in 1953, the chairman of U.S. President Dwight D. Eisenhower's Council of Economic Advisors emphasized that the U.S. economy's "ultimate purpose is to produce more consumer goods." B. Earl Puckett of Allied Stores added that "it is our job to make women unhappy with what they have." The age of consumerism was upon the United States, with an ever-increasing desire to produce and sell more. By 1954, this proliferation of the net of discontent was cast wide to include children as consumers.

The savage consumerism that ensued was legendary, with the 1980s being the epitome of overconsumption. By 1988, the Environmental Protection Agency (EPA) estimated that 70 percent of landfills had closed because they were full, unsafe, or had not adhered to set standards. Not seen as "good neighbors," NIMBY (Not in My Backyard) ensued and it was—and continues to be—difficult to site new landfills. In 1989, the EPA issued an Agenda for Action, with a focus on waste reduction and recycling. Michael Jacobson of the Center for the Study of Commercialism lamented that marketing initiatives could do more; people are "reminded a hundred times a day to buy things, but we're not reminded to take care of them, repair them, reuse them, or give them away." This growing sentiment of wastefulness has not shown a negative impact on sales and marketing but has shown some success in participation in recycling initiatives that, at the least, keep products out of the waste stream.

Zero Waste America reports that, while recycling efforts have increased dramatically (32 percent in

2005 compared to 6.4 percent in 1960), the amount of municipal waste per capita is also increasing. The amount of waste incinerated has decreased by nearly half between 1960 and 2005 (from 30.6 percent to 15.9 percent). Meanwhile, with recycling efforts on the rise, in 2005 the EPA issued the Resource Conservation Challenge 2005 Action Plan, creating recycling initiatives to help the United States reach the national goal of recycling 35 percent of municipal waste. Key areas of focus included paper/paperboard (from 44.9 to 53.8 percent), food waste (from 2.8 to 5 percent), yard trimmings (from 56.5 to 60 percent), folding paper cartons (from 8.7 to 14 percent), wood packaging (from 15 to 24 percent), plastic wraps (from 6.6 to 19 percent), and beverage containers (from 26 to 39 percent).

According to the Clean Air Council, one-third of waste generated in the United States is packaging. Further, an additional 5 million tons of waste is generated during the holidays; 4 million tons of this is wrapping paper and shopping bags. While conventional wisdom suggests that product packaging ravages landfills in its excess, there is some argument that additional packaging reduces the impact on landfills by reducing product breakage and food waste. Food waste, mostly from fresh fruits and vegetables, dairy, and grain products, is the third-largest waste component by weight.

When measuring municipal waste by weight rather than volume, packaging has decreased by 30 to 70 percent since the mid-1980s. This is largely because product packaging has become more compact as new technologies for product and shipping safety become available. This is a double-edged sword since, as packaging becomes increasingly economical, products travel farther distances. For example, due to enhanced packaging and transportation, kiwifruit can be imported by the United States from Australia. Long-distance shipping influences not only packaging and waste but also fuel expenditures and other wastes as transportation distances increase.

As demand for more exotic imports becomes increasingly widespread, cross-contamination by pests and diseases from once-remote quadrants becomes increasingly likely and dangerous. For example, West Nile virus, once endemic to Egypt and the Nile River basin, now makes regular appearances in the United States. The Mediterranean fruit fly (medfly) infestation in California in the early 1980s not only affected the local economies in which the infestation spread but has also affected agricultural exports. Pacific Rim countries, particularly China and Japan, disallow exports of crates containing evidence of medfly larvae for fear of contamination spread.

Supply and Demand

The rise of industrialization enabled producers to manufacture products that had previously been painstakingly made by hand. Steel and iron came into ready use by the 18th century in conjunction with technological changes such as the invention of the steam engine and the spinning jenny. Transportation and communication were also modernized with the widespread use of railroads and the telegraph. With the rise of process mechanization, the economy shifted from that of informal, home-based production to that of a formal, factory-based production. As production became increasingly formalized, bureaucracies were formulated to manage the new working class. The streamlining of processes through automation meant that much more merchandise could be produced in a fraction of the original time and at a substantial cost savings.

With the proliferation of merchandise that was available through industrialization in a market economy came an increased need to sell more products to more people. Rather than selling merely to the local economy, there was a need to expand sales to larger markets. The faceless nature of broad sales inherent in industrialization and bureaucratization also brought alienation. Not having hand produced each product, workers were less invested in the product because of mechanization; workers were responsible for only a part of the process, rather than the workmanship required to make the merchandise from start to finish.

Mechanization also meant that each piece could be made perfectly, faster than could be done by hand, thereby increasing the precision of components. Where industrialization created assembly lines and permitted mass production of items, it also permitted the creation of spare parts. Since parts were now identical, they could be more easily replaced.

Instead of buying a whole new product, products could be repaired, thus lengthening the longevity of the product.

The speed of production created an increased need for advertising because there was a need for higher demand to meet the larger supply. Since the products were not being bartered or sold between neighbors, there was a need to enhance the perception of want for the respective products. Enticing someone to purchase something that they could make themselves took a new way of thinking and approaching marketability. For rural customers of the late 1800s, catalog sales served as a lifeline to the lifestyle that many dreamed of having. The Sears and Roebuck Wishbook brought modern conveniences, styles, and home goods to those who otherwise did not have access.

Marketing and Mass Media

An unexpected boon for marketing occurred in 1904 when Postmaster General Henry Clay Payne first authorized permit mail. With this, a single fee allowed 2,000 or more pieces of mail to be delivered without stamps, thus creating the opportunity for direct mail. As a result, retailer Montgomery Ward mailed out 3 million four-pound catalogues to waiting customers. A century later, Americans currently receive approximately 4 million tons of direct mail each year, most of which ends up in landfills.

Mass media, spanning across print, television, radio, film, and computers, allows manufacturers and advertisers to communicate with vast numbers of potential customers across a wide array of locales and walks of life. Through highly accessible media outlets, advertising is largely able to promote products and convince large segments of the population to purchase questionably necessary products. The food of the ubiquitous U.S. icon, McDonalds' Big Mac, is now consumed worldwide in largely the same style, irrespective of cultural differences.

In an effort to keep up with the proverbial Joneses, Americans are buying more, working more, saving less, and getting further behind. Mass media campaigns are largely responsible for fueling rampant consumerism. Consumers are convinced that not only will the product work as advertised but also a single, convenient product will make them slimmer, smarter, more popular, and thus more desirable. Marketing to a bloated culture means that more and newer products are required not only to keep up but also that the products will achieve results faster and with less effort—the ultimate in convenience. For example, using Bod Man body spray will have women fighting over average-looking men, and Slimfast will make dieters model-slim, fast.

In addition to products that are designed to make the person appear more successful and desirable, mass marketing has spread to areas beyond the individual's presentation of self. Transportation, once considered merely necessary to get from one point to another, now serves as a status symbol. Public transportation is often perceived to be the transportation of the poor, with the wealthy driving (and displaying) increasingly upscale modes of transportation: luxury automobiles that purport to be driving as if riding on a cloud (and costing as much as some housing). In lieu of passenger planes or ships, private jets and luxury yachts take luxury and one-upmanship to the air and seas, respectively.

While the size of the average U.S. family has been decreasing over time, the average home size has increased by more than 50 percent since the 1950s, with nearly an additional 1,300 square feet of living space. One in five new homes is larger than 3,000 square feet, although the trend is to begin to scale back the size of homes. Fourteen million U.S. households own at least four television sets. Since 2001, the number of Americans who purchased second homes increased by 24 percent.

Overconsumption is rampant to the point that people who claim to be unable to afford food or housing display excess through designer-label clothes and smart phones with the requisite data plan. Mass media has displayed what are the appropriate icons of the culture and, to be a cultural member, these items must be displayed—even at the cost of basic necessities. All of this consumption comes at a cost, including deficiencies in health and well-being and the maintenance of an unending spiral of consumption and waste. As newer, sexier products are advertised and purchased, older items—often still usable in their capacity—are discarded.

Recycling Initiatives

Mass media is a powerful tool for social change. The same techniques used in product marketing have been shown to be effective in community development. Consumer-oriented social marketing includes design, implementation, and program control to increase popularity of a social idea among a target population. A prime example of the effectiveness of a social marketing campaign is the antismoking crusade that dramatically shifted public opinion and policies about consumption and public display.

According to the Council for Waste Solutions, nearly 40 percent of waste in the United States may have extended use or redistribution potential: 14 percent durable (such as appliances) and 25 percent semidurable (such as books or clothes). In the mix of appliances, furniture, and clothing, a significant portion of waste comes from food packaging and food remnants. In developing countries, these extended-use items fuel the local economy, much of which is surviving on scraps, rather than filling landfills.

As of 2010 in the Westernized world, recycling is well accepted at both consumer and commercial levels, with 90 percent of households reporting that they support recycling initiatives. Separate bins for recycling and trash can be found and are used in many public areas as well as in homes and offices. However, according to the EPA, the volume of household waste in the United States generally increases 25 percent between Thanksgiving and New Year's Day—about 1 million extra tons. In 2010, while unemployment soared at 9.6 percent, Black Friday, so named for the notorious shopping day on which retailers' sales put them "back in the black," sales rose (19 percent online and 12 percent in retail stores) with a 33-percent increase in Thanksgiving shopping. Ironically, studies show that greater waste occurs in time of scarcity: shortages create situational pressures during which people buy more than they need. In the United States, 12 percent of grocery products are wasted and never used. For example, if there were a shortage of bananas, consumers fearful of being denied access to bananas would be likely to purchase more than they need in an attempt to ensure that they are not left without any bananas, thus taking more than their "share" and generating additional waste when the bananas are not consumed before spoiling.

In addition to traditional recycling, in which items are destroyed to create new products such as paper and plastic, a type of recycling growing in popularity is the reuse of items through donation. Goodwill has been in operation since the early 20th century, selling inexpensive cast-offs to people in need. Organizations such as Matthew 25: Ministries accept usable products to be given to the world's less fortunate. In addition to individual donations of clothes and household goods, Matthew 25: Ministries receives many product donations from corporations. Misprints, overruns, or "imperfects" (products usable but not sellable that otherwise would have gone to feed local landfills) are given to people in need. Habitat for Humanity, best known for building homes for the poor, also operates ReStore, which accepts usable appliances and construction materials to sell at discounted prices, generating revenues to further operations and simultaneously avoiding contributing to landfills with otherwise serviceable products.

Precycling

Beyond recycling is an emerging initiative—precycling. The goal of precycling is to reduce the burden on landfills by encouraging consumers to make sustainability considerations part of the purchasing decision, including the rejection of the purchase of unnecessary products and packaging that cause disposal problems and instead choosing quality products that are reusable with a long product life.

Inherent in the philosophy of precycling is decreased consumption. This includes purchasing appliances only when older appliances are no longer functional or sustainable. When there comes a need to replace a worn-out appliance, careful planning takes place in an attempt to ensure that the purchased product will last for an extensive length of time and, where appropriate, will be an energy-saving device.

Unfortunately for many, this decision comes at a cost as the higher-quality, more-sustainable, and longer-lasting products are accompanied by a higher price tag. While the long-run benefits may be substantial, consumers may have difficulty absorbing the short-term costs. For example, tankless water heaters that heat water on demand purport to save

The goal of precycling is to reduce the burden on landfills by encouraging consumers to consider sustainability when deciding what products to purchase, or if the purchase is needed at all. Deciding factors include durability and minimal packaging.

energy and thus money. The financial reality is that, on average, tankless water heaters cost more than twice as much as standard water heaters, and installation costs are more than four times as much as a standard install.

Further, some consumers may opt to dispose of usable products in exchange for newer, more-sustainable products that claim to save energy, and thus money, in the short run. Purchasing a hybrid vehicle may be a sound choice if one were in need of a new vehicle. However, if a person were to dispose of a working vehicle in exchange for a hybrid vehicle, estimates indicate that it would take at least seven years to realize fuel-cost savings.

While precycling is certainly a wise choice toward achieving a sustainable environment, it is often a choice for the elite. Until sustainable products also become more affordable, as through supply-demand economics, they are less likely to be an option chosen by the masses. Assuming the market economy goal to produce more is maintained and demand for sustainable products continues to grow, mass-media marketing will continue to increase the desirability of quality, sustainable products. Precycling will certainly continue to grow as a successful initiative.

Conclusion

With industrialization came consumerism and the remains of that consumerism have created heightened levels of garbage. In an attempt to increase revenues and profits, marketers have sought to attract wider audiences through the use of mass media, creating a monolith of spiraling overconsumption. Perhaps as consumer preference shifts toward more-sustainable products and a general belief in environmental sustainability, marketers will find new ways to popularize thrift while investing in renewable systems and technologies to create a sustainable level of refuse.

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See Also: Capitalism; Consumerism; Gillette, King C.; Grocery Stores; Junk Mail; Materialist Values; Overconsumption; Sociology of Waste; Supermarkets; Sustainable Waste Management.

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Maryland

A U.S. state in the mid-Atlantic region, the variety of topography in the state of Maryland promotes the nickname "America in Miniature." Most of the population is urban and suburban and is situated around Washington, D.C. (the capital district), and Baltimore, the state's largest city, forming the Baltimore-Washington Metropolitan Area. The U.S. Census Bureau states that, in 2009, Maryland had the highest median household income ($69,272). The state is a major center of life sciences research and development, particularly in biotechnology. Economic activity is strong in the tertiary service sector, which is heavily influenced by location, including the Port of Baltimore and its related rail and trucking and the close proximity of the center of government in Washington, D.C., which requires technical and administrative staff. Food production is also a major part of the Maryland economy, having a large commercial fishing industry in and around Chesapeake Bay and also on the Atlantic Coast. Large agricultural areas also exist, primarily used for dairying and speciality horticulture crops. The southern counties are sufficiently warm to allow a tobacco cash crop to be grown. Manufacturing in Maryland has a high dollar value and is highly diversified. One of the most environmentally friendly states in the United States, Forbes.com ranked Maryland as the fifth-"greenest" state in 2007. The state is a very low consumer of energy and produces very little toxic waste. In 1988, the state passed the Maryland Recycling Act (MRA), which established that newsprint and telephone directories distributed in the state must use recycled paper and required recycling programs in Maryland's jurisdictions and in state government.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Maryland had an estimated 7,009,905 tons of municipal solid waste (MSW) generation, placing it 21st in a survey of the 50 states and the capital district. Based on the 2006 population of 5,602,017, an estimated 1.25 tons of MSW were generated per person per year (ranking 25th). Maryland has nine waste-to-energy (WTE) facilities, which processed 1,371,970 tons of MSW (eighth out of 32 respondents). Maryland recycled 2,536,633 tons of MSW, placing Maryland 17th in the ranking of recycled MSW tonnage. It landfilled 3,101,302 tons (26th) in the state's 22 landfills. It exported 2,861,849 tons of MSW, and the import tonnage was 302,167. In 2006, Maryland was not increasing its 84,838,536-cubic-yard landfill capacity; it was ranked 21st out of 44 respondent states for number of landfills. Separately bagged yard waste, recyclable containers and paper, asphalt paving, brick, concrete, metal, wood, whole tires, used oil, and white goods were reported as banned from Maryland landfills. Tipping fees across Maryland averaged $52, where the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively.

Brief History of Waste

With the invention in the early 1800s in England of a de-inking process for paper recycling by Matthias Koops, the potential of recycling paper and using wood pulp to make paper was unlocked. In 1874, Baltimore began the first-ever curbside recycling of

paper, but the program ultimately failed (the concept re-emerged successfully in the 1890s, in New York). Around this time, Baltimore had acquired an unfortunate reputation as "the city of open sewers," the last major U.S. city to use a cesspool drainage system; there were 80,000 open sewers in the city area.

City leaders rejected proposals for a citywide sewer system several times between 1859 and 1905 because of opposition and political infighting. Baltimore adopted the landfill system during World War II when there was insufficient manpower to run the city incinerators. The process was so efficient that it was continued in peacetime.

Hampden Community Archaeology Project

The University of Maryland Hampden Community Archaeology Project (HCAP), established in 2005, devoted its first seasons to the excavation of dumps and privies and studying the use and appearance of yards. Statistical comparisons of artifact assemblages from "end of row" communal dumps and single-family yard middens and privies has also been undertaken to examine the everyday lives and consumption of mill worker families. The HCAP set out to create a public and critical dialogue on the issues of class and economic inequality, which were relevant to the neighborhood's issues.

Hampden was a historical by working-class neighborhood in Baltimore, a 7,500-strong urban community dating back to the early 19th century. The village developed to support the gristmills along Jones Falls, which were then converted in the textile industry boom before being incorporated into the city in 1888. The area remained a predominantly white, working-class area into the 1970s and was transformed by gentrification in the early 1990s. The area had a strong history of working-class activism and labor disputes with the mill owners before the mill companies moved south in search of cheaper labor, and the massive drop in demand after World War II, reduced Hampden's industrial base.

Baltimore Pyrolysis Plant

In the late 1960s and early 1970s, faced with the crises of garbage accumulation and oil shortage, the U.S. government funded various resource recovery research programs in the hope that WTE could alleviate some of the problems. Pyrolysis, which cooked trash rather than incinerating it to release oil, carbon, and gas, was seen as the most promising method of disposal, as it provided a solution to both the garbage and the oil problems. It was, however, also the most expensive, technologically complex, and heavily funded of the WTE methods under research.

Roughly contemporary with the pyrolysis experiments in San Diego County, California, the city of Baltimore and the state engaged a similar project. The plant was constructed by Monsanto Enviro-Chem Systems, Inc., which was given one of the largest pyrolysis demonstration grants ever awarded by the Environmental Protection Agency (EPA). It proceeded with what was at that point the most expensive resource recovery facility ever built.

Monsanto was convinced that its Landgard system could process half of Baltimore's waste (1,000 tons of MSW per day) in a plant vaunted as the "first full-scale pyrolysis solid-waste disposal and resource-recovery system in the world." The Landgard system is not regarded as true pyrolysis, as a form of pyrolysis is only used in the initial processing stages before the heated waste is combusted and the gas converted to steam, not a product of true pyrolysis.

After cost overruns in excess of $11 million, when the Baltimore Pyrolysis Plant opened in 1974, it did not meet Maryland's new air quality regulations and was beset by unrelenting technical problems, which saw it dubbed the "Paralysis Plant." The plant ended up causing a city garbage crisis, and Baltimore was left with a large part of the final $27 million bill. The plant, which was technically an incinerator and not a pyrolysis plant, did irreparable damage to the reputation of pyrolysis, which led the director of Maryland Environmental Services to state that, "Just the word *pyrolysis* makes people nervous." Monsanto recommended shutting the plant down, but it was able to run at a reduced load despite the high expense per ton this involved. Eventually, Monsanto withdrew from the project, and the city converted it into a mass burn WTE plant.

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See Also: Incinerators; Sewage; Sewage Collection System.

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Massachusetts

The Commonwealth of Massachusetts has a population (2009 est.) of 6,593,587. The urbanized region of Boston is estimated to have a population (2008 est.) of 4,522,858. Massachusetts is the third most densely populated state at 809.8 persons per square mile.

With settlements dating from the 1620s, the Commonwealth of Massachusetts has a long history of handling and disposing of waste. Although industrialization brought inevitable environmental degradation, early adoption of public waste handling and infrastructural practices, presence of numerous educational and research institutions, and implementation of large infrastructural projects have made Massachusetts a center for advancements in waste treatment, disposal, reduction, and recycling.

General History

Under British rule, Massachusetts' ports were critical locations for international trade. As material and energy flows increased, the towns surrounding Massachusetts Bay flourished, as did waste accumulation and degradation of waterways. The Boston Tea Party of 1773 intensified a trend of pollution into Boston Harbor that would continue for the next 200 years. After the American Revolution, Massachusetts developed into a primary site of the Industrial Revolution, where textile manufacturing centers such as Lowell and Holyoke blossomed early in the 1800s, as well as other centers focused on machine tools, shoes, and paper products. This transition from agriculture to industry created long-lasting environmental damage as populations soared and industries took advantage of local natural resources. New Bedford, a shipping and textiles center on Buzzards Bay, exemplified the unfortunate outcome of years of neglect; the harbor was labeled a Superfund site in 1982 by the Environmental Protection Agency (EPA). The textile industry's collapse in the early 20th century has led to growth of high-tech and biotech industries emerging out of the many local educational institutions, which have generated associated hazardous and biological wastes.

Solid Waste Collection and Disposal

Throughout the commonwealth, waste collection and disposal has historically relied on both landfills and combustion. The use of one method over the other was, until the 1960s, a matter of availability and cost of transport, but with little regulation for health or environmental concerns. In the heavily populated eastern regions, local landfills have gradually been replaced by combustion and larger regional landfill sites because of space limitations.

Massachusetts enacted its first solid waste disposal law in 1955, allowing local health boards the power to approve new waste disposal facilities before construction. In 1982, voters passed the Beverage Container Recovery Law, or "Bottle Bill," requiring a $0.05 deposit on all retail sales of bottles and cans. A 1987 overhaul of the law included new regulations for siting facilities and provided funds for municipalities to improve outdated facilities. In 1990, the Massachusetts Department of Environmental Protection (MassDEP), the commonwealth's waste regulator and manager, introduced the first Solid Waste Master Plan, as well as a series of measures aimed at decreasing hazardous waste and banning specific materials from landfill or combustion. Since then, MassDEP

has overseen the closure and cleanup of countless contaminated sites, reducing the number of landfill sites from 150 before 1990 to 24 in 2010. MassDEP has also regulated mercury since 2006, with the intent of phasing it out of the Commonwealth's waste stream.

By 2010, seven combustion facilities existed in Massachusetts, disposing of an average of 25 percent of generated material, and all were operated by either Covanta Energy or the Wheelabrator Corporation, a division of Texas-based Waste Management, Inc. The 24 active landfills receive an average of only 15 percent of material generated. The remaining material, almost 50 percent since adoption of the MassDEP master plans, is diverted from disposal or combustion through recycling and compost. Although this rate ranks among the nation's highest, municipal recycling and composting rates remain consistently low (paper products still make up one-third of the municipal waste stream). Between 1997 and 2010, residential recycling rates fluctuated little at 27–28 percent, with the highest rate of almost 100 percent on Nantucket Island. Boston-area residential recycling is lower still, at 15–25 percent, although the gradual adoption of single-stream recycling practices in municipalities such as Cambridge have attempted to raise this statistic.

Boston's Infrastructure

As Massachusetts' economic, cultural, and political hub, the Boston metropolitan area is also its highest waste producer. Having grown out of a small neck of land in Massachusetts Bay, the city physically transformed itself over three centuries, expanding area, consuming vast monetary and physical resources, and causing substantial environmental impact. During the 19th-century population booms, Boston undertook extensive land-reclamation campaigns, filling surrounding marshlands and Boston Neck's perimeter. Citing health hazards from stagnant water, the Charles River basin's south marshes were filled to create the Back Bay, finished in the 1890s, followed by South Bay. The Massachusetts Institute of Technology (MIT) moved to its present campus on filled land on the Charles River's Cambridge bank in 1910, and Logan Airport added considerable acreage to east Boston in the mid-20th century for jet runways. Material for these operations came from hills at the center of Boston, and from hills and gravel pits as far away as Needham.

Not all large-scale infrastructural projects in Boston have been additive. The Central Artery/Tunnel Project, popularly known as the "Big Dig," was, at $22 billion, the most expensive transportation project in U.S. history by 2010, involving the removal of the 40-year-old elevated highway separating the North End from downtown, replacing it with a 3.5-mile tunnel. Although the project created vast quantities of waste, elements of the waste stream were productively used throughout the region. Of the 30 million tons (16 million cubic yards) of earth excavated for the tunnel, much of the material was used to cap Boston-area landfills or was added to Spectacle Island in Boston Harbor. In 2008, the architecture firm Single Speed Design designed and constructed a prototype house in Lexington using over 600,000 pounds of steel and concrete from the highway's demolition.

Water and Sewage

Massachusetts residents have used private sewers for water runoff since 1700, with the first publicly constructed and maintained storm sewers in Boston created soon after. In 1833, sanitary waste and sewage were added to the system, resulting in dangerous public health issues, chief among them an increase in cholera. Studies resulted in the 1875 construction of the Boston Main Drainage System to flush sewage into Boston Harbor. The Metropolitan Sewerage District was created in 1889, consolidating three formerly distinct districts, becoming the first entity of its kind in the country. As early as the 1930s, the public was voicing unease over polluted conditions in Boston Harbor as a detriment to health and leisure activities. Overflows of sewage from rivers emptying into Boston Harbor were common, resulting in vast beach closures. In response to growing environmental concerns, the city constructed two primary wastewater treatment plants: the Nut Island plant in Quincy (in operation from 1952 to 1998) and the Deer Island plant, which opened in 1968. In the mid-1980s, the newly empowered Boston Water and Sewer Commission oversaw the construction of two main interceptor tunnels to collect water and sewage; a renovation to

the Deer Island plant, which serves approximately 20,500 acres in 2010; and the addition of a 9.5-mile outfall tunnel, allowing the city to discharge treated water into the deep waters of Massachusetts Bay. The system remains far from perfect, with flooding and backups occurring often during heavy rains.

Reform Endeavors

With the presence of many top-tier educational and nonprofit institutions, significant segments of the population are active-minded and progressive. Many organizations, including MassDEP, have endeavored to affect waste management trends. "Don't Waste Massachusetts" was formed in 2009 as a commonwealth-wide alliance of environmental organizations committed to influencing policy decisions, expanding recycling programs, and opposing waste-to-energy and landfill facilities. In academia, at MIT's Media Lab, the SENSEable Cities group has created a system for visualizing the movement of trash after it is thrown away. Titled *Trash-Track,* it attracts volunteers to affix sensors to individual items of their trash, then visualizes their movements via the Internet. Since 1990, MassDEP has released a series of Solid Waste Master Plans in an effort to curb the continually increasing waste disposal demand and to spur job growth in the recycling sector. The master plan under development for 2010 sought to reduce residential and commercial waste by 80 percent by 2050 as well as to eliminate virtually all toxic materials from entering the waste stream. Additionally, MassDEP began a program in 2009 to add renewable energy facilities at closed landfills, including wind turbines and solar panels.

Massachusetts's long history of consuming resources and handling waste has led to vast improvements in efficiency and has allowed the Boston region to flourish. However, large infrastructural projects have forever altered the area's natural ecology, and centuries-old pollution continues to threaten local soils and watersheds. In the early 21st century, the commonwealth works hard to continue upward trends in recycling, waste, and sewage management, while key institutions help make these trends visible.

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See Also: Construction and Demolition Waste; History of Consumption and Waste, U.S., Colonial Period; Industrial Revolution; Pollution, Water; Rivers and Harbors Act; Water Treatment.

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Material Culture, History of

Human activities with objects over the past 2.5 million years have had a significant impact on human cognitive, linguistic, and social configurations. Although other animals, including mammals and birds, employ simple tools to achieve certain tasks (such as using sticks to extract termites from mounds), no other animal makes composite objects or objects that are creatively abstracted from natural forms to produce completely invented shapes and designs. Material culture can be viewed through four dynamic processes: production, distribution, consumption, and discard. Each of these processes leaves a durable signature in the archaeological record through the recovery of artifacts along with their locations of use and abandonment. Production results in the manufacture of objects as well as the discard of waste fragments. The distribution of objects enables one to trace historical trade patterns in both raw materials and finished goods.

The consumption and use of objects includes not only daily activities but also ritual use and the consecration of objects through burial with the dead. Finally, the act of discard is often purposeful in that

the treatment of unwanted objects indicates cultural perceptions of cleanliness and social order.

Earliest Tools

Archaeological remains show that starting in the earliest times, humans' use of material objects included attention to style as well as function. Just as in the 21st century, ancient people deliberately made and decorated objects through conscious decisions about form, function, projected lifespan, and the potential of the object to serve as a gift or as a statement of social status. Styles and forms can change rapidly, resulting in the frequent turnover of styles, which is interpreted as a language-like code by others in the social group. Sophisticated understandings of style and its changes can result not only in the adoption of new styles and designs but also the return of "retro" styles as a fashion or social statement.

Stone tools constitute the first evidence of human transformation of natural materials. The first crude pebble chopping tools date to approximately 2.5 million years ago, associated with the skeletal remains of hominids whose cranial capacity was a fraction of contemporary humans. The subsequent elaboration of both stone tools and brain size suggests that there was a mutually causal relationship between cranial capacity, cognitive sophistication, and material culture use.

By 1.65 million years ago, the Acheulian hand axe was developed: a leaf-shaped, bilaterally symmetrical stone tool that is found in many regions of Asia, Africa, and Europe. The repetitive aspects of the hand axe have led to suggestions that it had both a cultural and a physical function, perhaps even being used as a social signal of competence and reproductive fitness.

Ancient people also made objects from feathers, fur, wood, gourds, bone, leather, bark, and wax, although perishable objects are less visible in the archaeological record. Exceptional cases of preserved objects show the diversity of natural resource use, such as fire-hardened wooden spears from Germany dated to 400,000 years ago associated with butchered animals' remains.

Art and Agriculture

By around 65,000 years ago, the archaeological record shows the emergence of objects that were made primarily for a social rather than a technical function, such as beads and other ornaments meant to decorate the body. One widely used material was ostrich egg shell, which was made into containers as well as beads in Africa and in the Indian subcontinent. In this era, humans also created figurines and rock art for the first time.

By around 10,000–12,000 years ago, the human repertoire diversified considerably with the adoption of domesticated plants and animals. The move toward food production required the development and use of many new types of objects related to agriculture, including plows and hoes for tending plants, sickles and baskets for harvesting them, and grinding and cooking tools for preparing them.

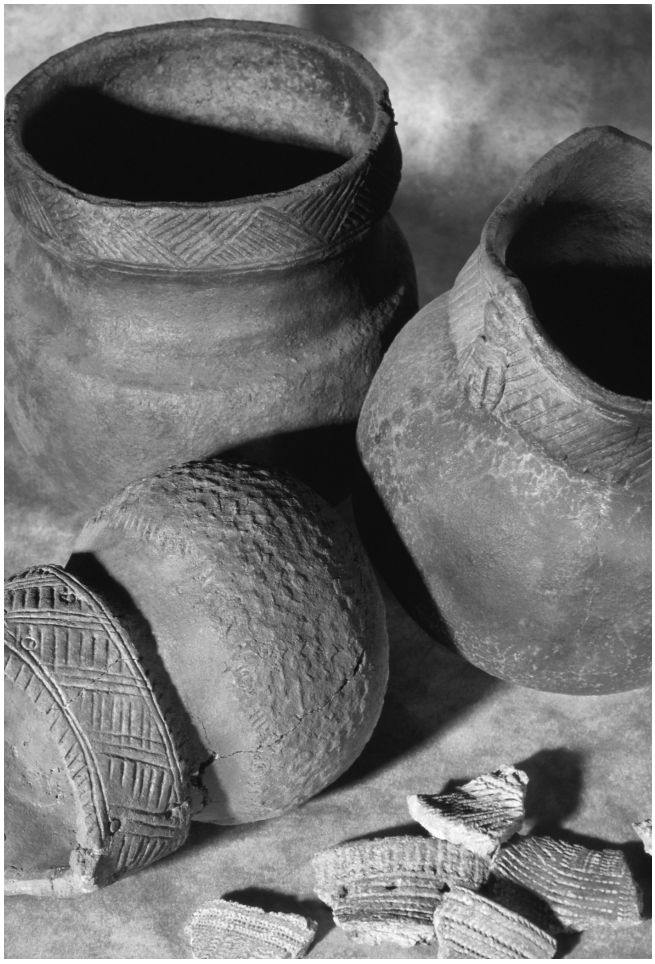
Architecture

In addition to portable objects, material culture also refers to modifications of the built environment. Humans initially took shelter in caves and under trees, but the first constructed architecture is seen in the form of huts in eastern Europe made of mammoth bones and draped with skins, starting around 15,000 years ago. Later types of architecture include many different structures made of durable materials, such as stone, as well as from perishable materials, such as reeds, bamboo, mud, and sod.

Architectural construction also included special-purpose features that were larger than regular dwellings. Even prior to settled village life, communities built large ritual structures to which they returned on a regular basis (such as Stonehenge in England and Watson Brake in the United States). Funerary monuments are seen throughout the world as a focus of communal labor investment; these take the form of megalithic tombs as well as wooden poles, stone sculptures, and other landscape modifications that honor the dead and express the claims of the living to particular landscapes and their productive resources.

Pottery and Metallurgy

In the agricultural period, two particular types of raw material became important for the development of objects: clay and metals. Clay, which is soft in the raw form but can be hardened by fire to produce durable objects, could be used to produce



In the agricultural period, clay was used to produce practical items such as jars and bowls that also provided a surface for decoration. Later, single metals were used as ornaments and then combined to create compounds of varying hardness for tools and weapons.

practical items (such as jars and bowls) that also provided a surface for decoration and the expression of style. Each global region quickly developed a repertoire of pottery shapes and forms that were particular to the prevailing foods and social customs. Changes in pottery design and form also provide archaeologists with a means of classifying cultures and examining changes in technology and social organization over time.

The development of metallurgy also provided people with the opportunity to create many types of distinctive and practical items. Most of the first metal objects were ornaments made of the most easily worked ores (copper, silver, and gold). Afterward, people combined metals to achieve specific properties of hardness, such as bronze, which is a mixture of copper with tin or arsenic. Iron was a more difficult metal to extract and work, but it provided a very durable material for the creation of a variety of tools and weapons starting in the 2nd millennium B.C.E.

Purposes of Objects

Objects often have a primary purpose, as tools for facilitating particular jobs. These include tasks such as cooking (pots, pans, and knives), eating (containers and utensils), making clothing (needles, thread, and cloth), tending to personal needs (toilets, washbasins, and soap), and child care (toys, diapers, and food items). However, even these basic objects can vary in style as well as in material, signaling the way in which ordinary goods have distinct forms from one culture to another.

Displays of Wealth and Social Roles

Objects are a tangible form of wealth display. Individuals in many mobile societies, such as pastoralists, carry wealth on their bodies in the form of elaborate ornaments and other portable goods. Wealth in stored goods or surplus food can be used not only to display individual or household status, but also to build political power through rewarding followers, sponsoring feasts, or paying for the construction of elaborate structures. Prior to the development of coined money in the 6th century B.C.E., and even afterward, many types of objects were used as modes of payment, including cowry shells, iron bars, copper ingots, and lengths of cloth.

In daily life, objects perform a variety of social roles in addition to their utility as functional tools. Gift giving is a social act in which the object's perceived value symbolizes the status of the giver and the expected obligations of the recipient. Material objects become the means of transferring wealth, for example, as collateral for loans or as the focus of gifts related to dowry or bride-price. Material objects also serve as the background for communication; for example, the same person might dress differently when performing roles as a teacher, homemaker, or community leader.

Identity and social roles can be enhanced and facilitated by the use of distinctive material culture such as clothing, ornaments, and even hairstyles.

Ancient depictions on murals, pottery vessels, and sculptures indicate that past peoples also had a keen awareness of the differences in styles worn by local people compared with newcomers or foreigners. The archaeology of colonial encounters (which includes the ancient Roman Empire as well as more recent British, French, Spanish, and other imperial expansions) also shows that new styles of food, clothing, and architecture were selectively incorporated into newly conquered territories.

Within any given culture, objects enable people to express their group affiliations and social status. Individuals seek out and utilize objects to show that they belong or aspire to belong to a particular group (whether through formal uniforms or through the adoption of prevailing styles of clothing and ornamentation). Objects also can become heirlooms and signify social ties carried from one generation to the next. The individual's interactions with objects include not only the objects worn and used outside the home but also the items used in private, including undergarments and medications.

Material objects also serve as an important component of spiritual activity. Nearly every ritual tradition has objects that are handled in specific ways and at specific moments of devotion as well as objects that are worn on the body or displayed in the home that show religious affiliation. Like daily-use goods, ritual objects can also show regional differentiation, for example, the distinctions in the form and style of the Buddha in India, central Asia, China, southeast Asia, and Japan. Even ascetic religions make reference to material culture, as their practitioners define themselves in terms of avoiding the objects otherwise prevalent in their culture.

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See Also: Archaeology of Garbage; History of Consumption and Waste, Ancient World; Material Culture Today; Needs and Wants.

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Material Culture Today

Material cultural studies presume that objects contain traces of their cultural importance. Objects thus become central to accounts of socially meaningful use and waste, because the materials of culture are remnants of consumption. Objects carry their history and continually pick up residual meaning.

What happens as objects move through the social system through unique, creative, or unexpected trajectories? Defining objects as relational, but still inherently material, allows for both the reconception of culture beyond subjective experience and reimagining consumption as not simply structured by institutions; each becomes interrelated precisely through the personalized histories of specific objects. Past uses and meanings continue to exist through the persistence of the object, even if cultural values have changed.

The purpose and meaning of things are not simply imposed by the people who possess them; objects equally figurate their beholders because they contain past interactions with others in their very design and continued possession. Ordinary objects are thus cultural texts that call into being collective publics and subcultures as they are repossessed by people who reclaim potential waste as significant material. Popular books recounting histories of mundane foods such as salt, coffee, or sugar mark an underlying current of what might be called—following French philosopher Michel Foucault's work on power and governmentality—a "genealogical concern for the material origins of ordinary life."

Cultural Commodities

A material culture approach can focus, for example, on what Will Straw calls the "spectacles of waste" of secondhand culture, which allows a view of the commodity cycle beyond the traditional two-step definition of purchase and disposal. Cultural commodities, in particular, tend to move toward sites of accumulation, whether in private collections, auctions, or secondhand stores, and they are thus exemplary illustrations of the possibility of recursive stages of possession, discard, and reuse. The circulation of secondhand culture—hand-me-downs, vintage clothing, used books and compact discs, antiques and ephemera at auction—encapsulates how meaning and value are negotiated and redefined through practices beyond acts of simple possession. Consider a brief, idealized history of one such specific but mundane object, a T-shirt.

It is 1982, and a teenage boy is attending his first heavy metal rock concert with friends. His parents do not approve, but he has just begun his first summer job and can purchase the ticket himself. At the merchandize display, he buys one of the band's souvenir T-shirts showing the most recent album cover on its front, listing all the stops on the tour on its back. Pleased and proud with this memento, the teenager thinks little of how this T-shirt was produced, the labor that went into it, the journey it had to take from factory to wholesaler to concert venue. Over the next months, he wears the shirt often and gladly tells about attending the concert when strangers start conversations by asking about the T-shirt. The next year he gives the T-shirt to his first girlfriend as a sign of his undying love for her. Although she appreciates the symbolism, by the time she goes to college they have split up and the defunct band is now considered juvenile among her college friends. She still wants the keepsake, but puts it at the back of her closet. Years pass before her parents decide to give all her remaining youthful things to the local charity shop, where the T-shirt ends up in a bulk-purchase bin amid a pile of similarly storied clothes. Enough years have passed that nostalgia for the music of the rock band has emerged. A young entrepreneur buys the T-shirt and a dozen others to sell at a premium at a vintage clothing shop, where the entrepreneur promotes used clothing in relation to environmentalism and awareness of overseas sweatshop labor. The T-shirt is washed and put out for sale, catching the attention of a young skateboarder, who wears it with hipster irony for a few months. The skateboarder is surprised to have more than one ageing metal fan point to the T-shirt and express continued fandom. He auctions the T-shirt online and mails it to the highest bidder in another county. The online buyer is so much an enthusiast of the band and values the rare collectible item so much that the buyer puts the T-shirt in a frame and mounts it on a wall as part of a display of the history of the band.

The T-shirt, as an object, collects more meaning than was consciously held by any of the persons who had a hand in its history: the manufacturer, laborers, band, designer, and original merchandiser had only limited intentions or contact with the shirt, as did each of the people who possessed it in turn. The same is true of any specific academic interest in the T-shirt: pop music fandom, fashion and identity, lifecourse patterns, consumer habits, environmentalism, social networking—all are important but partial ways to analyze the case study of this T-shirt. Tracing the circulation of objects begs for an interdisciplinary approach precisely because objects circulate in and out of disciplinary fields of concern as they get produced, used, reused, and discarded. Even this account of the T-shirt misses the full variety of possible material histories of clothing, which could attend to the cultural legacies of cotton plantations and thus slavery, colonialism, and globalization; looms and sewing machines, and thus industrialization and urbanization; fashion and shopping, and thus arcades, department stores, ready-to-wear clothing, marketing, and branding; and factories and sweatshops, and thus unionization, child labor regulation, and workplace safety.

Sometimes, nothing remains except the object as a record of the coordinated relations between humans. Among academic disciplines, archaeology often studies unearthed artifacts as a way of deducing cultural meaning from the material remnants of past civilizations. Studying the present, anthropology also often focuses on material artifacts as emblematic totems of group membership and as a way to translate insiders' meanings into terms more generally understood by outsiders. Similarly, qualitative research methods within

sociology can rely on responses to objects elicited through surveys and interviews as a means to externalize in language interior feelings and opinions. The form of such expressions allows literary studies to focus, in turn, on the representation of objects in texts, just as historians can look to the archived record of the same objects to represent a cultural past. With reference to the T-shirt, the anthropologist might be interested in the neo-tribal ways people recognize fellow group members through symbols; the sociologist might be more interested in how objects mark distinctions of class position and identity; the historian might focus on how consumer goods represent a zeitgeist; while the media and cultural scholar might be more interested in how popular culture is built upon commodified memorabilia. The T-shirt's life cycle as a commodity incorporates all of these approaches, but the interdisciplinary scope of a general material approach allows the continual risk of objects becoming waste to come to the forefront by attending to the continual reproduction of the cultural meaning of material objects.

Excess

Waste is just one option for what people do with excess. Attending to cultural excess illuminates some canonical theories of material culture. Discarded culture can be cast aside as garbage, following Mary Douglas's definition of "dirt" as matter out of place, but the very idea of surplus and thus security can also be ritualized in potlatch, central to Georges Bataille's writing on the general economy. The ritual offering has its equivalent in the gift, which Marcel Mauss argued as a fundamental objectification of social ties. Each of these dwell in the anthropological or symbolic character of objects deemed no longer needed. Excess symbolic value can also be objectified as sacred totems, following Emile Durkheim's theories of religion, but transformed in secular modernity into conspicuous consumption in Thorstein Veblen's characterization of the leisure class. Such sociological understandings of how objects mediate economic and cultural realms are extrapolated by Pierre Bourdieu to nearly all things as signs of taste and markers of class distinction. While each of these theories of objects can be applied across class positions, between societies, and over time, Walter Benjamin was concerned especially with the dominance of contemporary commodities and thus focused squarely on the display of consumer products in 19th-century Paris arcades.

Benjamin's turn to the value of display atop use and exchange complements Bataille's reconstruction of the economic. Both counter assumptions of scarcity and rational choices, with emphasis instead on the situated presentation of excess and luxury and, in turn, the dislocated representation of objects through media and technology. These theories allow a consideration of relations focused on the gift (and the obligation created through it), the collection (and its catalogue of prices), window-shopping (and the leisurely *flâneur*), the souvenir (and the gazing tourist), and the status symbol (totemic for forms of legal-rational leadership). These relations are geographically and temporally dependent and cannot exist without designating meaning through some form of material object relation. However, these meanings, like the material cultures they contain, are not unchanging or unchangeable.

Object Interaction

In contemporary cultural studies, Bruno Latour's articulation of actor-network theory is notable for defining objects as social actors, distinct but nonetheless on par with intentional human actors in reproducing culture. People interact with objects—from doors and chairs to airplanes and surveillance monitors—as much or more than with other people; social interactions are mediated, or figurated in Latour's terminology, through objects as often as through interpersonal commingling. Objects thus exert inscribed norms with as much force and efficacy as people. Emerging out of studies of science and technology, Latour's tipping of the balance of attention toward the object is a robust, general argument for the importance of material culture, albeit so generalized as to render waste and commodities as merely types of objects among many others.

Conclusion

Contemporary reconsiderations of material culture have shown how modernity and global capitalism are made meaningful through the circulation of objects: the relations and flow of capital; the move-

ment of goods, markets, and cultures; and the global connections across modes of production and consumption. The centrality of circulation of goods in globalization is foundational—not simply parallel to—the flow of information, capital, and migrants around the planet. Cultural connections made through the production, consumption, and discard of objects can thus become a central concern in studies of global capitalism and late capitalism. Material culture at once surrounds society and is also as specific and distinct as a T-shirt. Objects are in constant movement through cultural spaces and provide a wealth of locations within which one can begin to understand their meanings.

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See Also: Culture, Values, and Garbage; Garbage in Modern Thought; Overconsumption; Shopping; Sociology of Waste.

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Materialist Values

The term *materialist values* refers to the worth attributed to physical goods that are usually associated with the economy, technology, and biology, whether the goods are for function, status, or the joy of accumulating objects. Scholars generally argue that widespread materialist values, often referred to as *materialism*, have been part and parcel of the industrial period of growth, especially in more-developed countries, where goods became mass-produced and more affordable for the lower and middle classes.

The increase in materialist values is also associated with urban lifestyles, which proliferated throughout the 1900s and have intensified to the point where over half of the world's population currently live in urban areas. Items such as vehicles, refrigerators, televisions, and several changes of clothes became commonplace in the 1950s and thereafter, and such trends have followed among the middle and higher classes in newly industrialized countries, such as China and India, and among the wealthier classes in the least-developed countries, such as Lesotho and Haiti.

Environmental Threat

The human worth placed on objects and the pursuit of owning more things—the more central role of materialist values in urban life, in particular—is often considered one of the key threats to sustainability. Materialist values are associated with over-consumption, given both the amount of withdrawals from the ecosystem and additions in the form of waste and pollution and the massive material resources involved in highly consumptive lifestyles. The growing number of goods and services consumed tends to offset the efficiency gains achieved through, for example, improved production technologies and processes.

Housing, food, drink, and mobility have the greatest environmental impact over their lifecycle in terms of emissions of greenhouse gases, acidifying and ozone-depleting substances, as well as resource use. Thus, both environmentalists and, increasingly, religious groups concerned about environmental problems question materialist values as a core element of modern civilization, believing that materialist values must be kept in a more-modest place among a suite of other cultural values (such as environmental, community, or social justice) that shape the development of human society.

Negative Popular Conceptions

There are many media accounts and folk legends about how characters who have strong materialist values became greedy and obsessed with accumulated wealth, status, and possessing high-status goods. Consequently, these characters' relentless pursuit, as driven by materialist values, is associated with losing sight of one's interdependent place in collective life—one's responsibilities to, and benefits from, family, community, nation, nature, and a full self that honors many kinds of values (for example, caring for the home). These commonplace stories—reproduced in fairy tales and Hollywood movies, where someone "had it all" and lost it to greed, corruption, or careless mismanagement of savings—celebrate cultural skepticism and the moral stance against strong materialist values in society.

Materialist values are also associated with those who will pursue material goods at the expense of other people and other moral actions. For example, materialist values are often associated with the abuse of power of large organizations—be it government or industry—that have placed the pursuit of revenue or profit over human safety and environmental protection and stewardship. Thus, many social justice issues are tied to a critique of materialist values as a distal cause, rather than a proximate cause, that at the core of the issue distorts human decision making to narrowly focus on the accumulation of wealth. For example, while the proximate cause for an oil rig blowout may be a failed technology, the distal cause may be attributed to materialist values held by the company or companies involved. In other words, the pursuit of profit overruled the oil company's investment in wisely assessing the risks, safely constructing the technology, and being prepared to assure safety to all citizens if a technological accident occured.

Growing Phenomenon

In addition to goods becoming more available and affordable, materialist values are theorized to have increased due to social psychological reasons. There are several social mechanisms that tend to self-fulfill consumerism and, hence, support materialist values. For example, the cultural practice of comparing how well off one is relative to others, or social comparison, often leads to obtaining more possessions. One social mechanism among North Americans is omnivorousness (the tendency to buy specialized equipment for every eventuality). The fluidity with which one can perform different tasks is a practice that displays status, where a person can be equipped for any possible activity, as infrequent as these activities might be. Furthermore, the tendency to use consumer goods to display identity is heavily reinforced in advertising, as people are enticed to buy food, clothes, shoes, and furniture to show a sense of style or individuality. In fact, advertisers encourage consumers to take on different identities through the clothes, cosmetics, and other items they buy as part of their individual style. The increased demand for consumer goods is also associated with cultural expectations, as reinforced by advertising, to buy items that match one another; thus, a new house requires new furniture.

Goods are increasingly specialized and may quickly become outdated (for example, planned obsolescence of cameras), which entices people to upgrade and buy more objects. For example, the notion in more-developed countries that one must stay "up to date" in the suite of electronic personal items one uses has led to a continual cycle of replacing cell phones, personal digital assistants (PDAs), and computers. Social celebrations, such as birthdays and winter holidays, have become highly commercialized events, where social expectations for gifts and indulgences become commonplace and the abundance of goods exchanged is celebrated. Conspicuous consumption (the tendency to obtain items to show wealth or status) has become inconspicuous where the materialist values embedded in the practice of displaying status and prestige are normalized.

Structural influences on materialist values might include growing incomes in more-developed countries, globalization of the economy, technological breakthroughs (such as the Internet and mobile phones), decreasing household sizes, and an aging population. In addition, the pervasive role of advertising, the normalization and ubiquity of stores and other buying opportunities (even in schools, churches, and at home via the computer and mail order catalogues), and the easy availability of credit all make purchases of convenience and compulsion more likely. For example, in her 1993 book *The Overworked American: The Unexpected*

Decline of Leisure, Juliet Schor describes the needs for a consumptive lifestyle for many Americans who work two and three jobs to maintain a "normal" U.S. lifestyle. Thus, people are caught on a treadmill of sorts, working long hours to have more income, and then spending more income to be able to get to work, wear the appropriate clothes to work, reward themselves for working so hard, and display the outcome of their work through material acquisitions.

Structural Theories

There are a number of structural theorists in sociology who address materialist values. Structural theories about materialist values often address the role of capitalism, the state, and relationships of power among corporations, the state, workers, and the most vulnerable in society to explain how those with more wealth and power can maintain their material advantages over time, even as income disparities grow. A general theme from structural theories in sociology, for example, is that the state, or governments, can be hamstrung, or co-opted, by the material expectations of both corporations and workers.

The state is less effective at all of its roles to govern the good society (one that inherently strives to protect human welfare) because the growth imperative (the accumulation of wealth and business growth) is too often equated with the pursuit of full employment for working-age citizens and, by association, business success. Thus, the pursuit of economic growth is theorized to become more important than safeguarding collective goods and services, such as high-quality schools, healthcare, infrastructure, and environmental protection. Similarly, the growth imperative of many governments is theorized to hinder their ability to examine the overemphasized role of materialist values in government decision making. Numerous scholars argue that there is both opportunity and evidence that materialist values, as manifested in assuming economic growth is necessary for a healthy society, is flawed and that economic growth is not necessarily related to the health of the population, ecosystem integrity, and human happiness.

Another approach to materialism, in terms of the pursuit of material goods, is to view it as part of human survival and cultural expression, thus embedded in patterns of seeking food, clothing, and shelter. Human materiality is such that some degree of materialist values is always present, given that to live is to use material and symbolic objects in life practices, services, and leisure activities. Thus, it is the degree to which people hold materialist values above other values that is important. Consequently, some scholars have addressed materialism as a feature of human life that is not to be criticized as much as shaped by reasonable, ecologically sustainable practices. Various scholars discuss a social practices approach to understanding materialism and consumer behavior.

This approach emphasizes the flexibility of the capitalist system to incorporate ecosystem values so that materialist values can work in concert with other values to maintain ecosystem integrity and reduce waste. Thus, this approach encourages improved planning and development of buildings, parks, neighborhoods, towns, and cities that take into account daily practices that have material consequences. A more wisely designed infrastructure can support new norms that, in turn, allow daily habits to automatically conserve water and energy, reduce waste, and foster healthy human interactions. If materialist values are part of the human affair of life, there are opportunities to align systems of provision for food, clothing, shelter, and transportation with human needs for cultural expression and ecosystem renewal.

Material Needs

Abraham Maslow's hierarchy of needs is often referenced when academic scholars discuss materialism. From this perspective, "lower needs" are material; beyond that are physiological, safety, belongingness and love, esteem, and self-actualization needs. The assumption then is that in order to seek "self actualization," material needs must first be met. Maslow recognized that most people's needs are generally only partially satisfied and that, for a temporary period, people can forgo lower needs for higher needs (for example, give up safety to go on an adventure). Other higher needs that one might seek, which generally rest upon material needs already being taken care of, are the needs for aesthetics, knowledge, and understanding.

The implications of Maslow's theory are significant; those who are distracted with meeting material needs have less energy, time, and ability to pursue higher needs. Furthermore, the higher needs are the more social ones, such as the search for love and respect, and these can be sidelined if one is chronically hungry, for example. In other words, this particular perspective places materialist values as a necessary but insufficient set of values to live a full life, where self-actualization, or values associated with a full expression of one's potential, is possible when materialist needs are no longer of consistent concern.

Post-Materialism and Countermovements

Materialist values are conceptualized very differently from the point of view of Ronald Inglehart, who developed a longitudinal data set on a broad intergenerational shift in wealthy countries of the world to what he describes as a shift from "materialist values" to "post-materialist" values. Here, the term *materialist values* refer to "concerns about economic and physical security" and these are contrasted with post-materialist values, which are "a greater emphasis on freedom, self-expression, and the quality of life." The trend in many countries to move to place more emphasis on post-materialist values than materialist values is attributed to the economic improvements that younger generations have enjoyed, where they have had greater opportunity to focus on self-actualization, as Maslow describes it, than economic security.

There are a number of countermovements challenging the public trends of materialism when it manifests itself as overconsumption. For example, the slow food movement is a growing trend in Europe and North America, where place-based communities are organizing efforts to grow and prepare culturally celebrated food that they eat with each other. Members of the slow food movement seek to share home-cooked meals with other community members, in their homes. This movement is opposed to eating out at fast food and other franchise restaurants, where the food may come from thousands of miles away and is often quickly eaten, and the art and pleasures of cooking are forgone.

The challenge to materialist values is that food is considered not just a thing to consume but rather food is seen as an integral element of life to be learned about (such as how to grow food well), supported by local food producers, and celebrated through the joy and art of harvesting, preparing, and sharing food with others.

The slow food movement is a growing trend: communities grow and prepare food to share with neighbors and friends. This philosophical approach to consumerism celebrates food as an art, a pleasure, and a means to strengthen local and personal ties.

Materialist values will continue to be hotly debated in world politics as the role of unequal access to material goods (such as energy resources) and material "bads" (such as electronic waste) continues to be addressed in the designation of responsible parties to address climate change, waste streams, transboundary pollution, water scarcity, and the protection of habitat.

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See Also: Commodification; Consumerism; Material Culture Today; Sociology of Waste.

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Meat

There is no denying that meat plays a major role in the history, economy, and culture of the United States. Classic images of Thanksgiving include families gathered around a table abundant with food, featuring a turkey. The summer months bring backyard barbecues with hamburgers and steaks on the grill, and baseball games are not usually considered complete without a hot dog. Despite being surrounded by meat, people do not often consider how meat fits into the consumption and waste stream.

Consumption Rates

Americans seem to have a large and growing appetite for meat. Between 1909 and 1919, the average American ate about 140 pounds (lbs) of meat per year. In 2002, per capita annual meat consumption reached 275 lbs in the United States, the highest per capita meat consumption rate in the world. For comparison, in 2002, China's per capita meat consumption rate was 115 lbs, Italy's was approximately 198 lbs, and the United Kingdom's was approximately 175 lbs. Though humans consume more and more meat each year, tastes and preferences have shifted over the years.

Poultry only constituted about 8.5 percent of all meat consumed between 1909 and 1919. In the 1960s, poultry made up about 17 percent of all meat consumed, and between 1970 and 2005, per capita consumption of poultry jumped from 34 lbs per person to 74 lbs per person. While the popularity of poultry—particularly chicken—was growing, the consumption rate of red meat was dropping. Between 1970 and 2005, per capita consumption of red meat declined by 22 percent. Still, red meat remains the main source of protein in the U.S. diet, with beef the most preferred.

Production

Keeping up with this growing demand for meat required changes at all levels of production and consumption. During the 19th century, meat production evolved from local, highly skilled butchering to consolidated industrial production. The development of the refrigerated railcar and slaughterhouse centralized meat production in Chicago, distributing pork, beef, and poultry across the nation. At

the same time, wastes from the slaughterhouses concentrated in the Bubbly Creek tributary of the Chicago River. Upton Sinclair called this body of water Chicago's "Great Open Sewer" in his 1906 book *The Jungle,* and public uproar surrounding revelations of unsanitary meatpacking practices in that book led to the creation of the U.S. Food and Drug Administration that same year. The industry began to decentralize in the early 20th century, in part due to a transition from using rail to trucks to transport meat. Subsequently, meatpacking operations developed in several states.

Over the decades, animal farms have grown in size to both meet the needs of the population and to remain economically competitive. North Carolina, a top producer of both hogs and turkeys, experienced a 300 percent increase in the number of animals per square mile between 1977 and 2006. On a larger scale, the total number of cattle on the planet has nearly tripled since the early 1900s. Additionally, modern cattle are much larger than their predecessors and can be brought to slaughter earlier compared to the past.

In the 1900s, it could take as long as five years before cattle were ready for slaughter; in the 21st century, cattle can reach an acceptable weight for slaughter within 14 months. This is due in large part to changes in animal husbandry techniques. Rather than grazing cattle on grass, many cattle are now raised on feed made primarily of corn and grain. This mixture allows cattle to gain weight nearly twice as fast as grazing on grass. Growth hormones and antibiotics have also been used to hasten animal growth and prevent the spread of disease in the close quarters of 21st-century confined animal feeding operations (CAFOs).

Meatpacking techniques have also changed to keep up with the increased level of demand and production. Though much of the slaughtering process still relies on human workers, technological advances have allowed large processing plants to handle larger numbers of animals faster. All of these techniques, from increased animal density to corn diets, are controversial. Proponents of modern meat production cite the economic benefits to regions where CAFOs are present. These large facilities provide jobs and pay taxes. Critics stress the health and environmental risks associated with such high levels of meat production and consumption.

Waste

Waste is a part of the meat consumption cycle, present in different forms at every step. The slaughter and processing of animals produces waste in the form of scraps that cannot be sold for human consumption. In some cases, these discards can be used for other purposes. Feathers, for instance, may be used in pillows and comforters or used as filler in feeds produced for commercial animals. Meat spoilage becomes a concern for grocers, restaurant managers, and consumers alike.

For example, in 2006, supermarkets had to throw away an estimated 4.4 percent of their fresh beef, 4.2 percent of fresh chicken, 10.6 percent of fresh lamb, and 27.8 percent of fresh veal. The discrepancy of these waste rates is explained by consumer familiarity with a food group. Beef and chicken make up the largest shares of meat consumed in the United States. Veal, however, is consumed less frequently. Still, grocers stock their meat cases with veal in an effort to enhance shoppers' perceptions of variety. Because it is generally priced higher than beef or chicken and because it is a less-familiar item, more veal goes to waste.

Finally, there is a great deal of the meat that is cooked but not consumed. Sometimes, too much meat is cooked or, as in the case of the beef shortage of 1973, the cut of meat was unfamiliar to the consumer, and they were unable to prepare it in an appealing way. This is one theory proposed by researchers who discovered that more beef was wasted during the beef shortage of 1973 than during times when beef was in good supply.

Of all of the waste generated during the production and consumption of meat, animal excrement might be the most studied. Excrement is a natural aspect of raising animals. In some cases, this form of waste can be used as a fertilizer for crops. In very large quantities, however, animal excrement can have negative effects on the quality of the environment. Nitrogen, which is naturally present in animal waste, can accumulate in the water as animal waste seeps through the soil. At high levels, it supports the rapid growth of algae, which robs the water of the oxygen that fish need to live. Nitrous

oxide, a greenhouse gas, is also associated with animal waste. Nitrous oxide is found in nitrogen-based fertilizers and is associated with soil management techniques and manure. Because of this, all food groups contribute to the release of nitrous oxide into the environment. Red meat and dairy, however, are responsible for the largest portions.

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See Also: Beef Shortage, 1973; Farms; Food Consumption; Food Waste Behavior; Methane.

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Medical Waste

Medical waste, also known in Europe as healthcare waste or clinical waste, is a distinct and complex waste stream for regulation and management. Due to the infectious, toxic, and radioactive nature of this type of waste, it is important that these materials are separated from other wastes and stored, transported, treated, and disposed of in ways that minimize their risk to both human health and the environment.

Generally, medical waste is waste generated at hospitals and other healthcare establishments, such as clinics, physician's offices, long-term healthcare facilities (nursing homes), blood banks, dental practices, and veterinary hospitals. Further sources of medical waste materials arise from medical and animal laboratories and research centers, mortuary and autopsy centers, funeral homes, schools, universities, factories, prisons, and emergency service providers.

Production

While hospitals and other facilities produce medical waste that can pose a threat of infection, the vast majority of waste volume arising in most healthcare facilities is municipal solid waste, such as paper, plastics, metal, glass, and food waste. In fact, approximately 80 percent of waste arising from these sources and operations is general waste, which is either identical or similar to that generated by hotels, offices, and residential properties. The remaining 20 percent of waste is what may be considered as hazardous materials, which may be infectious, toxic, or radioactive. However, this proportion has been calculated by the Centers for Disease Control and Prevention (CDC) as a significant overestimation of the true volume of medical waste that needs to be treated and disposed of separately. The CDC suggest that as little as 2–3 percent of hospital and healthcare wastes are likely to be medical waste for the purpose of regulation and control.

Risk Factors

Although medical waste constitutes a small fraction of the waste produced by these sources, it is of special regulatory concern because of the potential risks of harm to human health and the environment from pathogens that may be present in the waste or from hazardous chemicals. Poor management of medical waste can expose healthcare workers, waste handlers, patients, and the larger community to infection and toxic effects, as well as cause environmental risks, including pollution and contamination. Other potential infectious risks include the spread of microorganisms from healthcare establishments into the environment. Wastes and by-products can cause injuries, for example, radiation burns, sharps-inflicted injuries, poisoning, and pollution. These impacts can occur through the release of pharmaceutical products, such as antibiotics and cytotoxic drugs, into wastewater or by the release of toxic elements or compounds, such as mercury or dioxins. Chemicals such as dioxins are often

found in the air, water, soil, and living organisms. An unwanted by-product, they are formed when heating processes create certain chemicals like chlorine. Dioxins increase the risk of cancer, although they are also linked to reproductive health, lowering sperm counts, causing behavioral problems, and increasing the incidence of diabetes. In these ways, medical waste poses a significant risk of transmitting infections and contamination.

Waste Management in the European Union

In the European Union (EU), the sustainable management of waste is set out in the Waste Framework Directive (2008/98/EC). This piece of legistation outlines the basic obligations and objectives of member states in relation to waste. It is supplemented by a series of other directives that deal with specific wastes. Under Article 17, member states are required to take the necessary action to ensure that the production, collection, and transportation of hazardous waste, as well as its storage and treatment, are carried out in conditions providing protection for the environment and human health. This must be achieved in a way that minimizes risk to water, air, soil, plants, and animals and prevents nuisance of odor through adequate record keeping. It also requires member states to establish penalties and enforcement provisions in their national legislation to prohibit abandonment, dumping, or uncontrolled management of waste.

For the purpose of regulatory control, it also lists the properties of waste that render it hazardous. This list includes "infectious," and healthcare waste that is infectious is not accepted in EU landfills. Prior to disposal, the waste must be rendered safe. This is understood as (1) reducing the number of infectious organisms present in the waste to a level that no additional precautions are needed to protect workers or the public against infection by the waste; (2) the destruction of anatomical waste such that it is no longer generally recognizable; (3) rendering syringes, needles, or any other equipment or item unusable and no longer in their original shape and form; and (4) the destruction of component chemicals of medicinal waste.

The United Kingdom, as a member state of the EU, has an obligation to ensure that all clinical waste is managed as hazardous waste. Clinical waste can be broadly divided into two categories of material: waste that poses a risk of infection and medicinal waste, including drugs and other pharmaceutical products. Clinical waste is any waste that consists wholly or partly of human or animal tissue; blood or other bodily fluids; excretions; drugs or other pharmaceutical products; swabs or dressings; and syringes, needles, or other sharp instruments. These must be rendered safe, since they are considered potentially hazardous to any person coming into contact with them. The central management requirement for clinical waste is that it be separated from all other types of waste and treated and disposed of in an appropriate manner. In the United Kingdom, all businesses, employees, and persons involved in the waste management chain have a duty of care to ensure that waste is securely stored and disposed of legally.

There are stringent controls in place to ensure that clinical waste is managed safely and is recovered or disposed of without harming the environment or human health. It is unlawful to deposit, recover, or dispose of controlled (including clinical) waste without a waste management permit, contrary to the conditions of a permit or the terms of an exemption, or in a way that causes pollution of the environment or harm to human health. The Environment Agency is responsible for regulating and enforcing the hazardous waste regime.

Waste Management in the United States

In the United States, the Occupational Safety and Health Administration (OSHA) regulates several aspects of medical waste, including management of sharps, requirements for containers that hold or store medical waste, labeling of medical waste containers, and employee training. In response to OSHA's recognition of the need to protect healthcare workers and other downstream medical waste handlers, the Occupational Safety and Health Act was introduced. It applies at a federal level to the storage and management of medical waste, although it is limited in its scope to human blood, human infectious wastes, and human pathological wastes. In practice, most states extend this definition of medical waste to include waste or blood from animals.

The act provides rules surrounding worker safety regulations by stipulating (1) the need for personnel

to wear protective clothing and equipment; (2) that contaminated reusable sharps be placed in containers that are resistant, labeled, or color coded and leakproof on the sides and bottom; (3) that specimens of blood or other potentially infectious material are placed in a labeled or color-coded container that is closed prior to being stored, transported, or shipped; (4) that regulated medical wastes—including liquid or semiliquid blood, other potentially infectious materials, and contaminated items likely to release blood or other potentially infectious materials, items that are caked with dried blood, and other potentially infectious materials that are capable of releasing these materials during handling—must be placed in containers that are closable, constructed to contain all contents, and prevent leakage of fluids, labeled or color coded, and closed prior to removal; and (5) that all receptacles intended for reuse that have the likelihood of becoming contaminated with blood or other potentially infectious materials are required to be inspected and decontaminated on a regular basis.

These rules have resulted in different interpretations over what exactly constitutes regulated medical waste. This has led to a greater amount of waste generated at sources to be considered as potentially infectious; for example, under the OSHA universal precautions guidelines, a worker handling a bandage with a single drop of blood on it should wear gloves, but the waste itself would most likely not be classified as infectious. Since medical waste is often the most expensive waste stream to manage, the broadening of what constitutes medical waste for the purpose of regulation and control, stemming from confusion over its meaning, has increased the volume of materials and substances to be stored, treated, and disposed of separately as medical waste. In turn, this has a significant cost implication for healthcare facilities. Taking a business perspective, the primary objective of the management of medical waste is to minimize the risk of disease transmission associated with the handling of this waste stream while at the same time minimizing the amount of medical waste arising that falls under separate and specific regulatory procedures. Studies have suggested that as much as 50 percent of waste sent for incineration as medical waste is general waste. This results in unnecessarily high disposal costs. Improved segregation has the potential to generate substantial savings, although this can be inhibited by confusion over the meaning extended to medical waste.

Medical waste is defined by the U.S Environmental Protection Agency (EPA) as "any solid waste which is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals." This definition was enshrined in Congress's Medical Waste Tracking Act (MWTA) of 1988, which was a direct result of public health concerns following washed up medical waste on a number of beaches. Under the MWTA of 1988, which made changes to the Solid Waste Disposal Act, medical waste includes blood-soaked bandages, culture dishes and other glassware, discarded surgical gloves, discarded surgical instruments, discarded needles and medical sharps, cultures, stocks, swabs used to inoculate cultures, and removed body organs

The Occupational Safety and Health Act was introduced to protect healthcare workers and medical waste handlers. Between 3 and 20 percent of waste from healthcare facilities—estimates vary widely—is considered hazardous (toxic, radioactive, or infectious).

(for example, tonsils, appendixes, and limbs). The definition does not include hazardous waste, nor does it include household waste, as defined in those regulations.

Unlike many regulations that apply to healthcare, most regulations governing medical waste are defined at the state, rather than the federal, level. Almost all U.S. states have established their own medical waste regulations, although their extent and interpretations vary considerably. For instance, the MWTA has been used by some states as a basis on which to shape their medical waste rules, while other states' regulations bear little or no resemblance to historical law in this area. These regulations tend to cover the packaging, storage, and transportation of medical waste, with some states also requiring healthcare facilities to register or obtain a permit. The EPA is primarily responsible for developing and enforcing regulations for medical waste management and disposal in most states, although the Department of Health may also serve as the primary regulatory agency.

While in the United States it is left at the federal level to determine the precise interpretation to be give to medical waste, the CDC has issued guidelines for infection control. They cite four categories of infective wastes that should require special handling and treatment: (1) laboratory cultures and stocks, (2) pathology wastes, (3) blood, and (4) items that possess sharp points such as needles and syringes, termed *medical sharps*. These categories require that those producing these types of wastes determine the scope of material that should be included within these categorizations.

The category that has generated the greatest regulatory interest (and at the federal level) is sharps. This is because needles and syringes can be particularly harmful, as they have the potential to penetrate the skin, thereby increasing the potential for disease transmission. Each category tends to have special handling requirements that may be state specific.

Medical waste presents a number of compliance challenges. Due to the state-level responsibility in regulating medical waste, a complex and diverse network of rules exists between states, although the one consistent element that tends to be present in most state rules is the requirement that medical waste be rendered noninfectious before it can be disposed of as solid waste.

Transportation and Incineration

It is a requirement that regulated medical waste be transported and treated separately from other wastes. These activities are considered as important factors in managing medical waste, particularly where such wastes are to be incinerated or disposed of off-site. To this end, the Department of Transportation (DOT) has determined medical waste to constitute hazardous material for the purpose of transfer, and therefore DOT rules apply to transporters of medical waste. The importance of treating medical waste prior to ultimate disposal is to purge the material and substances of infectious toxins and pathogens. Medical waste can be treated in a variety of ways, but the most traditional and common treatment method is incineration.

While incineration is intended to destroy pathogens and cytotoxic chemicals in medical waste, its efficiency and effectiveness is dependent upon the operation of the incinerator. Important factors include the temperature of incineration, maintenance, and training of operators. The EPA introduced regulations governing the operation of and emissions from medical waste incinerators as well as requirements under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) for certain medical waste treatment technologies that use chemicals for treating the waste.

There are a number of weaknesses in incineration as a treatment option for medical waste, including the fact that there is potential following treatment for the continued survival of pathogens, radioactivity, infectiousness, and metals in the residual incinerator bottom ash and fly ash carried by air and exhaust gases and captured in the incinerator stacks.

This has led to countries such as the Philippines completely banning incineration because of its adverse environmental impacts. The EPA has cited medical waste incinerators as among the top sources of mercury and dioxin pollution. In addition, some medical wastes are unsuitable for incineration and release pollutants into the atmosphere. The incineration of materials containing chlorine can generate persistent dioxins, furans,

and coplanar PCBs, which are considered human carcinogens and exist indefinitely in the environment. Human exposure to dioxins, furans, and coplanar PCBs is through the intake of food. Likewise, incineration of heavy metals, especially lead, mercury, and cadmium, can lead to the spread of heavy metals in the environment.

Although incineration is still widely used, particularly in less-developed countries, alternatives to incineration exist for medical waste and are gaining increasing support in Europe. For instance, in Slovenia, all infectious waste is treated by using a steam-based system. Portugal has closed almost all its medical waste incinerators and is treating medical waste in autoclaves. In France, in the 21st century, many operators have introduced shredding/steam/drying systems for medical waste treatment. Nonincineration techniques include steam sterilization, chemical disinfection, irradiation, and enzymatic processes. Wet heat treatment involves the use of steam to disinfect and sterilize waste and is commonly done in an autoclave.

Chemical disinfection involves a process employing disinfectants, such as dissolved chlorine dioxide, bleach (sodium hypochlorite), peracetic acid, or dry inorganic chemicals. The process often involves shredding or mixing of the waste to aid exposure of the material to the chemical agents. Irradiation-based technologies involve electron beams, Cobalt-60, or ultraviolet irradiation. These technologies destroy microorganisms and pathogens. Biological processes use enzymes to destroy organic matter, although, as of 2010, this was not a common technology for medical waste treatment. Mechanical destruction is a supplementary process to these technologies. It renders the waste unrecognizable and is used to destroy needles and syringes so as to minimize injuries or to render them unusable. However, it does not cleanse the material of its infectious nature, and thus medical waste cannot be processed in this way and sent directly to a landfill.

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See Also: Emissions; European Union; Hazardous Materials Transportation Act; Hospitals; Human Waste; Toxic Wastes.

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Mega-Haulers

Mega-haulers transport massive quantities of material and are known for their very large capacity to hold and transport materials. Also called *ultra-haulers*, mega-haulers are associated with a range of applied uses, including pickup trucks, with the ability to traverse any type of landscape while towing a heavy cargo trailer; container ships, which are often described in terms of the number of football fields whose length they equal; tractor trailers, for myriad uses of on-road heavy transport such as long-distance container shipment, refuse collection, and construction; and heavy-hauler trucks, such as the Caterpillar 797 series that represents the highest off-road payload capacity of 400 tons. The Terex MT 6300AC and Caterpillar 797 series B and F models were some of the biggest trucks in the world in use in 2010 and were predominantly used in mining operations to transport raw materials, like heavy metals and bitumen.

History

Historically speaking, it is worthwhile to consider the trajectory from horse-drawn trailers to the current mega-hauler incarnation. Mike Woof notes

that initially mining operations created a demand for moving heavy material around a mine site. At the same time that teams of horses struggled to haul trailers with solid wheels through difficult terrain, other operations employed train tracks. However, the train track system is limited by its bi-directionality. In 1925, Holt and Best merged to proceed under the name Caterpillar and began selling crawler tractors to replace earlier models that used metal and solid wheels, which were known for poor braking capacity and limited traction. Crawler tractors used a rolling track system that ensured good traction. Although the rolling track system provided sure footing, movement was slow, meaning that the track system would be inefficient for moving massive quantities of material distances of a few miles.

Since 1998, Caterpillar has manufactured the most recognizable fleet of mega-haulers, otherwise known as off-highway, ultra class, two-axle, mechanical powertrain haul trucks. Since the early 1900s, there has been a historical evolution toward larger and more-robust engines, heavy-duty construction materials, and increased comfort for the driver. Mega-haulers of the 21st century feature safety as first priority; a reliable and efficient engine and transmission; superior braking control; durable and flexible steel structure body for performance; long life; minimal maintenance; an ergonomic, comfortable, productive, and safe operator station to minimize operator fatigue; and customer support and serviceability.

In mining, mega-hauler trucks are typically paired with a correspondingly large hydraulic shovel, which can handle up to 100 tons per scoop and top the trucks off with 400 tons of bituminous sands.

The Alberta Oil Sands represents one of the largest-scale mining projects in the world. In terms of the production of consumable goods, oil has come to play a primary role in the composition of many of the products that are bought in the 21st century, including clothing, food, packaging, and fuel. Alberta's Oil Sands operation in Canada has been a driving force behind the development and use of, in particular, the Caterpillar 797 series mega-haulers. The Oil Sands correlate to a massive area totaling approximately 27,000 square miles. One of the primary methods of oil sands extraction involves simple mining techniques, albeit on an exponentially large scale. Keyano College, the regional postsecondary education institute, offers training courses for a range of heavy equipment. Information for prospective students notes that heavy hauler trucks are used for hauling oil sands to feed the crushers, as well as overburden to waste dumps. *Heavy haulers,* rather than mega-haulers, is the preferred term in regard to oil sands mining operations.

Photographers, such as commercial photographer Edward Burtynsky and freelance photographer Peter Essick, have used a birds-eye aerial view in order to photograph the oil sands mining operations. Upon viewing the aerial photographs, the viewer can recognize the perceived need for massive scale. Simply put, mega-haulers strive to master the massive landscape. As seen from above, the image may appear to resemble a child's sandbox complete with yellow dump trucks.

Size

Mega-haulers can be characterized by their sheer scale. Photographs are commonly shared between friends and online depict a person standing next to one of these trucks. In particular, children are often pictured as dwarfed next to one wheel of the truck. In relation to scale are the staggering numbers and capacities that mark these mega-haulers. The capacity to carry 400 tons of material is seen as an engineering challenge—to design and build a machine capable of providing years of service wherein the demand for raw materials is still increasing. To illustrate the magnitude, consider that these trucks are moving back and forth between the track-based shovel in the mine and dumping the load in the crusher, which may be up to a few miles away, 24 hours per day, seven days per week.

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See Also: Industrial Waste; Mineral Waste; Mining Law.

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Methane

Methane is a common chemical compound and the primary constituent of natural gas (also called biogas). Methane arises primarily from the decomposition of organic material, which means that most forms of garbage that are left to rot will produce it. Because it is highly combustive and its production is associated with pungent and potentially poisonous gases, many anthropogenic sources of methane, such as landfills, are regulated to secure air quality and site safety. Methane also has a high greenhouse gas potential, and, since the 1800s, methane emission levels have risen dramatically in the atmosphere alongside the carbon dioxide emissions blamed for global climate change. Therefore, government climate change mitigation efforts increasingly include an emphasis on capturing the methane produced by waste, which is one of the world's greatest sources of methane emissions. Because methane serves as a prominent source of energy, furthermore, waste is also drawing increasing recognition as a potential source of renewable power, whether in the form of redesigned modern landfills or more specialized anaerobic digestion facilities. At the same time, industry and state initiatives are criticized for promoting waste treatment as a source of biogas given its risks and socioenvironmental costs, complicating assumptions about what really counts as "renewable" or "sustainable."

Chemical Processes

Abbreviated with the symbol CH_4, methane is composed of simple hydrocarbon chains, which bond when organic materials—including biological wastes—decompose outside the presence of oxygen. A special class of microorganisms known as methanogens are responsible for generating much of the world's methane. Methanogens belong to a unique microbiological domain known as archaea, a separate branch of life from that of bacteria and multicellular eucaryota. They flourish in the world's wetlands and in more extreme environments, such as landfills and the guts of animals, living amid high temperatures with no oxygen. Methanogens do not consume waste alone but are mutually dependent on colonies of bacterial microorganisms, which break down organic material into smaller organic compounds rich in hydrogen and carbon dioxide and ideal for methanogenesis. Methane is one of the final end products of the chemical process through which these small organic compounds are broken down by methanogens.

Hazards

Though it is commonly assumed to have malodorous properties, methane is an odorless gas. The chemical reactions in different methanogenic systems may also produce pungent chemicals, such as hydrogen sulfide or methanethiol, which could be responsible for this misperception. These co-occurring gases may pose more than a nuisance. In sufficient quantities, hydrogen sulfide is poisonous, and some epidemiological studies confirm that living and working in proximity to waste sites may have negative long-term effects on cognitive function. Wherever methane is produced in proximity to human dwellings and workplaces, the copresence of other gases may raise concerns about health and quality of life.

For many centuries, refuse sites have been associated with fire. It has been suggested, controversially, that the idea of the Christian hell as a place of eternal fire comes from the Valley of Hinnom, south of Jerusalem, which some have claimed was a place where bodies and rubbish were once left to burn. Because of methane, open dumps and other waste sites are typically susceptible to fires and even explosions unless they have gas management systems in place. The potential dangers of methane leaks drew the attention of regulatory authorities in the late 20th century. As gases gradually leak from waste sites, they may accumulate in nearby buildings. In 1967, a methane leak from a landfill site in Georgia was responsible for the deaths of two people when their nearby house exploded; a similar event occurred two years later in North Carolina

when an armory close to an abandoned landfill site exploded, killing three and injuring 25 others.

Capture and Management

In the 21st-century United States, the Resource Conservation and Recovery Act requires that modern landfills manage the gas they generate. This can be done in several ways. The most common method was once to simply burn off the gas in flares, and this is still done at most facilities, as has been done as part of the process of oil and gas extraction. In landfill gas collection systems, emissions from the decomposing waste are collected and diverted through a network of pipes to a treatment system, blower, or flare. The 1996 Environmental Protection Agency (EPA) Standards of Performance for New Stationary Sources and Guidelines for Control of Existing Sources and the National Emission Standards for Hazardous Air Pollutants both recommend combustion to reduce nonmethane organic compounds, although they do not apply to smaller landfills.

Most landfill gas projects in the United States utilize it for electricity generation, which is either used on-site or pumped to the electrical grid. Alternatively, the gas is not converted into electricity but is used directly on-site to offset energy requirements. It may also be used in a combined heat and power unit to create usable thermal energy alongside electricity. Some landfill sites are being designed as *bioreactor landfills*, an industry term in the United States to describe a landfill that incorporates selective wastes, such as sewage sludge, alongside normal solid waste loads in order to promote more stable gas collection and better energy production.

Most gas is siphoned off from landfills through collection methods, but even under existing regulations, it is difficult to extract all the methane and, where levels are particularly high, it is possible for small amounts of fugitive emissions to bubble up to the surface when collection systems are insufficient. A more precise way of deriving biogas from waste is to process it in a closed container, as is done with anaerobic digestion technology, to prevent gas from escaping and to precisely control the process of methanogenesis. As with landfills, the feedstock delivered to digestors can be tailored to better methane production—food and green wastes can be codigested alongside energy crops like corn or other readily digestable materials in order to maintain high energy yields—but digestors can also be designed so that conditions within the vessel, such as temperature or pH, promote more efficient chemical exchanges between microbes. Another way in which consumption practices are linked to waste methane is through industrial farming. Cow flatulence and decomposing manures are leading contributors to methane emissions, and anaerobic digestors are increasingly utilized throughout the world as one technique of farm-based methane management systems.

Energy Potential and Risks

By some estimates, natural gas accounts for almost one-quarter of worldwide energy use and approximately one-third of the total energy consumed in the United States. Because waste is so abundant—a by-product of human activities—some view methane derived from waste as a source of "renewable" or "sustainable" energy, capable of contributing to industrial society's high energy demands at a lower overall environmental and social cost. There are potential problems with the emphasis on deriving methane from landfills and other waste streams, however. Typically, natural gas is considered the "cleanest" of all fossil fuels because it is comprised of much lower ratios of carbon, nitrogen, and sulfur than coal or oil. When combusted, other fossil fuels release more carbon emissions, nitrogen oxides, and sulfur dioxide into the atmosphere, resulting in various forms of pollution.

While natural gas is made up of approximately 80–99 percent methane, some estimate landfill gas to be approximately 40–60 percent methane, with a greater proportion of nonmethane organic compounds and inorganic contaminants. Because of the heterogeneous composition of municipal solid waste, landfill gas may contain trace amounts of mercury, radioactive hydrogen, and toxic chemicals such as benzene, toluene, and chloride. When combusted with organics, some of these inorganic compounds produce highly toxic dioxins and furans, such as are generated by conventional incineration. Thus, it may be that the gas derived from waste decomposition is too low in methane

and is potentially contaminated with other substances that may pose unseen risks when it is converted into energy.

Greenhouse Gas

In addition to the risks and energy rewards that methane generation introduces to its local surroundings, it also poses more of a global threat. Methane is estimated to be anywhere from 21 to 25 times more powerful than carbon dioxide as a greenhouse gas. While its chemical bonds degrade 10 times faster, the result is only more CO_2. For every metric ton of methane, 2.75 metric tons of CO_2 are left lingering in the atmosphere. Furthermore, methane is responsible for slowing down the formation of sulfate aerosis, sulfur-rich atmospheric particles that are believed to have a cooling effect on the Earth. Since the Industrial Revolution, methane levels in the atmosphere have more than doubled. Human beings are responsible for approximately half of the world's methane emissions in 2010, with the most prominent sources including the production of fossil fuel, domesticated livestock, and waste management activities. Therefore, additional incentive exist to trap the methane produced by waste.

Landfill gas and anaerobic digestion projects have become preferred ways of mitigating the greenhouse effects of industrial waste production globally. Throughout Europe and much of the industrial world, digestors and landfill gas systems are touted as a means of creating more locally sustainable waste management systems, which simultaneously address global climate change concerns.

The United Kingdom has promoted landfill gas projects since 1990, but began a renewed effort to finance such projects alongside digestors with the introduction of the Renewables Obligation in 2001, combining energy, waste, and climate change politics. The primary mechanism through which the U.S. government has encouraged the development of landfill gas collection is through the EPA's successful, and entirely voluntary, Landfill Methane Outreach Program (LMOP), introduced in 1994.

In its first 13 years of operation, LMOP assisted in the development of over 360 landfill gas energy projects by providing landfills with access to a national network of expertise and technical guidance. As a consequence of these initiatives, the level of U.S. methane emissions from landfills decreased—as measured in units of teragrams of carbon dioxide ($TgCO_2$) equivalents—from an estimated 149.3 in 1990 to a reported 126.3 in 2008. During this period, landfills went from the country's leading source of methane emissions to the second, behind enteric fermentation in farm animals. There are additional schemes that provide financial incentives to landfills to reduce methane emissions, including emissions trading initiatives such as the Chicago Climate Exchange. Additionally, landfills may be able to receive revenue in the form of green credits, awarded for offsetting methane emissions and either exchanged bilaterally or sold directly to buyers. Because of these schemes and LMOP, there were over 450 landfill gas energy systems in the United States by 2010, which were responsible for 12 billion kilowatt hours of electricity generated per year.

Conclusion

Few would quarrel with the introduction of landfill gas and other methane extraction initiatives are some of the best ways to utilize the energy potential locked in organic wastes. However, there are concerns that incentives to derive energy from waste may distract from policies directed toward waste reduction, which is a far more comprehensive means of lowering emissions in both carbon and methane. It remains to be seen to what extent transforming waste into an energy feedstock alters the political economy of waste treatment and disposal and whether it will one day be recognized as a "resource" more so than a pollutant or a byproduct. But insofar as waste-to-energy projects depend on practices of mass production and mass wasting, they do not provide a complete solution to unsustainable fossil fuel addiction. This brings the purported "renewability" of landfill gas systems and other waste-to-energy projects into question, despite the potential of methane to alter the landscape of energy practices and politics.

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See Also: Anaerobic Digestion; Incinerators; Landfills, Modern; Microorganisms; Open Dump; Organic Waste.

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Mexico

With 31 states and a federal district, and over 110 million residents living on more than 760,000 square miles of land featuring coastal plains, mountains, forests, and deserts, Mexico is by no means a homogenous country, and therefore residents generate nonhomogenous quantities and qualities of waste. But in accordance with consumption patterns in other industrialized and industrializing nations, as the country's population grows, Mexicans—whether they are rich or poor, rural or urban—are acquiring and discarding increasing amounts of objects. Both in typology and quantity, material refuse chronicles the nation's history and reflects modern Mexicans' garbage-related values, which can be highly political.

Seventy-five percent of Mexicans live in urban areas. The highly stratified national capital of Mexico City is the most populated city in the Western hemisphere and one of the largest in the world. Article 10 of Mexico City's Current Regulations for the Federal District's Cleaning Service mandates that solid household trash removal will be free of cost to all residents. Although semi-functional, considering the nation's poverty, sprawling and exponential population growth, and taxation model, it is growing increasingly difficult for Mexico City, and other municipalities that model their regulations after the capital's, to honor that promise.

Environmental Problems

Due to the unmanageability of the quantity of the trash Mexicans generate, refuse-related environmental problems abound. Disposal issues plague communities of all sizes, though garbage sanitation sometimes comprises up to 40 percent of cities' budgets. But in 2010, according to the World Bank, Mexico had only 97 officially controlled waste disposal sites. Just 11 of those sites were mechanized or manual landfills, as opposed to dumps.

Mechanized landfills are engineered and must have sanitation instruments to ensure proper waste management, while manual landfills are intended to be sanitary and are small enough that employees manage most quotidian tasks by hand, employing technological instruments only for irregular large tasks. In Mexico, however, landfills do not meet most industrialized nations' environmental standards; they are poorly lined, spilling toxins into the soil and groundwater. The World Bank has found that only 15 percent of the nation's municipal solid waste (MSW) is safely treated upon disposal.

One exception, Mexico City's innovative Prados de la Montana controlled contaminant release landfill, treats its leachates (the water that escapes from the landfill after percolating through the waste) via chemical and biological processes. It is the only landfill in the country to do so. Improved leachate management is the World Bank's first recommendation to improve Mexico's landfills. Various entities are working to meet that recommendation by increasing composting and recycling facilities.

Illegal Dumps

In contrast to landfills, dumps are simple, open-air, human-made pits or natural quarries where discarded trash accumulates in an uncontrolled or semicontrolled manner. Mexico City alone features an estimated 1,200 illegal dumps. Dumps present extreme environmental health risks, producing stench and attracting disease carrying vectors, including rats, flies, dogs, and even pigs that sometimes end up as food for squatters and nearby residents. Because of these risks, dumping grounds are usually situated within the most impoverished parts of the community. In the poorest parts of the country, residents simply burn their trash, regardless of type.

Throughout the nation, municipal services collect only about 75 percent of the waste generated (in Mexico City, about 1.2 kilograms of trash per

person per day; in Oaxaca and its suburbs, about 600 tons per day total). The remaining 25 percent of trash pickup service—usually in lower income areas—is left to informal private-sector collectors who perform the task for a fee. Householders and business owners are expected to tip low-salaried informal trash removal personnel, though there are usually no written contractual obligations mandating this practice. In proportion to what they pay, individual households and businesses negotiate with their refuse handlers over the frequency and quantity of garbage removal.

Every day or so, a member of a Mexican household or a business employee will take a plastic bag or two of trash to a "sweeper" or a sweeper's container, and tip them a couple of pesos to take it away. The sweeper gives the trash and most of the tips to a garbage truck driver, who takes it farther away. Throughout the nation, garbage employees occasionally take trash to clandestine sites, which include vacant lots as well as occasionally city parks. Usually, however, they take trash to official refuse sites, which charge a per-tonnage fee (though they seldom weigh the trucks).

The government usually owns the land upon which the landfill or dump sits and negotiates contracts with these private-sector trash businesses. However, nonstate garbage services can grow into large independent companies, sometimes developing their own private landfills, as in the case of SIMEPRODE, which controls three in the Monterrey metropolitan area. Because they fill an important (and sometimes vital, lest the garbage accumulate) role in Mexican civil and economic structure, political parties, especially the PRI (Institutional Revolutionary Party), have organized or attempted to organize these companies.

Recyclable Waste

The Mexican National Institute of Statistics, Geography and Information (INEGI) classifies waste as industrial, municipal, or special, all of which can go into either dumps or landfills. Sara Ojeda-Benitez et al.'s 2003 study quantified the residential solid waste (or RSW, which falls into the municipal category) in a sector of Mexicali, Baja, Mexico. Researchers found that a random sample of 160 families generated a vast majority of recyclable organics, especially food scraps, paper, and cardboard—a recyclable inorganic, or what some Mexicans call "clean waste." Potentially recyclable waste constituted 61 percent of the garbage the community of Mexicali generated. Of the nonrecyclables there, textiles occurred most frequently, followed by plastic, and then sanitation wastes. About 2 percent of RSW throughout Mexico qualifies as hazardous. As with most other Mexican cities the size of lower-income Mexicali, there is no landfill, only a dump.

Substantial environmental hazards result from filling dumps with so much organic waste. For the first time ever, in September 2011, the annual international Waste and Recycling Expo took place in Mexico City, a testament to how Mexico's priorities may be taking a turn toward the sustainable and sanitary. However, composting is almost unheard of and formal recycling is at this time faddish only in cosmopolitan areas. It is increasing in wealthier cities and touristic areas as they follow the examples developed nations set, and even this is happening slowly. Residents of certain wealthier sectors are beginning to sort their recyclables from their nonrecyclable waste, but sometimes express doubt as to whether the two actually have different final destinations.

Informal Recycling

Informal recycling, however, has been an important component of the story of Mexican trash disposal for several decades. Depending on the type of activity, informal recyclers save landfills and dumps various quantities of space, energy, and money. Their living and working conditions can be extremely harsh, but they sometimes have political clout and leverage.

One type of informal recycler, *carretoneros,* walk through neighborhoods, hunting through trash cans for recyclable objects to sell. They are independently employed and not usually officially organized, except in some neighborhoods in Mexico City. In some cities, the government licenses and monitors *carretoneros*. They are not permitted to dump waste in clandestine sites, nor leave their carts uncovered overnight, and they must pick up after their horses. According to Martin Medina, one reason the government decided to control

these informal recyclers is that they can earn up to five times the national minimum wage and thus are important sources of tax revenue. Another sort of informal recyclers, waste pickers, sort through trash at dumps or landfills to reclaim and sell reusable materials, facilitating new production. In Mexico they are known as *pepenadores*, and they help eliminate tonnage at refuse sites.

Waste pickers working throughout Mexico organize themselves into cooperatives, which have gone on strike protesting and forming blockades around dumps. *Pepenadores* seek job security, assistance treating job-related health risks, and fairer compensation for the role they fill in helping sort the up to 6,500 tons of trash many Mexico City dumps receive every day. They have closed waste facilities for days, rendering them unable to process trash as full trucks wait to unload their hauls.

Regardless of the rights they may have won, *carretoneros* and *pepenadores* are objectified, perceived as dirty, like the objects with which they work and often in which they live. However, they serve a vital function in Mexican society; without them it is apparent that the sanitation service would literally fall apart. In Mexico, economic stratification tends to correlate with access to sanitary and environmentally safe and responsible disposal conditions, as it tends to in other parts of the world. Most people, however, regardless of their socioeconomic status, tend to agree with the sentiment that garbage equates to immorality, which is inconsistent with the aesthetic reality of the majority of Mexicans.

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See Also: Dump Digging; Landfills, Modern; Mexico City, Mexico; Street Scavenging and Trash Picking.

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Mexico City, Mexico

Mexico City is the capital and largest city of Mexico, the largest city in the Americas and the third most populated metropolitan area in the world. The political, economic, and cultural center of the country, it is a federal entity unto itself, not part of any Mexican state—much like Washington, D.C. The metropolitan area has about 21.2 million people and accounts for over one-third of the country's gross domestic product (GDP). Within the city limits, the per capita GDP is $47,396, one of the highest in the world. Despite this wealth and a high ranking on the Human Development Index, the city's sheer size has led to a number of unique challenges of waste management and resource consumption. Because of its size and age, in many ways Mexico City is a canary in a coal mine: many of the problems it faces represent challenges other cities can expect as they approach similar scale and density.

Brief History

The city was built on an island of Lake Texcoco, and the Spanish colonists dug canals and tunnels in the surrounding Valley of Mexico in the 17th century because the lack of natural drainage led to periodic flooding from mountain runoff. The lake was subsequently drained, and the city rests on heavily saturated clay, which has begun to collapse since the early 20th century due to overextraction of the groundwater. The sinking complicates runoff and wastewater management and exacerbates flooding problems in the rainy season.

Water Management

Responsibility for Greater Mexico City's water management is divided among various governments. The federal government regulates the use of water resources. The state of Mexico treats wastewater, provides bulk water, and assists municipalities in providing water and sanitation services. The 60 municipal governments in the area are in charge of sanitation and water distribution. The federal district provides water and sanitation services to the city proper. The federal government takes a particular interest because of Mexico City's economic, political, and infrastructural importance to the country and the national welfare. These

An aerial view of the northern part of Mexico City and the Palacio de Bellas Artes (Palace of Fine Arts) reflects the statistic that Mexico City is the largest city in Mexico and the third most populated metropolitan area in the world. It also accounts for over one-third of the country's gross domestic product. The size and age of the city have led to a number of consumption and waste management challenges. About 85 percent of the wastewater in the city is discharged, untreated, into the north to irrigate crops; this presents serious health risks.

governments have instituted a water sustainability program and a green plan, which emphasizes water conservation. Both plans call for transporting groundwater from north of the city where the groundwater table is higher, constructing a significantly expanded stormwater drainage tunnel, and investing in wastewater treatment improvements.

The National Water Commission is the federal body responsible for water resources management in the country, granting of wastewater discharge permits, and the supply of bulk water to Mexico City. The combined sewer system of Greater Mexico City collects municipal wastewater, storm water, and industrial wastewater, and it consists of 7,400 miles of pipe, 68 pumping stations, and numerous open canals, tunnels, underground collectors, dams, lagoons, and regulatory tanks, and intersecting with rivers. A single storm in the rainy season can produce a full tenth of the annual precipitation, necessitating significant capacity for the stormwater drainage system in order to avoid highly damaging floods.

Only about 15 percent of the wastewater collected in Greater Mexico City is treated, primarily in Mexico state wastewater treatment plants. Most of the remaining wastewater is discharged to the drainage system untreated and eventually is discharged in the north where it is used to irrigate alfalfa, barley, wheat, corn, and other crops. The nutrients in the sewage keep crop yields high and reduce dependence on other fertilizers, but the wastewater also contains both industrial and biological contaminants (such as bacteria, larvae, and eggs), which present health risks both to farm workers and to consumers. In theory, using the wastewater to irrigate crops that will be heavily processed and cooked before consumer contact—grains and cereals—mitigates the health risk, relative to such use to irrigate fruit and vegetable crops. Technically, use of untreated wastewater to irrigate crops that will be eaten raw is illegal; in practice, it is widespread in the area. There are many farms and farm workers whose livelihoods would be in jeopardy should they switch to more expensive water sources. (Industrial wastewater is partially

treated at the source, but the data is uncertain as to the efficacy of its pretreatment before entering the drainage system.) A portion of wastewater is also diverted for use to irrigate urban landscapes (such as parks and lawns) and for commercial uses, such as car washes. Private-sector companies also buy up municipal wastewater and redistribute it for nonpotable reuse.

An ongoing problem in the early 21st century is leaks in the water distribution system, as a result of which soil is permeated by contaminants from one source, which are then passed on to another part of the distribution chain—one that is supposed to be carrying uncontaminated water. Studies by the local government have found that the quality of tap water is lower in neighborhoods that have frequent water distribution service interruptions (caused by such leaks), a public health problem compounded by the common practice of using *tinacos* (open tanks kept on rooftops and used for household water storage when water pressure is insufficient).

When the tanks are not regularly cleaned, the level of chlorine in the water falls low enough to permit contamination by microorganisms and bacteria, and the chlorine in the tap water is sufficient only to prevent that growth (not to kill living microorganisms introduced to the water supply). Estimating the extent of leaks is difficult because Mexico as a whole, and Mexico City specifically, has a nonrevenue water level of 40 percent—in other words, only 60 percent of the water that goes through the system is accounted for in billing. However, the level of loss is far too great to be the fault of leakage alone and represents a significant amount of theft through illegal, unbilled connections to the distribution system. Financing the water system is further complicated by the fact that the water department has an exceptionally low collection efficiency and fails to collect more than half of the revenue it is owed. The Greater Mexico City population thus uses at least three times as much water as it pays for.

Much of this will be at least addressed, if not fully remedied, by the new water programs being put in place in the early 21st century. The extent of some of the problems is great enough that it may not be revealed in full until a partial remedy is in place, like opening a patient for surgery in order to survey the damage. The green plan in particular aims to reduce water loss through leakage and other problems, reduce unnecessary or inefficient water usage, recharge wells and aquifers, meter all water users in order to increase bill collection efficiency and better fund water distribution, and create better wastewater treatment plants in order to increase the amount of wastewater that is converted into safe water. These programs are more ambitious than the water conservation programs attempted in the 1990s, which had ambiguous results.

Air Pollution

Air pollution has been a significant problem, addressed by both federal and local governments. When levels of ozone or nitrogen oxides reach critical levels, factories are closed, school hours are modified, and the *Hoy No Circula* program is extended to two days a week in order to reduce emissions. *Hoy No Circula* (meaning "A Day Without A Car") is a Greater Mexico City program that limits car usage to six days a week (or five during such emergencies), based on the last digit of the license plate. The program applies to any car with a plate from Mexico City, Mexico State (the surrounding state), or surrounding states with reciprocal programs. These contingency plans, along with the reformulation of auto fuels and strict enforcement of the twice-per-year emissions inspections, has helped reduce pollution levels by significant amounts. As of 2010, lead had been reduced by 95 percent since 1990 (when pollution levels in Mexico City were more than 10 times greater than those of New York City), sulfur dioxide had been reduced by 86 percent, and carbon monoxide had been reduced by 74 percent. The populace is also more dependent now on public transportation, including an underground rail system with subsidized fares.

Solid Waste Management

Solid waste is also a mammoth problem for Mexico City, with more than 10,000 tons of garbage produced daily by the city. Much of this ends up in places like the 600-hectare Bordo Poniente landfill, which emits 2 million tons of greenhouse gases a year, second only to automobiles in the list of Mexico City

emission sources. Bordo Poniente's shutdown was announced in 2004 but was continually delayed. The national government has repeatedly called for its closure, arguing that it is far over its capacity. The city government, bereft of any alternative, has insisted that the landfill can and will continue to operate until 2012. Further, official studies indicated over 100 unauthorized garbage dumps operating throughout the city, most of them little more than heaps of refuse dumped in a vacant lot or green area. The city's fleet of garbage trucks has long lagged far behind what it needs.

While other countries have made some progress exploiting municipal solid waste for its biogas and other economic possibilities, Mexican waste law does not address the ownership of garbage, leaving it unclear who has the authority to act on such an opportunity. The Clinton Climate Initiative founded by former U.S. President Bill Clinton embarked on the largest waste management project undertaken by a climate change organization, initiating a project in Mexico City that intends to cap the current landfill and initiate a new waste management program based on recycling, landfill gas collection, and composting.

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See Also: Developing Countries; Mexico; United States; Water Treatment.

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Miasma Theory of Disease

The miasma theory of disease causation has some incipient roots in Greek and Roman medicines, in particular in Hippocrates's "On Airs, Waters, and Places." It developed as a naturalistic theory during the Renaissance and was especially popular in the 19th century to explain yellow fever, malaria, typhus, tuberculosis, cholera, and other diseases. According to this theory, disease causation relates to environmental emanations (gases), or miasmas. Miasmas are infectious noxious vapors emanated from putrefying carcasses, rotting vegetation or molds, and invisible dust particles inside dwellings. The understanding was that in some cases the air became attacked by an epidemic influence that became malignant after interaction with the emissions of organic decomposition from the earth.

However, in the early 19th century, it was clear that some diseases (e.g., yellow fever) did not develop if the person suffering from an infectious disease changed location. This fact enhanced the theory of miasma based on the presumed connection of the disease with a certain place, although it also propelled a search for other reasons. Professor François Magendie's lecture at the College of France in 1834 provides an example of how miasmatic disease was defined in early 19th century:

> Yellow fever is a disease strictly miasmatic; it exists only in certain localities, in places favourable to the development of various exhalations of an injurious nature; it devastates one quarter of a town, while the rest are habitually free from it. If an affected individual be transported to a distant and healthy situation, he does not carry the disease with him. . . . The Americans tried this principle upon a grand scale during the prevalence of cholera, but without success. . . . It was either there before them, or did not long fail to arrive. . . . Cholera was proven not to depend on miasma, like yellow fever and other diseases of that class, which are characterized of being confined to peculiar localities, and of not being transmissible to healthy situations where the developing cause does not exist.

Later it was clarified that the cause of yellow fever as an acute disease was mosquitoes and that explained why changing places had a preventive health effect. By the mid-1800s, the concept of miasmas was intimately connected with theories of fermentation (so-called spirituous fermentation, acetic fermentation, lactic fermentation,

and putrefication). Despite the invention of the microscope in the 1600s, fermentation was not anchored in these theories to microorganisms and the common belief was that chemical rather than biological processes caused fermentation. The miasma theory of disease postulated a sort of airborne "ferment"—the cholera epidemic was explained by such factors as calm, stagnant, high barometric pressure weather and high river water temperatures at night.

In the later part of the 19th century, the miasma theory competed with germ theory and helped prevent a quicker recognition of the latter. It is a lesson for the history of science, since William Farr, the advocate of the miasma theory, demonstrated one of the typical characteristics of narrow-minded authorities—insistence on one thesis and ignoring all others. However, even in the early 19th century, there were specialists who did not connect cholera to miasma.

The miasma theory of disease did have a positive effect on modern human preventive health history: avoiding infectious diseases meant cleaning the streets of garbage, sewage, animal carcasses, and wastes that were features of urban living at the time.

Sanitary Movement

One of the miasma theory's main benefits was improving health conditions in the cities during the sanitary movement (1838–1914). It started in Great Britain and had a strong influence on the United States.

Miasma theorists suggested that the development of disease is a result of harmful odors, mists, or substances (i.e., pollution), found as organic matter in the environment. The cholera epidemic in 1854 stimulated public health officials to develop successful strategies for preventive health by eliminating accumulated waste, cesspools, and contaminated water as presumed miasmic breeding grounds for epidemics. The focus was on sewage management, drainage, clean water, ventilation, and other sanitary measures. In the 19th century, the policy of personal and public hygiene concerned mostly the wealthy levels of society, while the environment in low-income areas led to epidemics of cholera, typhus, typhoid, and plague, as well as endemic tuberculosis. In 1848, the British government passed a special law for hygiene, followed by other countries, including the United States. The preventive health and social measures consisted of paving streets, building sewers, providing clean water, establishing ventilation, reducing crowding in housing, and hauling away garbage. These reforms correlate with decreases in mortality caused by epidemic diseases.

Toward the end of the 19th century, there was a policy shift in public health from interest in cleaning of the environment toward protection of individuals from the hazards of their environment. One of the reasons was the changed disease causality explanation: the role of microorganisms was recognized, as was the contagious nature of epidemic diseases. By 1875, the germ theory moved public health into a "bacteriological era." However, sanitation and hygiene became commonly understood as remedial measures.

Epidemiology

Epidemiology, the basic science of public health, is a reflection of the miasma theory of disease that required sanitization and hygiene. When it emerged, it was associated with 19th-century infectious disease epidemics. It started as the study of the distribution of disease in populations and later included the determinants of disease. Since the 20th century, the focus has been changed from an interest mainly in infectious diseases toward chronic diseases and health-related states and events such as injuries, violence, environmental and social conditions, and regulation of health problems.

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See Also: Children; Germ Theory of Disease; Human Waste; Public Health.

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Michigan

Michigan is renowned for two seemingly contradictory reputations: the beauty of its lakes and industrialization. Michigan spans 96,810 square miles across two peninsulas, making it the 11th-largest state. Rural areas include much of the upper peninsula, where copper and iron mining were the dominant industries in the early 20th century. The most urbanized area is Detroit in the southeast, the center of U.S. automobile production. By 2000, the population of Michigan was 9,938,444, making it the eighth most populous state.

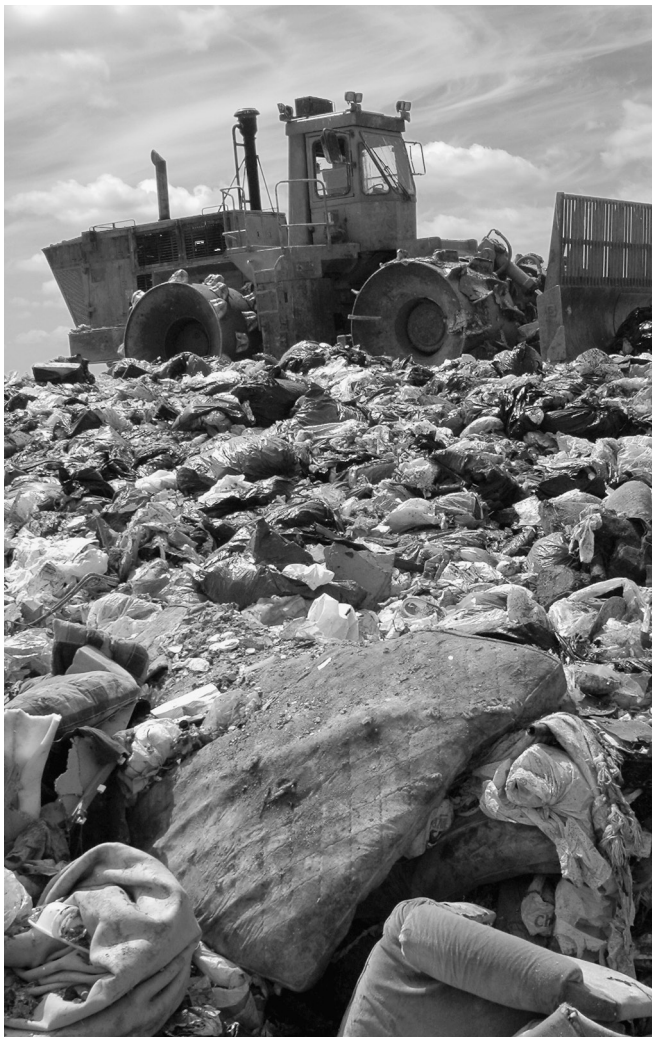
Through the automobile industry, the state redefined capitalist labor and consumption, changing the significance of waste in the process. But from the start of the 21st century, it became one of the country's leading importers of out-of-state waste. Unlike Pennsylvania and Virginia, however, Michigan's status as a waste importer was the result of an international trade with Canada, providing a unique set of conditions from which to reconsider the relationship between the economics and international politics of waste. For some, Michigan's exceptional natural resources have to be defended from material and legal encroachments; for others, waste imports offer opportunities for the prosperity and productivity lost through the postagrarian and postindustrial transformations of recent decades.

Natural Resources

Michigan's natural resources were not always regarded as something to preserve or conserve. During its colonization over the course of the 19th century, Michigan's abundant forests were often considered wasteland and were burned as part of laying claim to Native American territory and making way for new farms and villages. As Michigan moved from a leading source of beaver pelts to agricultural produce, timber, and ore, there was a similar embrace of industry and accumulation at the expense of environments and their inhabitants. In the early 20th century, innovations like the modern assembly line and the $5 day made Michigan industry synonymous with the spread of mass production and consumption, and a concomitant overproduction of waste.

Automobile Industry

The Fordism of the automobile industry was not merely emblematic of these transformations but also created waste problems of its own. On the one hand, there are the waste products of cars, such as exhaust, which has been held responsible for rising levels in greenhouse gases associated with climate change. On the other hand, there is the afterlife of the car body as it breaks down or is replaced with a



While Michigan's recycling rates are lower than the U.S. average, its rates of incineration and landfilling are higher, in part due to an arrangement with Toronto, Canada, to accept their solid waste. In 2006 alone, Michigan accepted 12 million cubic yards from Canada.

newer model. General Motors' (GM) CEO, Alfred P. Sloan, helped introduce the concept of planned obsolescence by promoting annual changes in automobile styles to encourage consumers to continually buy new vehicles and dispose of old ones, which cultural critics like Vance Packard would later hold responsible for the profligate production of waste associated with U.S. economic life.

Henry Ford recognized this as a problem and aimed to promote a disassembly line that would take apart old cars and recycle their components. The frequent replacement of automobiles supplies raw materials for Michigan's strong scrap industry, which produces metal and spare parts for sale through the recycling of old cars in junkyards. In 2009, the federal Car Allowance Rebate System or "Cash for Clunkers" bill was sponsored by Michigan congressmen and signed into law. This bill provided incentives for car owners to scrap their old cars in order to purchase more fuel-efficient vehicles and stimulate demand for the automobile-dependent economy of the Midwest.

Waste Management

Like most states, after the boom in consumption that accompanied World War II, Michigan began relying heavily on sanitary landfill disposal in order to manage its increasing consumer and industrial waste. A concomitant reliance on truck drivers to haul waste and consumer goods helped enable the growth of the Teamsters Union, which under the leadership of Detroit native Jimmy Hoffa grew to one million members by the 1950s.

Like in other parts of the country, accusations of corruption and criminal connections continue to shape perceptions of Michigan's waste management industry long after Hoffa's downfall. Truck drivers and machine operators in the waste industry remain heavily unionized in Michigan—perhaps in part because of the example and influence of the state's powerful auto unions—and they have used garbage strikes in Detroit and elsewhere throughout the late 20th century. With the gradual privatization of the waste industry, collection and disposal became divided between the largest waste companies, with Waste Management holding the greatest share.

According to data collected in 2004, Michigan performs average in comparison to other states in terms of the amount of waste generated, producing approximately 1.26 tons per person per year, or 12.76 million tons annually, an amount that increased to over 15 million tons the following year. Michigan recycling rates fare worse, at little over 20 percent in comparison to over 28 percent for the nation. Consequently, the state incinerates and landfills more, at less than 10 percent and 70 percent, respectively. This reliance on landfills was promoted as part of a statewide strategy to manage an anticipated waste crisis. Like all states, Michigan was required to comply with the Resource Conver-

sation and Recovery Act (RCRA) of 1976, which introduced a more rigid and standardized regulatory framework for managing waste. Michigan introduced the Solid Waste Management Act in 1978 in response.

After further amendments to RCRA required the closure of substandard landfills, there was growing concern about a looming waste crisis. In response, some municipalities turned toward incineration, which had lost favor to landfill in the United States over the course of the 20th century. In 1989, the largest incinerator in the world was built in the middle of Detroit. Processing waste from the greater Detroit area, the incinerator has raised considerable controversy, leading to local protests in 2010 aimed at preventing the plant's recertification.

New Landfills

In response to the crisis, the state government required individual counties to produce solid waste management plans that would secure enough landfill space to supply their needs for a specified period of time. To facilitate this process, the state introduced a program that offered tax-free bonds for the construction of new landfills. The result was the development of new, large landfills, typically in rural areas, with abundant capacity and a need for additional revenue to make up for the new costs of environmental compliance. While most states reported a net loss of landfills in the 1980s and 1990s, by a total of 67 percent, Michigan was one of two states to have increased its number. As a consequence, an increasing number of landfills were given an incentive to seek out-of-state waste contracts, especially after the 1992 U.S. Supreme Court case *Fort Gratiot Landfill v. Michigan Department of Natural Resources*, which determined that waste imports were protected under federal anti-protectionist laws.

Importing Waste

Due to strong opposition among First Nation communities to a proposed landfill site in northern Ontario that was meant to supply Toronto after its old city landfill closed, the city of Toronto decided to begin sending its waste to Michigan landfills in 2000. Between 2000 and 2006, the amount of out-of-state municipal solid waste disposed of in Michigan doubled, from approximately 9.4 million to 19 million cubic yards. At its peak, over 12 million cubic yards were in one year imported from Canada, much of it from the Toronto area, which amounted to 18.9 percent of the solid waste disposed of in Michigan that year. This dramatic increase led to strong public opposition, organized at the local level by residents living in the vicinity of transnational landfills and statewide by political candidates running for reelection.

In 2003, the Not in My State and Don't Trash Michigan programs were launched, both of which sought to organize support in order to summon a challenge to the waste trade. Critics pointed out that Michigan also exports significant amounts of hazardous waste across the border into Canada. Furthermore, the waste trade actually provides considerable economic revenue to rural Michigan communities without comparable sources of funds. For this reason, town supervisors from one landfill community actually traveled to Lansing to protest shutting down the border to waste imports, expressing their concern that this would cripple the town budget, which had become dependent on the revenue supplied from the host fee. With declining farms, a housing market in turmoil, and fewer reliable industrial jobs than in the past, outside sources of revenue such as that stemming from the waste trade are important.

Even so, a wide range of methods were explored to eliminate Canadian waste imports or to find them in violation of state environmental regulations and international agreements. A total of 11 bills were signed into law in 2004 by the governor, including attempts to ban beverage containers, increase the number of inspections, and impose a moratorium on waste imports. These were largely unenforceable rules, which received stiff opposition in the courts and elicited lawsuits on the part of the waste industry. Their largely symbolic significance was an attempt to voice state-level opposition to a transnational market in landfill space regulated into existence by particular interpretations of national and transnational law. Ultimately, however, political maneuvering on the part of Michigan political leaders forced Ontario officials into an agreement that would first limit waste exports from Toronto, then end them altogether by 2010.

Alternatives

Despite the government's past emphasis on increasing landfill capacity to handle the waste crisis, new efforts have been undertaken to promote alternative forms of waste disposal and treatment in Michigan. Beginning in the mid-1980s, Michigan landfills began introducing gas-to-energy projects in order to increase their revenue and comply with new regulations under the changing laws of RCRA. By 2007, there were 12 active gas recovery projects in operation in the state, nearly twice the national average per state and enough to produce 60.3 megawatts of electricity every year.

By 2010, in southeast Michigan, a company was attempting to create an innovative plasma arc gasification plant that would operate at 100 megawatts annually. An advanced form of thermal treatment, gasification converts waste at high temperatures into a synthetic gas that can be converted into any number of things. At the proposed Michigan site, the plant will produce syngas alongside ethanol, biodiesel, insulation, and animal feed, all of which it would process from unsorted black bag waste. Michigan also has several anaerobic digestors operating on a trial or experimental basis. The once agriculturally dependent state had as many as six farm-based digestors in operation prior to 2005; five failed, largely for financial reasons. As in other parts of the country and at other times in its history, Michigan politicians, researchers, and entrepreneurs are beginning to experiment with various waste treatment options. It may be that politicians who were elected to protect Michigan from foreign waste may be committed to keeping waste on the political agenda, particularly in light of a suffering economy and growing uncertainties about climate change and other environmental threats.

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See Also: Anaerobic Digestion; Automobiles; Economics of Waste Collection and Disposal, International; Landfills, Modern.

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Microorganisms

Microorganisms have played a critical role in the history of waste management, and some believe they will play an even greater role in its future. Microbes are responsible for most of the characteristics associated with waste materials, including odor, putrefaction, and transience, but they were not always recognized as such. The influence of microbial activities on waste was gradually accepted in the aftermath of the devastating cholera outbreaks that affected concentrated urban populations in the 19th century. Ideas from epidemiology and bacteriology eventually influenced hygiene movements and the use of antiseptics in medicine. The germ theory of disease had begun to replace the miasma theory of disease, and fear of the pathological dangers posed by microbes grew along with microbe-based models of cleanliness.

The importance of sanitation in preventing environmental contamination and disease took hold in various social domains in the early 20th century. The notion that hidden microbial agents might spread disease through offensive materials, including waste, provided a potent symbol for the commodification and purification of domestic spaces and the public management of waste collection, treatment, and disposal. Garbage handlers in the United States became known as sanitary engineers, and modernized dumps became known as sanitary landfills. More recently, the actions of microorganisms in processing and treating organic wastes, as in landfill gas recovery operations or anaerobic digestion, have been identified as offering a possible form of renewable energy and a possible alterna-

tive to mainstream models of waste disposal, such as landfilling and incineration. The application of microorganisms to waste treatment forms part of a larger shift in technoscience toward the manipulation of biological life at a microscopic scale as a source of new value and societal transformation.

Early Conceptions and Study

Microorganisms represent a diverse range of creatures that are too small to be seen by the unaided human eye. Before the activities of microbes were experimented with and documented with the assistance of the microscope, their profound effects on the world were commonly attributed to other causes. The tendency for abandoned or unpreserved items to break down and transform was associated with the spontaneous generation of life, while the link between organic decay and odor helped lead to the belief that foul air contaminated with decomposed matter, or miasmas, was ultimately responsible for disease. These beliefs shaped waste management, as decaying waste matter was seen to be a source of pestilence and vermin. Without the recognition of microbial actions, waste may not have been contained and treated in the same way, but it was still removed from spaces of human habitation and sent to the margins of settlements. The dominant influence of these beliefs also shaped preferred waste treatment methods. Early incinerators, known as destructors, were greatly preferred among municipal engineers, even after modern landfill techniques were developed, precisely because cremation served as a method of destroying the noxious miasmas associated with the putrefaction of wastes, as well as getting energy in return.

The study of microbes and their effects on human health in the later 19th century played a central role in the modernization of waste management. The emerging field of bacteriology and the scientific writings of Louis Pasteur, Joseph Lister, and Robert Koch, among others, helped to enlist microbes in the moral and medical arguments of Western hygiene movements of the Progressive Era. Their efforts helped the germ theory of disease to take hold in the 20th century and associated microbes, above all, with disease transmission. Hygiene movements went beyond medical explanations for disease and encompassed a whole host of efforts to establish social order in industrial societies, including alcohol prohibition, opposition to prostitution and vice, and, later, eugenics. As a corollary to these social movements, sanitation engineering emerged as a means of preserving social order through material purification. Bacteriological models of hygiene introduced a scientific ethos of waste policy and practice. In the 1920s and 1930s, a sanitary inspector with a position in the English Ministry of Health named J. C. Dawes began advocating "controlled tips." His main recommendation, for which he is considered one of the most influential modernizers in sanitary engineering, was to use soil cover on waste dumps in order to prevent unwanted organisms from using them as breeding grounds for disease—an application of Pasteur's model of biogenesis and refutation of spontaneous generation. This key innovation was incorporated into the designs of modern landfills in later decades.

Germs and Hygiene

While both miasmatic and germ theories of disease would have advocated removal and containment of wastes, the latter made the influence of waste on health potentially imperceptible and therefore potentially more uncertain. While it is still the case that fragrant smells are associated with cleanliness or purity in everyday life, when it comes to the management of cities or households, fears over unseen microbes helped launch a boom in domestic products, including antibacterial soaps, detergents, and other chemical cleaners. The commodification of domestic labor was facilitated by a fear of unseen microbes and the damage they could do as well as by a desire for social and moral distinction, which reached from the colonial margins of Euro-American empires to middle-class neighborhoods.

Germ theory gripped the hygienic imagination and provided a model for later criticisms and regulations of the waste industry. Fear over the hidden effects of microbes on health may have helped contribute to an analogous anxiety, later articulated by environmental advocates, that equally undetected toxic agents or carbon emissions might contaminate the health of whole ecosystems. Pollution events like the Love Canal disaster raised awareness of such possibilities. The development of landfill liners and gas and leachate collection systems in the later

20th century applied concern over hidden microagents more broadly. 502

Microbiology

While microbes have dominantly been cast as an enemy of cleanliness and health in the 20th century, there have been renewed efforts in the 21st century to harness the special abilities of particular microorganisms through technical application or biological modification. For example, with the increasing sophistication, speed, and affordability of genome sequencing technologies, microbiologists have begun identifying the trillions of microbes that inhabit the human body, especially the digestive tract, in order to better understanding how these beneficial microorganisms contribute to particular diets and disease immunities. Other microbes have been discovered that give clues to the evolution of life on Earth or, it is claimed, could be modified to make advances in climate change mitigation, renewable energy production, and waste treatment. In one laboratory, researchers from the University of California, Berkeley, and LS9 biotech firm have modified a form of *Escherichia coli* bacterium that can produce usable biofuel from the digestion of crop and grass waste.

Aerobic Composting

There are other microbes that occur naturally and have been used to treat waste for centuries. Aerobic bacteria play an important role in the digestion of wood waste and other green wastes. Composting relies on a whole host of microbes, including bacteria, fungi, protozoa, and rotifers, which break down different kinds of materials and also feast on one another, producing an ecological balance to the process. Specific microbes are also necessary for breaking down paper products, called actinomycetes. The result of a successful composting operation is a nutrient-rich fertilizer and a destruction of biological pathogens when functioning at high-enough temperatures. There are industrial applications of composting techniques, as well as domestic ones. In-vessel composting units are a relatively new waste treatment technology that reduce the presence of unwanted pests from composting heaps and can control air flow and temperature of their units to encourage more efficient and more thorough conversion of wastes into a usable fertilizer. This is essential if organic composting operations are to generate a product that can compete in the market with industrial fertilizers. At a very different scale are home composting units, such as the popular Bokashi receptacles. These and similar home-composting units come equipped with efficient microorganisms (EM), which, the company claims, have been carefully selected to encourage successful decomposition, reduce odors, and produce successful fertilizer.

Anaerobic Digestion

Landfills are constructed precisely to trap material from escaping and, consequently, do not allow in the oxygen that would enable composting to occur. Particularly important for the breakdown of landfill organics are a class of organisms distinct from bacteria called archaea, an ancient form of life adapted to extreme conditions and capable of digesting waste outside the presence of oxygen. The resulting chemical reaction, known as anaerobic digestion, transforms organic wastes into both methane (which can be harvested for energy use) and a fertilizer-like substance known as digestate. Anaerobic microbes are utilized by landfill biogas collection systems, which draw methane from the garbage as it decomposes and burn it off, pipe it away, or convert it into electricity. Such landfills are also known as bioreactors because they are constructed in order to encourage these chemical reactions by creating conditions favorable to the microbe populations within.

There are microbiologists who examine the microbial populations cohabiting inside landfills, perhaps opening up the possibility of better promoting their activity and harnessing their outputs in more sophisticated ways. But those who study anaerobic digestion admit that the process itself is somewhat unpredictable, precisely because the necessary containment of the organisms and the waste they consume, as well as the microscale at which they operate, make it difficult to engage in direct manipulation of the methane production process. Even if one buries organic wastes, there is no guarantee they will spawn microbial colonies. The lack of sufficient microbes can hinder the organic breakdown of landfills and, ultimately, reduce landfill capacity. Landfill bioreactors may seek to enhance the process by

dumping more readily digested organics than solid waste, such as sewage. Another method involves taking the leachate, or excess fluids, collected from the base of the landfill and reapplying them to the active cells, encouraging digestion of the fresh waste by adding a volatile inoculant to the mix.

Another method of controlling the conditions of anaerobic digestion with more success is through particular plants dedicated to the treatment of organic wastes, known as anaerobic digestors. Like industrial composting units, digestors make waste treatment more predictable. The design of digestion plants can be accommodated to reach specific temperatures and, thus, rates of decomposition. There are specific microorganisms for different ranges of heat in anaerobic conditions, depending on whether they are mesophilic or thermophilic. Digestors can also better control the kinds of feedstock that are incorporated (this is difficult to accomplish with mixed waste loads) and use different forms of mixing before or during the digestion process. Because the anaerobic archaea are sensitive, inoculants can be added to facilitate their growth and pH levels can be carefully maintained. Anerobic digestion is a four-stage process, which relates to the four kinds of microbes involved in the process of chemical transformation.

It is particularly difficult, at the laboratory level, to control volatile fatty acids created by the secondary process of acidogenesis, ensuring that they do not overpower the methanogens that create energy-producing methane in the final stage of the treatment process. For this reason, to accommodate the different microbial populations, there exists a multistage design for anaerobic digestors that separates the four processes into discrete steps, allowing the operators to optimize conditions in each tank to the particular requirements of the microbes within, thus improving waste treatment and gas generation.

Conclusion

Aerobic composting and anaerobic digestion offer methods of treating organic wastes that involve more control of inputs and the treatment process, as well as outputs that resemble products rather than pollutants. For this reason, both are being experimented with and promoted in places where there is a desire to combine solutions to climate change with new markets in green energy and goods. Of these methods, by far the most common has been landfill biogas extraction, both because it is the cheapest means of treating organics and one that is most accommodating to existing methods of waste collection and disposal. Organic treatments require some separation of material inputs because microbial activity works most effectively when feedstocks are tailored to them. In those places where these new microbial waste technologies have been trialed, the source-separation of wastes has represented one of the biggest challenges.

Householders need to be trained on new waste separation methods, distinguishing not only organics from nonorganics but also green waste from food wastes. Different garbage containers can be designed for this purpose to aid in sorting, either arranged with an existing recycling system or mounted in the kitchen to compete with garbage disposals. Either way, waste habits need to be accommodated to microbial demands, which is merely the latest chapter in a century-old dialogue between humans and their unseen companions in waste management.

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See Also: Anaerobic Digestion; Composting; Germ Theory of Disease; Landfills, Modern; Methane; Miasma Theory of Disease.

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Middle East

The Middle East can be thought of in the broad sense of the Middle East and North Africa (MENA),

regional unit defined by most key international institutions such as the World Bank and the Organisation for Economic Co-operation and Development (OECD). The MENA region typically stretches from Morocco to Iran, and could under some definitions include Afghanistan and even Pakistan. In terms of waste production and management, the Middle East can be classified, with the important exception of the oil-rich Gulf states, as part of the developing world. Recycling often falls to the informal sector, which is deprecated in official discourse and is often in the hands of religious or ethnic minorities. Solid waste management (SWM) has been a topic of growing interest in the Middle East since the 1970s under the influence of massive postcolonial urbanization, modernist national policies, and international development efforts, especially those of the World Bank. Today, the key trend in the SWM sector is growing private-sector participation. A number of cultural elements affecting what happens to waste in the Middle East are important to consider, including conceptions of public/private space, the fact that waste-related tasks are often divided along gender lines, and the importance and particular form of cleanliness in Islam.

Waste

The countries of the Middle East are incredibly disparate on a variety of levels, especially socioeconomically. Generalization across the region is difficult. Nevertheless, leaving aside the oil-rich Gulf states, Middle Eastern countries mainly fall in the developing world category, as concerns their garbage: most produce about half to one-third the amount of municipal solid waste per person per year of the developed world, and their waste tends to be high in organic content. The World Bank estimated that in 2002, Morocco, Algeria, Tunisia, Egypt, Jordan, Lebanon, Palestine, and Syria together produced over 40 million tons of municipal solid waste, at an average rate of 248–259 kilograms/person/year, that is, between 0.68 and 0.71 kilograms/capita/day. An increase of 44 percent in total regional waste generation was predicted over the 1998–2010 period. In terms of composition, the same study estimated that organic waste comprised 55–70 percent of the solid waste, plastics 11–14 percent, and paper and paperboard 8–10 percent.

Despite an estimated $325–$400 million expenditure across the enumerated countries in 2000, solid waste management is very inadequate. With increasing urban populations and waste generation rates, the prognosis is negative. Syria, where large areas of towns and cities are unserviced or underserviced—up to 80 percent in some cases—is not exceptional by regional standards. Poorer residents almost invariably get the short end of the stick. They must often fend for themselves, burning their waste or throwing it in canals, empty lots, or streets and alleyways near their homes to decompose. Their garbage may eventually be picked up by municipal street cleaners. If it is collected at all, waste often gets dumped in antiquated or improvised facilities lacking effective controls. Incineration is limited.

Official recycling figures, whether waste management is in public or private hands, are low. Tehran, where waste is collected by the municipality, is estimated to recycle 5 percent; Jordan's rate is the same, most of which is achieved by nongovernmental organizations (NGOs), rather than by the official system. Real recycling rates are probably much higher, however, since few major cities in the region are without at least some informal-sector waste recovery. Cairo is home to a group often celebrated as the "world's best recyclers": the *zabbaleen* allegedly put 80 percent of the thousands of tons of waste they collect daily to profitable use. The scale and sophistication of the zabbaleen is exceptional, however, and this rate is not representative of the region on the whole.

Scavengers and informal-sector recyclers in the Middle East often have a shared low-status ethnic, geographic, or religious identity; they may be born into the profession, rather than joining or leaving according to purely economic dictates. Yemen's *akhdam* are supposedly set apart by African features, betraying Ethiopic descent that implies Christian heredity and, legendarily, connects them to pre-Islamic, foreign oppressors. True or not, what counts is the widespread representation. The zabbaleen are endogamously marrying—almost all trace ancestry to a limited number of common villages—and share common places of residence in enclaves around the city. They are also primarily, though not entirely (as it is often wrongly claimed), Christian. One should not conclude too hastily in religious dis-

crimination, even if the predominance of Christians in garbage collection has been observed in other Muslim-majority settings as well, such as Pakistan. In Egypt, rather than being pushed into the business by Muslims, Christians took it over through their comparative advantage: unconstrained by Islamic taboo, they can make better money than Muslims in the garbage business by using the organic waste to fatten pigs for slaughter.

The official view is typically that the informal sector is illegal and unsanitary, produces little benefit for anyone but its own tax-evading members, and results in no improvement to the environmental condition of the city. It is also generally considered shameful, especially for those who engage in it, but also for the country on the whole. Accordingly, efforts are frequently made to repress or at least conceal it, especially from foreign eyes.

Garbage piles in Manshiyat naser, or "Garbage City," Cairo, Egypt. The zabaleen *have historically been Cairo's trash collectors, recycling 80 percent of the waste they collect. As primarily Coptic Christians, they are not held to Islamic taboos regarding garbage.*

Historical and Cultural Context

Most countries of the Middle East experienced massive rural–urban migration in the post-independence era. The resulting rapid urbanization and accompanying growth of informal quarters and slums created a renewed interest in urban sanitation writ large, including SWM, especially from the 1970s onward. Beyond the need to address increasing rates of infant mortality and disease, for example, governments also frequently sought to express a certain vision of their new independence and civilizational grandeur through modernist infrastructure projects, of which sanitation and waste management played an important part. Instead of providing a moderate level of service across the board through support for cheap, pre-existing appropriate technology, like push- or donkey-drawn carts, they often preferred massive investment in technologically sophisticated, mechanical systems covering restricted but symbolically important zones, such as rich neighborhoods and tourist areas.

"Flashy" engineering was thought to symbolize a kind of modernity, while at the same time promising to usher in an equally symbolic order of impeccably neat showcases. This phenomenon was not unconnected to Islam's self-conception as a religion of cleanliness, troubled by the cognitive dissonance of daily encounters with waste in the public space, suggesting the opposite.

Up to the present day, waste-related educational and awareness programs (e.g., signs, posters, leaflets, schoolchildren's textbooks and slogans painted on the walls of schools) in Egypt and Saudia Arabia, and undoubtedly elsewhere, remind the public that cleanliness is a religious duty, part of the faith, or a civilized habit. The choice to combat littering in an Islamic or civilizational, rather than environmental key reflects a conviction about which discourse is most apt to mobilize people. It is true that SWM and, more broadly, public cleanliness and beautification are often (though not always) encompassed within the environment portfolio in Middle Eastern countries. This occurs in a context where the act of waste removal and the names of institutions responsible for it often refer to "(public) cleansing"

and neighborhood cleanup programs take the form of community cleansing days.

A study of cultural constructions of environment in Egypt titled *People and Pollution* found that pollution had much more resonance with respondents than the concept of environment. Respondents' number one definition of pollution was "garbage," but they also gave a series of responses conveying a religio-moral conception, identifying the poor, drugs, hooliganism, sex, and other failures to observe religious prescriptions concerning morality as sources of pollution. Accordingly, when cleanliness—as opposed to, say, nature, as one might expect in the United States—revealed itself to be the central trope for understanding environment and pollution, this referred not only to physical and aesthetic cleanliness, but also encompassed a series of religious symbolisms, what might better be called purity.

Puzzled by the contrast between fastidious bodily and household cleanliness in the Middle East, on the one hand, and the apparent neglect of public space evidenced by the omnipresence of waste in the streets, on the other, anthropologists have suggested that the dirtiness of the one is in fact the paradoxical result of a preoccupation with maintaining the cleanliness of the other. The imperative to maintain private cleanliness requires evacuation of waste from the home, meaning, in the absence of alternatives, littering the street. It is revealing that residents of large cities in the region, such as Cairo and Tehran, consider daily door-to-door collection a necessity. Waste should ideally be removed from the home as soon as it is produced. However, dealing with waste tends to be a female responsibility, but women's access to public space is constrained. In the absence of door-to-door collection, one of two undesirable scenarios imposes itself. Either the woman is forced into the public space in order to carry the waste from the apartment to a dumpster or the man, in order to avoid the woman, entering the public space, is forced into contact with a substance he wishes to avoid. Ultimately, spatial restrictions on women seem to trump male avoidance of polluting tasks. While Latin American or southeast Asian scavengers are both male and female, in the Middle East they are almost exclusively male. The same is true of organized collection. While postcollection waste sorting among Cairo's zabbaleen is done almost exclusively by women, the task of collection is reserved for men.

The Role of International Institutions

Outside intervention, often in the form of development projects or cooperation, also played an important role in the development of SWM in the Middle East after the 1970s. The key institution was probably the World Bank. In the late 1970s and early 1980s the Bank's Regional Office for Europe, the Middle East and North Africa (EMENA) sought to promote a three-pronged strategy for populous urban areas, integrating infrastructure, transport, and SWM. Morocco, Tunisia, Egypt, and others obtained loans under this regime for SWM programs.

One change typically made under the bank's influence was administrative centralization. For instance, in the early 1980s, Cairo and Tunis both saw the creation of centralized bodies (the Cairo Cleanliness and Beautification Authority and the Office National de l'assainissement). Another common feature of the programs were compost plants. They constituted a major component of waste management systems in Egypt, Lebanon, Morocco, and Syria and were also undertaken on a smaller or pilot scale in other countries in the region, such as Jordan. Often constructed through turnkey contracts with specialized European companies, the plants emphasized engineering: mechanized homogenizing drums, mechanical equipment for forming the windrows, and machine-driven sifting screens for producing fine compost. Those left to operate the plants after initial setup were unable to keep them running. Either they were unfamiliar with the complex apparatus, or the sophisticated technologies were too expensive to maintain. Illustratively, of the numerous such public facilities in Morocco, only the Rabat-Salé plant, opened in 1971, worked more than six years. Plagued from 1978 onward by breakdowns, as well as financial difficulties resulting from its low-quality product that, since 1984, lead to steadily decreasing output, it closed in 2000.

Today, there continue to be a large number of international development and aid agencies involved in SWM in the Middle East, for example, through the Mediterranean Environmental Technical Assistance Programme (METAP). The key objective of the program seems to be to shift the orientation away

from a logic of public cleansing toward one of integrated solid waste management (ISWM), particularly through the updating of legislative and administrative frameworks, development of national plans, and widespread privatizations.

Trends: Privatization

Private sector participation (PSP) is the watchword of the day. Beginning in the 1990s and accelerating since 2000, many Middle Eastern countries have been engaged in large-scale privatization of public utilities like electricity, water, transport, and communications. The World Bank and various national development agencies, like the U.S. Agency for International Development (USAID), promote this. In the field of SWM, 60 Tunisian municipalities have contracts with private companies; in Morocco there are 22 such contracts, including in most of the country's major cities (Rabat, Tangiers, Essauouira, Fez, Casablanca and Nador); and approximately 30 percent of municipal solid waste in Damascus and 40 percent in Homs is collected under private-sector contracts; and so forth, across the region. Where contracts have not yet been concluded, public authorities are generally receptive to the idea and tend to be moving in that direction.

The phenomenon often takes the form of public–private partnerships, particularly of the build, operate, transfer (BOT) kind. Unlike the privatization of a pre-existing utility—basically a sale contract that provides the government with an injection of cash and promises users better service at cheaper prices—BOT arrangements are used where public authorities do not have a sellable going concern, but instead seek to build a network up, without having to borrow capital. The contracting waste management company makes the upfront investment to build the network in exchange for an exclusive right to operate it, at a profit, for a fixed period of time, after which it may or may not be transferred to the state. The contracting companies are often foreign (typically, European). Prominent examples include Alexandria (contracted with a subsidiary of the French company Véolia in 2000) and Cairo (contracted with four Spanish and Italian companies beginning in 2003). Jordan and certain parts of the Palestinian territories, which had previously transferred some or all responsibility for waste management to arm's-length institutions that, while still owned by the state, are run like commercial ventures, are now moving toward more fully privatized schemes, with domestic firms.

User fees are a keystone in the transition to a more-market-centered model of SWM and have sparked many controversies and political struggles. Rather than pay for waste collection out of the general revenues, raised, for instance, from property taxes, the municipality may now seek to operate on a commercial model in which beneficiaries pay for the service they receive. The fees are commonly piggybacked on pre-existing utilities' billing systems. A number of African countries following this path have added the waste levy to water bills, but Middle Eastern countries have preferred electricity. In either case, the idea is that most people are already connected to a grid with a functioning billing system and that the service (water or power) is indispensable enough that the threat of cutting it off will avoid nonpayment for waste collection.

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See Also: Africa, North; Cairo, Egypt; Iran; Saudi Arabia; Turkey.

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Midnight Dumping

Garbage is a constant feature of modern human existence. While waste management programs collect and haul much of this garbage, some material waste is disposed of illegally. Midnight dumping is a

form of illegal waste disposal that often occurs late at night in unauthorized places that often have very low visibility. In the United States, where the average American produces roughly 4.4 pounds of garbage per day, midnight dumping and other forms of illegal dumping are common. Other types of illegal dumping include open dumping, where materials are dumped in open spaces; and fly dumping, which happens when waste is thrown from moving vehicles onto roadways. Regardless of the specific type of dumping, this phenomenon is more than mere petty littering. Illegal dumping activities have contributed to environmental pollution and have very real public health consequences.

Illegal dumping can occur for a variety of reasons, including avoiding disposal fees and not taking the proper time or following the proper procedures for disposal. Often, landfills prohibit materials such as automotive parts and tires, large household items, and some yard waste, or may require fees for disposal of these items. Common sites for illegal dumping include abandoned buildings, vacant lots, and seldom-used alleys and roadways. When they dump illegally, people primarily dispose of nonhazardous materials. These items include a wide range of materials from both construction and demolition sites such as bricks, concrete, lumber, drywall, shingles, siding, and nails.

Old household appliances and furniture, such as refrigerators and couches, automotive parts, tires, and even whole abandoned cars, are also commonly seen at illegal dump sites. Other frequently dumped items include household trash, residential yard waste, and medical waste. People also dump waste that waste haulers or landfills prohibit, such as car batteries, appliances that contain Freon, and many other hazardous chemicals. These materials not only contribute to environmental degradation and pollution but also pose health risks and can lead to serious injuries for local residents.

Hazards

Illegal dump sites cause a variety of problems for people and other biological life in the area. Dumpsite materials can potentially catch fire in extremely dry conditions or can be the target of arsonists. These fires have led to countless instances of property damage and bodily injury to nearby residents. Dump site fires have also destroyed nearby forests. In some places, flooding has resulted from dump site materials collecting in places that block water drainage grates or stop creek water flow. Runoff contamination is another common occurrence in sites where harmful chemicals, paints, and other fluids have been illegally disposed of. In addition to drinking water, this pollution impacts wildlife and threatens biodiversity.

Not only does illegal dumping negatively impact the environment but these practices also threaten public health standards. Both physical and chemical hazards litter these often easily accessible sites. Rusty nails, jagged glass shards, and other pieces of dangerous waste have the potential to badly injure people. People can also be exposed to harmful chemical substances that can burn the skin or may result in even more serious injury or death. Dumpsites often serve as a breeding ground for various disease-infested vermin, such as rodents and insects. For example, rainwater tends to collect in and on materials that biodegrade very slowly, such as old tires. Mosquitoes can then reproduce rapidly in this stagnant water. These dump site insects have been responsible for infecting people with diseases such as encephalitis and dengue fever.

Sites

Whether in inner-city neighborhoods or in rural areas, illegal dumpers are much more likely to target certain places over others. They tend to prefer unsecure, undeveloped, or abandoned lots. These places serve as an ideal disposal spot, as midnight dumpers are much less likely to be caught in the act. Similarly, sites such as railroad tracks, highway underpasses, construction sites, alleyways, nature preserves, and farms afford midnight dumpers the low visibility they prefer. Junkyards and landfills also tend to attract midnight dumping. Researchers have observed that sites with previously illegally disposed-of materials tend to attract more illegal dumping. This phenomenon is especially visible after natural disasters, such as floods, and people deposit damaged household debris across the landscape.

Causes

A variety of factors contribute to the problem of midnight dumping. A shrinking tax base is the real-

ity for many local governments in the early 21st century, and this has led to budget cuts in public services. In some places, this means less funding for waste management, which has led to policies like twice-per-month garbage collection. Other financially strapped places do not offer convenient locations for disposal. Perhaps the most problematic for residents are locations that charge high fees for waste disposal and recycling programs. In tough economic times, there is often not enough money in the household budget to make ends meet, much less to afford these garbage costs. This is especially true for low-income residents. These segments of the population often resort to more economically viable measures, like midnight dumping, in order to dispose of their waste. There also tend to be higher crime rates in these areas, which law enforcement gives a much higher priority than illegal dumping. Consequently, midnight dumping goes unchecked.

Solutions

As a way to curb illegal dumping activity, the Environmental Protection Agency (EPA) has suggested implementing "pay-as-you-throw" (PAYT) programs. PAYT programs, which are also known as variable-rate pricing or unit pricing, establish a waste disposal charge that varies based on the amount of waste a given household throws away. This approach departs from traditional methods of either taxing residents or charging them a fixed fee for waste disposal services. Instead, people are charged in a manner similar to other utilities based on how much or how little waste they generate. The EPA initially devised PAYT as a way to encourage resource conservation, and it has observed that areas with these programs experience a decrease in illegal dumping. Whether programs like PAYT will eliminate illegal dumping remains to be seen, but given consumption patterns, these activities will are likely to continue in the 21st century.

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See Also: Crime and Garbage; Hazardous Materials Transportation Act; Industrial Waste; Landfills, Modern; Open Dump; Pollution, Land; Pollution, Water; Public Health; Residential Urban Refuse; Toxic Wastes; Waste Management, Inc.

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Mineral Waste

Mineral waste is the solid, liquid, and airborne by-products of mining and mineral concentration processes. Although mining and metallurgy are ancient arts, the Industrial Revolution launched an accelerating global demand for minerals that has made waste generation and disposal modern industry's most severe environmental and social challenge. Mineral solid waste production alone is staggeringly vast.

Although no accurate estimate of global waste volumes exists, estimates range from millions to billions of tons annually (depending on whether coal wastes are included), and the mining industry accounts for the largest proportion of total industrial waste production. Mine spoils are often regarded as a blight on the landscape as well as a serious environmental and public health threat. Nevertheless, mining by-products and landscapes may shift between the categories of "waste" and "value" due to changes in technology, economics, and cultural attitudes. Paradoxically massive in scope, yet largely hidden from everyday life, mineral waste is significant not only for its environmental impacts but also as a material index of contemporary rates of commodity production and consumption.

Mining Processes and Wastes

Mining entails the excavation and separation of valuable minerals from their geological matrix. In metal mining (as opposed to quarrying), since target

minerals are typically only a fraction of the ore (or mineral-bearing rock), ore processing results in considerable volumes of waste, known as tailings. A typical, modern, base-metal operation yields greater than 98 percent waste from the excavated material. These residuals are generally disposed of to the lithosphere at waste-rock dumps and tailings disposal areas (although tailings are sometimes disposed of directly to waterways or backfilled into old mine shafts). Surface materials such as soil and vegetation, removed as "overburden," are not typically considered waste, although they contribute to mining's environmental impact. Slag, the solid by-product of smelting, was historically left in massive piles beside smelters or dumped in nearby watercourses. Although once used as an all-purpose building and grading material, smelter slag may also contain contaminants.

Copper, nickel, lead, and zinc smelters were notorious for producing noxious smokestack emissions. The pollution could travel long distances, threatening public health and damaging downwind crops and other vegetation.

Waste Hazards and Pollution

Mill waters and mine drainage are the principal liquid residuals. Because water is usually used to process ore and transport mill tailings for disposal, liquid and solid wastes are often considered together in waste-disposal planning. Environmental pollutants in both solid and liquid wastes may include heavy metals and metal salts, process reagents used to recover minerals (such as cyanide or mercury), and other contaminants in the ore (such as arsenic and selenium). Acid mine drainage (AMD) is a common and widespread water pollution problem, whereby sulfuric acid is released into the environment through the oxidation of sulfur-bearing rocks exposed during the mining process. Tailings impoundments may contribute to pollution through the overflow of contaminated water to surrounding waterways. In some instances, the catastrophic failure of tailings dams has choked streams and coated their banks with a flood of finely ground material. At their worst, tailings dam collapses have caused extensive landscape and property damage as well as human fatalities.

Many of these same pollutants are features of airborne wastes associated with mining and mineral refining. Airborne particulate matter blown from slag heaps and tailings ponds may bear harmful substances. Copper, nickel, lead, and zinc smelters were notorious for producing noxious smokestack emissions that not only affected the health of local populations but also transported pollutants over long distances, where they denuded large areas of vegetation and damaged downwind crops and livestock.

Mining has long been associated with environmental degradation. In his classic 1555 text, *De Re Metallica*, German doctor Georgius Agricola attempted to refute the accusations of environmental devastation leveled by mining's detractors by insisting the waste and damage associated with mineral extraction was temporary. More recently, in the 1934 text *Technics and Civilization*, Lewis Mumford linked mining with the historical exploitation of both nature and humanity. For Mumford, the pursuit of minerals represented an abandonment of the organic environment for the inorganic, subterranean realm; in turn, the wastes generated by mining and metallurgy destroyed the natural world at the surface.

The problems of waste disposal and environmental degradation have made the mining industry a target of environmental critics and government regulation. For its part, the industry often resisted environmental regulations and, in many mining districts around the world, developed a reputation of disregard for local environmental and public health impacts. For instance, at the Ok Tedi Mine in Papua New Guinea, uncontrolled tailings disposal into the Ok Tedi River destroyed the local ecosystem and the livelihood of the region's indigenous inhabitants, prompting local and international protests and subsequent court cases. In situations where ore exhaustion or financial conditions have led to mine closure and abandonment, accumulated waste materials and unsecured mine workings may continue to pose environmental hazards; the estimated millions of abandoned or derelict mine sites around the world constitute a major environmental hazard. However, large mines are by no means the only source of environmental damage. In the developing world, millions of unregulated miners engaged in small-scale, artisanal mining, generating considerable water pollution. Government and industry efforts to promote sustainable mining practices emphasize improved waste disposal, pollution remediation, and ecological restoration as critical challenges for improving the industry's environmental record and preserving its "social license" to operate.

Impacts of Technology

In modern mining, changing technologies and mining practices have facilitated the extraction of ever-smaller fractions of target minerals and the production of an ever-increasing proportion and volume of waste. For instance, while individuals or small groups of miners associated with gold rushes and exploiting rich placer (alluvial) gold deposits moved considerable amounts of material and could significantly impact aquatic environments, the large-scale removal of such unconsolidated deposits by dredging or hydraulic cannons (called monitors) generated far greater volumes of waste. In California, hydraulic mining for gold in the 1880s instigated some of the earliest efforts to control waste from the industry, which had contributed to altered flood regimes in the state's rivers and the siltation of San Francisco Harbor. Similarly, lode or hard rock mining proceeded from underground operations to the use of open-pit methods in order to process extensive deposits of low-grade ore. These methods were pioneered to meet the 20th century's sharply rising mineral demand, fueled by accelerating industrial growth, mass consumption, and military needs. Historian Tim LeCain describes the resulting growth in waste production and large-scale landscape devastation as environmental "mass destruction."

The status of mineral wastes as simply pollutants or unwanted residuals is, however, subject to change due to technological developments in ore recovery, the emergence of new mineral uses and demands, or changing mineral market conditions. In such cases, former waste may gain value, and the history of mining contains many examples of the reworking of old, apparently exhausted ore bodies or the reprocessing of waste deposits to extract valuable minerals. For instance, the legendary silver mines at Potosí in Peru were revolutionized in the 16th century by the development of the mercury amalgamation process, which enabled the recovery of silver from mineral-rich smelter wastes. Uranium is a classic example of a mineral's sudden transmutation from waste to value: once regarded as a nearly worthless by-product associated with wildly valuable and exceedingly rare radium deposits, it was typically discarded along with mine tailings. With the discovery of nuclear fission in the late 1930s, however, stockpiled or rejected uranium-bearing ores from the Katanga in Africa and northern Canada formed the basis for the Allied nuclear weapons development program.

The notion of value in waste may be extended to the mining landscape. In some cases, what the photographer Edward Burtynsky describes as mining's "residual landscapes" may become significant as sites of aesthetic appreciation and contested social and cultural meaning. Some observers challenge the simplistic association of mining with pollution and environmental degradation, pointing to the ways in which mining communities use, experience, and interpret the apparently "wasted" landscapes of mining. Slag heaps and tailings piles may be incorporated into local recreational or heritage landscapes or become the focus of ecological restoration and economic redevelopment activities in

former mining localities. Photographers and tourists are often drawn to the technological sublime of huge waste heaps and massive open pits such as Utah's Bingham Canyon. Archaeologists and historians may explore mining landscapes, including wastes, for insights into technological change, social relations, and human/nonhuman interactions in historic mining regions.

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See Also: Copper; Industrial Waste; Iron; Mining Law; Pollution, Water; Uranium.

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Mining Law

Mining regulations and legislation have increased and changed since the early days of the industry. In Great Britain, laws regulating the ownership and operation of mines proliferated in the 19th century, and the Metalliferous Mines Regulation Act of 1872 directed the inspection, working conditions, and regulation of coal mines as well as mines of stratified ironstone, shale, and fireclay. In the late 19th and early 20th centuries, mining occurred on a much smaller scale than it does in the 21st century and therefore required less legislation. As mechanization and industrialization changed the mining industry, both state and federal governments became increasingly responsible for regulating the health, safety, and environmental aspects of mining.

Early U.S. Laws

The first mining law in the United States was passed in 1872 by President Ulysses S. Grant. Passed to promote the development and settlement of publicly owned lands in the western United States, particularly the Rocky Mountain West and Alaska, the law governs hard rock mining on 270 million acres of public-domain lands. Under the 1872 Mining Law, any U.S. citizen can freely enter public-domain lands to explore minerals, except in national parks. According to the Mining Law, once a citizen discovers a valuable hard rock mineral, that person can then establish the right to mine that mineral by staking a claim. This law continues to be in effect into the 21st century.

In 1891, Congress passed the first federal statute governing mine safety. The federal government saw the ills of child labor and prohibited operators from employing children under the age of 12. This early regulation also established some minimum ventilation requirements for underground coal mines. Congress opened the Bureau of Mines in 1919 as an agency within the Department of the Interior. The Bureau of Mines was permitted the authority to conduct research that would help reduce the number of deaths and accidents in the coal-mining industry. In 1941, the Bureau of Mines was given the authority to enter mines in order to conduct inspections and Congress passed the first codes of federal regulations for mine safety in 1947.

The 1947 act led to the federal Coal Mine Act of 1952. This legislation gave the Bureau of Mines the authority to issue violation notices and imminent withdrawal orders to companies, should their mines be found conducting work in violation of federal regulations. While there were no monetary penalties against companies at this time, the Coal Mine Act of 1952 authorized the Bureau of Mines to call for civil penalties should the Bureau find company violations.

Safety Regulation

A disastrous explosion occurred at the Consol #9 coal mine in Farmington, West Virginia, on

November 28, 1968. This explosion killed 78 men and changed the industry forever. The public was outraged after this disaster and called for further regulation. The federal Coal Mine Health and Safety Act of 1969 came into being. This act was the most forceful regulation to date, calling for two annual safety inspections of surface mines and four annual inspections of underground mines. The penalties for violations of regulations could be considered criminal if the violations were knowing and willful. The act also provided compensation to those miners who had become disabled due to black lung disease. This 1969 act continues to be the backbone of all federal health and safety standards in the 21st century.

In 1973, the responsibilities of regulation were transferred from the Bureau of Mines to the newly established Mine Enforcement and Safety Administration. This was the first federal agency with the sole mission to assure miners' health and safety during work. After yet another horrible mining disaster at the Scotia Mine in Letcher County, Kentucky, in 1976, the public demanded further federal regulation. As a result of the Scotia disaster, the Mine Safety and Health Administration (MSHA) was established in 1977. It is housed within the U.S. Department of Labor and continues to operate into the 21st century. The 1977 act consolidated all mining, from coal to metal, under the same administration. Beyond increasing mandates for inspections, the law called for mandatory miner training, mine rescue teams for all underground mines, and increased involvement of miners and their representatives in health and safety activities at all mining sites.

This 1977 act and the MSHA consolidated the regulations from the 1966 and 1969 mine acts into a single mine health and safety act that would help further recognize the individual rights of miners. This law was the reigning legislation in the United States for another 30 years until the 2006 Sago mining disaster in West Virginia. This devastating explosion and its aftermath trapped 13 miners under ground for two days. Only one of the 13 men came out of the ground alive.

In response to the Sago disaster, the MSHA enacted the Mine Improvement and New Emergency Response Act of 2006. Referred to as the MINER Act, this legislation was the most stringent regulation to date. The MINER Act is extremely detailed, but in general, the MINER Act requires companies to improve their preparedness for accidents. All companies are required to have emergency response plans should a disaster strike. Mining companies are required to develop specific emergency response plans for each mining location they operate, and every mine is required to have at least two mine rescue teams located within one hour of their location. The MINER Act also calls for continued research to enhance mine safety, criminal penalties of up to $500,000, and civil penalties up to $220,000 for violations of regulations.

Environmental Regulation

Environmental regulation continues to be one of the most important aspects of mining law in the 21st century. The Surface Mining Control and Reclamation Act (SMCRA) came into being on August 3, 1977, and is the primary federal law regulating the environmental effects of surface mining in the United States. The law created the federal Office of Surface Mining within the Department of the Interior. The act calls for the reclamation of abandoned mining sites, the regulation of active mining sites, and permitting of mining and reclamation bonds. SMCRA also established the Abandoned Mine Lands Fund. This fund was established to reclaim land that was mined prior to this 1977 act. The law requires companies to pay a per-ton fee for their mined product to this fund. The money gathered is then given back to the states to fund the cleanup of earlier surface and water damage from surface mining. The Office of Surface Mining helps individual states implement regulations and oversees that states are properly meeting federal regulations.

Much of the environmental concerns regarding mining waste and reclamation were addressed in the Clean Water Act of 1972. The Clean Water Act is the primary federal legislation governing water pollution in the United States. Of primary concern to the mining industry is the issuance of permits 404 as part of the nationwide permitting required for mountain top removal, a form of surface coal mining. During this type of surface mining, operations place soil and rock that they remove from

the tops of mountains into streams and wetlands nearby. In the case of mountain top removal, pollutants from this valley fill become discharged into nearby streams, significantly affecting local water quality. The Environmental Protection Agency and the Army Corps of Engineers continues to deal with this issue into the 21st century.

Regulation of all mining has increased since the 1800s, as has the amount of mined products consumed. With improved technology comes faster output and new opportunities. Mining corporations, consumers, and legislators are beginning to think not only about the laws that govern the extraction process but also mine waste disposal and the possibility for a sustainable future.

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See Also: Clean Air Act; Clean Water Act; Coal Ash; Copper; Mineral Waste; Pollution, Water.

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Minnesota

Minnesota is an upper midwest state in the United States, sharing a Lake Superior water border with the states of Michigan and Wisconsin and an international border with the Canadian provinces of Ontario and Manitoba. Prior to European settlement, the Anishinaabe and the Dakota were the main Native American groups in the area. Capital St. Paul and largest city Minneapolis, known as the Twin Cities, adjoin to make the Minneapolis-St. Paul urban area the largest metropolitan area in the state, home to nearly 60 percent of the population. With an early economy based on logging and farming, increasing industrial development in the early 20th century urbanized most of the population; after World War II, this increased again, making Minnesota a center of technology. The creation and proliferation of suburbs is thought to be key to this success. Although less than 1 percent of the population are engaged in agriculture, it is a major part of the Minnesotan economy, which is the largest producer in the United States of sugar beet, sweet corn, green peas, and farm-raised turkey. Forestry also remains strong. Minnesota has both the nation's earliest and the nation's second-largest indoor shopping malls: the Southdale Center, opened in the Edina suburb of Minneapolis in 1956, and Bloomington's Mall of America, opened just four miles away in 1992.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Minnesota had an estimated 5,894,933 tons of municipal solid waste (MSW) generation, placing it 24th in a survey of the 50 states and the capital district. Based on the 2006 population of 5,154,586, an estimated 1.14 tons of MSW were generated per person per year (ranking 33rd). Minnesota landfilled 2,200,457 tons (ranking 34th) in the state's 21 landfills. The state exported 740,269 tons of MSW, and the import tonnage was not reported. In 2006, Minnesota was increasing its 27 million-cubic-yard landfill capacity; it was ranked joint 22nd out of 44 respondent states for number of landfills. The following are banned from Minnesota landfills: yard waste (since 1990 in metro area, 1992 statewide); whole tires (1985); used oil (1988) and other motor vehicle fluids (1994); batteries (1988), some dry cell batteries (1990), and rechargeables (1991); white goods (1990); mercury-containing products (1992); fluorescent tubes (1993); and telephone directories (1994). Minnesota has nine waste-to-energy (WTE) facilities, which processed 1,170,841 tons of MSW (ninth out of 32 respondents). Landfill tipping fees across Minnesota were an average $40 per ton, where the cheapest and most expensive average

landfill fees in the United States were $15 and $96, respectively. Average WTE tipping fees were $36 per ton. When disposal fees were first introduced in 1973, they were $0.15 per cubic yard. Minnesota recycled 2,523,635 tons of MSW, placing the state 18th in the ranking of recycled MSW tonnage. In an innovative scheme to reduce backyard burning, Chisago County residents who hand in their burn barrels and sign up for waste collection receive six months service at half price.

Waste Management

In Minnesota, open burning and dumping were common until the 1960s (as had been common historically across the United States), and there were over 1,500 dumps across the state in private and municipal hands. In 1967, the Metropolitan Council and the Minnesota Pollution Control Agency (MPCA) were created and began developing legislation to protect air and water quality; they were also given the authority to oversee waste management. During 1969–71, many waste management provisions and rules came into force: counties were given control of their own MSW (County Solid Waste Management Act); general open burning was prohibited; solid waste disposal permits were introduced; and landfill requirements were upgraded. By 1973, 13 landfills managed 90 percent of MSW, and 135 permit-issued sanitary landfills had replaced the multitude of dumps.

Recycling was legislated in 1973, and the federal Resource Conservation and Recovery Act (RCRA) was introduced in 1976. The Joint Minnesota Legislative Committee on Solid and Hazardous Waste was formed in 1978 as statewide legislation came to the fore. Flow control became the dominant issue in Minnesota waste management in the 1990s; with local government's power to direct waste management limited, waste began going to cheaper out-of-state facilities. The 1994 Landfill Cleanup Act and Closed Landfill Program also had a significant effect on the state's waste management during the 1990s. The 135 sanitary landfills licensed in 1973 were reduced to 55 by 1990; after the Landfill Cleanup Act, only 27 remained in operation by 1994. The waste management problems of the 1990s have been tackled in the 21st century by revising and updating legislation.

James J. Hill Mansion

Almost 800,000 people in the United States are homeless. Minnesota is the first state where the archaeology of homelessness has been studied archaeologically, rather than being regarded as refuse (which it can resemble). In 2003, Professor Larry Zimmerman, then head of archaeology at the Minnesota Historical Society, excavated the mansion of 19th-century railroad magnate James J. Hill, "the Empire Builder of the Northwest," on Summit Avenue in St. Paul, less than one-quarter mile from the city's downtown area. The 36,000-square-foot mansion was completed in 1891. Scatters of clothing, sleeping bags, and cooking materials on the surface of the garden gave way to stratified deposits in the earth, revealing four distinct layers of homeless occupation since the 1940s. The garden was situated on a hillside held back by retaining walls and contained several built structures, including a mushroom cave in the lower wall, three greenhouses, a gardener's residence, and a coal gasification power plant. Homeless people had occupied several of these, and even a tree throw had been used as a shelter and the garden walls as windbreaks. The tree throw shelter was substantial enough to have developed its own downslope midden, and the mushroom cave was used for decades, accumulating one meter of deposits on its floor. Hill's daughters had donated the mansion to the Roman Catholic Archdiocese of Saint Paul and Minnesota in 1925, and it remained church property until 1978 when the Minnesota Historical Society acquired it. Apart from building a small grotto, the church did little with the gardens. Zimmerman went on to lead the first archaeological investigation of homelessness in Indianapolis, Indiana.

Professor Zimmerman, regarding the Hill Mansion, stated that "The trash 'stream' is much more complex than we realize, with trash being more than just material that ends up in landfills or strewn across the landscape. The question is, when does something actually become rubbish/trash? Much of the material that we initially saw as 'just' trash went through another level of use after the original owners disposed of the items by donating them to the Dorothy Day Center in St. Paul (the same in Indianapolis). Used by the homeless, it became trash only after the homeless saw no more use for

it. Even then, some items we documented, excavated, or collected from the surface saw another use as archaeological artifacts. Some Hill garden items will see permanent curation in the Minnesota Historical Society Archaeology Department collections, which means they never really become trash, or perhaps archaeology just does a different kind of recycling."

Washington County Landfill

In 2009, excavation began at the Washington County Landfill in Lake Elmo, a significant landfill remediation project estimated to take three years and cost $21 million. The landfill, closed since 1975, covers 35 acres and contains approximately 1.9 million cubic yards of waste: 73 percent residential waste, 26 percent commercial waste, and 1 percent demolition waste. The site was added to the Environmental Protection Agency (EPA) National Priorities List (NPL) in 1984 because of volatile organic compound (VOC) groundwater contamination. Once added to the Minnesota Pollution Control Agency (MPCA) Closed Landfill Program (CLP) in 1996, the landfill was removed from the NPL. Since the initial detection of groundwater VOCs in 1981, they began to be detected in private wells in 1983–84. Local residents were advised not to drink tap water and were connected to a new supply. Monitoring wells and a water extraction system were then inserted into the landfill site. The two-foot landfill cover placed on closure in 1975 was upgraded to current standards in 1996. A methane explosion in the early 1990s led to the installation of an enclosed flare and gas extraction system.

In 2004, the MPCA used newly developed tests for perfluorochemicals (PFCs), which showed positive in onsite monitoring wells and downslope residential wells. Further testing led to 100 homes being placed on bottled water and another 22 homes having granular carbon filters installed. PFCs were dumped in the landfill legally between 1969 and 1975 by 3M from its Cottage Grove plant, which used the chemicals to make products resistant to heat, oil, staining, grease, and water, such as Teflon and Scotchguard. In 2006, tests were developed for perfluorobutanoate (PFBA), another form of PFC, which was discovered leading away from Lake Elmo 15 miles to Hastings. The Minnesota Department of Health (MDH) found no increased health problems in the affected area, and judges have since ruled that no one has been harmed by PFCs in drinking water and there is no "class action" status, so any plaintiffs must sue 3M individually. Although the MDH says the PFC levels are too low to be a threat, they have been found in local fish and limited fish consumption is now advised.

By 2010, the Washington County Landfill was being excavated and replaced in triple-lined cells constructed on the same site where three geo-synthetic membrane layers will pump out any leachate liquid. Removing the garbage to another site would have tripled the cost of the project. Other PFC-contaminated landfills nearby include Oakdale (late 1950s), Woodbury (early 1960s), and 3M Cottage Grove (early 1970s); these are being excavated and placed in a specially constructed landfill in Rosemount. Although found to have no liability, 3M contributed generously to the remediation programs, both financially and technically.

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See Also: Archaeology of Garbage; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Definition of Waste; Landfills, Modern; Malls.

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Mississippi

One of the southern U.S. states, Mississippi takes its name from the Mississippi River, which flows along its western border. Jackson is the capital and largest city. The entire state is composed of lowlands and

is densely forested outside the Mississippi Delta. Most of the farm-bred catfish in the United States are produced by Mississippi's catfish aquaculture. According to Commonwealth Fund data, the state ranks last in the United States for healthcare, with the highest obesity rate of any U.S. state 2005–08. Mississippi is also at the bottom of the American Human Development Index and has the lowest per capita personal income of any state, but also the nation's lowest living costs. The six states of the Deep South have a common history of cotton and tobacco production attendant with depending on and supporting slavery. These monoculture production systems have had far-reaching consequences on Mississippi's environmental and socioeconomic history. Mississippi's overreliance on cotton agriculture before, during, and after the Civil War can be linked to its current ranking as one of the poorest states.

History

From 1800, the King Cotton economy developed in the South on land ceded and sold by the Chickasaw and Choctaw tribes. By the time of the Civil War, Mississippi had become the fifth-wealthiest state, its wealth created by the cotton plantations along the rivers, where slaves (counted as assets) had increased in value since the 1840s. At this point, 90 percent of the delta bottomlands were undeveloped frontier and the low population was 55 percent enslaved. The dominance of the "planter aristocracy" minority and agricultural cotton meant that taxation was intentionally kept low and there was very little investment in infrastructure, with some areas remaining unindustrialized until the late 20th century. This "planter aristocracy" was an elite of slave owners in a state where in 1860 only 31,000 out of 354,000 whites owned slaves; the elite were the 5,000 slave owners who owned more than 20 slaves, including the 317 who owned more than 100 slaves.

The southerners were convinced that such was the importance of their cotton that it would support the economy of an independent Confederacy and force cotton-reliant Britain and France to intervene in the Civil War. Mississippi became the second state to secede from the Union. In 1861, the south withheld its cotton from sale or export and then the Union blockade prevented 90 percent of export. This cotton diplomacy strategy failed as Europe had large stocks of cotton and production increased in Argentina, Egypt, and India to meet demand. Southern faith in cotton monoculture had proven disastrous, using land and labor that could have been used to grow much-needed food and leading the Confederacy into a Civil War it ultimately could not win.

Agricultural depression and changes in labor structure wrought by the massive damage and casualties of the Civil War caused the south to lose huge amounts of wealth. Although tens of thousands migrated into the state after the Civil War and began clearing land and farming, cotton prices continued to fall, culminating in another agricultural depression in the 1890s. New legislation introduced by white legislators in 1890 and the Jim Crow system disenfranchised most of the black and poor white population, resulting in their losing lands and leading in part to the Great Migrations to the north (1910–30 and 1941–70).

In 1966, Mississippi was the last state to revoke prohibition of alcohol, having up until then taxed illegal bootlegged alcohol. In the segregated south, black people were often barred from skilled work and garbage collection was a common occupation for black men. The assassination of Martin Luther King Jr. while in the south to support the rights of black sanitation public workers led to increased recognition for the American Federation of State, County and Municipal Employers (AFSCME). Pascagoula sanitation workers were among the first to win union recognition in the wake of King's assassination.

Landfill Tonnage

The 16th Nationwide Survey of MSW Management in the United States found the following: In 2006, Mississippi had an estimated 3,194,368 tons of municipal solid waste (MSW) generation, placing it 33rd in a survey of the 50 states and the capital district. Based on the 2006 population of 2,899,112, an estimated 1.1 tons of MSW were generated per person per year (ranking 37th); 3,049,368 tons were landfilled (27th) in the state's 17 landfills; 740,876 tons of MSW were imported, the export tonnage was not reported. In 2006, Mississippi had sufficient landfill for 817 years and was still adding to this capacity; it was ranked 25th out of 44 respondent states for number of landfills. Only whole tires and

lead-acid batteries were reported as being banned from Mississippi landfills. Tipping fees across Mississippi averaged $28, where the cheapest and most expensive average landfill fees in the United States were $15 and $96. The high water table in Mississippi limits the location of landfills in the state. Mississippi was 43rd in the ranking of recycled MSW tonnage, with 145,000 tons of MSW recycled. Mississippi has no waste-to-energy (WTE) facilities.

Oil Spills

Mississippi was affected by the 2010 BP oil spill in the Gulf of Mexico, but was given time to prepare by being separated from the Gulf proper by the Mississippi Sound and the Barrier Islands. The Gulf Islands National Seashore and several important conservation areas, including globally important bird areas, were affected within Mississippi. The complex nature of the Gulf coastline made oil cleanup difficult due to the number of marshes, bays, creeks, estuaries, and inlets. Further controversy was sparked in the state when oil-contaminated cleanup waste from south Mississippi beaches was sent to landfill at Pecan Grove, Harrison County. Officials from the county moved successfully to block the dumping by Waste Management and were concerned that alternatives such as WTE had not been considered. More than 150 tons of scooped oil and used personal protection equipment and hand tools contaminated with oil and Corexit (a solvent used to break up oil slicks) were deposited in the landfill. The Environmental Protection Agency directed BP to make its waste disposal plans transparent and to stop using Corexit. Sampling carried out by the Mississippi Department of Environmental Quality (MDEQ) showed that the oil waste dumped at Pecan Grove was nonhazardous, as had been claimed.

Litter

The state has a serious litter problem; litter rates along rural roads are 30 percent higher than the average of other states and 71 percent of litter is in public view from the interstate and highway. In the 2008 American State Litter Scorecard, Mississippi was ranked the lowest (50th) for littered public roads and property; by 2011, the state had risen to joint 47th. It costs Mississippi more than $2 million a year to remove this litter from public highways. Only around 20 percent of the total state highway miles are in the adopt-a-highway program for Keep Mississippi Beautiful, the state affiliate of the Keep America Beautiful program. This is attributed to the largely rural nature of the state. Although 38 percent of Mississippi litter is accidental, 62 percent is deliberate, the highest percentage of any state. Most (26.6 percent) of this deliberate litter originates from convenience products such as take-out food containers. The rest of the litter composition is as follows: 17.3 percent beverage containers; 9.8 percent miscellaneous plastic, metal, foil, and glass; 9.4 percent candy, gum, and snacks; 9.1 percent miscellaneous paper and cartons; 7.4 percent vehicle parts, supplies, and debris; 6.7 percent newspapers, advertising fliers and leaflets, food packaging, yard waste, and other unspecified items; 5.7 percent cigarette packs and matchbooks; 5.4 percent building material and construction debris; and 2.6 percent toiletries, toys, cassettes, and recreational items. The litter problem is viewed as chronic, hav-

Mississippi is ranked near the bottom of all 50 states in terms of its chronic, long-standing roadside litter problems. Litter rates along rural roads are 30 percent higher than the average of other U.S. states. Removal costs add up to $2 million annually.

ing developed over a long period, and will need a long-term solution has been projected.

In line with national statistics, 60 percent of people deliberately littering along highways and rural roads were aged 18 to 34, and they were mostly male. However, in Mississippi male motorists driving pickup trucks were found to be a disproportionate source of litter, responsible for nearly a third of all motorist littering and for two-thirds of single items escaping from motor vehicles. While the source of the litter could be classed as accidental in pickup trucks, it is regarded as deliberate due to inappropriate decisions about unsecured items in the back of the vehicle. Part of the solution to the problem was the "I'm Not Your Mama" advertising campaign featuring former first lady of Mississippi Pat Fordice in four award-winning TV spots. Developed by GodwinGroup for the Mississippi Department of Transportation, the campaign chose a strong matriarchal figure to reach the target younger male audience. The five-year campaign was launched in 2003.

Environmental Racism in Mississippi

"We all know about the wrong side of the tracks. It's where we put our poor people and people of color. It's where we put our toxic wastes" (Helen Hershkoff, American Civil Liberties Union, referring to a case in Mississippi). The modern concept of environmental racism emerged in the early 1970s, but the practice goes back to ancient times, when noxious tanneries were situated on the outskirts of towns in the poorest areas. Environmental racism is a serious issue in Mississippi; the state is also one of the few to have had nuclear weapons detonated within its borders. Racial inequality and unequal distribution of wealth dominate the state's recent history.

The Moss Point Incinerator is viewed as a classic case of environmental racism in Mississippi, involving two Gulf Coast cities along the Escatawpa River in Jackson County. Predominantly white and relatively affluent Pascagoula began having waste disposal issues in the late 1970s and the city council opted to build an incinerator. Residents of Pascagoula protested having the incinerator sited near their homes and the incinerator contract subsequently went to a chemical company in Moss Point, a less wealthy, mostly black city nearby. The Moss Point Incinerator opened in 1985 near a number of schools and residential areas but was owned by the city of Pascagoula, although Moss Point also had usage. This situation remained amicable until 1991, when the Pascagoula City Council voted to send commercial medical waste contracts to Moss Point for incineration, causing an uproar in Moss Point. The incinerator was in debt, financed by a $6.9 million federal loan—the collapse of the natural gas market and the falling price of the steam it sold had seriously damaged the incinerator's income and left it unable to pay even the interest. As the Gulf Coast erupted in claims of environmental racism, the incinerator drew criticism for being antiquated and malodorous. As Moss Point filed suit against the proposed clinical waste burning-for-profit scheme, local doctors voiced concerns that the already heightened incidence of respiratory problems could be increased by the plan.

The 1983 U.S. General Accounting Office study Siting of Hazardous Waste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities found that three of four off-site commercial hazardous waste landfills in Region Four were in mainly African American communities. Region Four includes the states of Alabama, Florida, Georgia, Kentucky, Mississippi, North and South Carolina, and Tennessee, where African Americans account for only 20 percent of the population.

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See Also: Culture, Values, and Garbage; Fast Food Packaging; Food Waste Behavior.

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Missouri

Located in the midwest, Missouri is a U.S. state with both midwestern and southern cultural influences, as it is historically a border state between the two regions. The state is named after the Missouri River and, by extension, the Siouan-language tribe. Jefferson City is the capital, Kansas City is the largest city, and Greater St. Louis is the largest metropolitan area. The state is known to mirror the demography, economy, and politics of the nation in general, having a mix of urban and rural culture, is considered a political bellwether state. There have only been two years (1956 and 2008, as of 2011) when Missouri presidential election results have not accurately predicted the next U.S. president. The state has a mixed economy, but has one of the largest numbers of farms in any U.S. state and is ranked in the top 10 states for hog, cattle, and soybean production.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2004, Missouri had an estimated 9,939,008 tons of municipal solid waste (MSW) generation, placing it 14th in a survey of the 50 states and the capital district. Based on the 2004 population of 5,837,639, an estimated 1.7 tons of MSW were generated per person per year (ranking seventh). Missouri landfilled 6,731,844 tons (ranking 15th) in the state's 21 landfills. It exported 2,520,071 tons of MSW, and the import tonnage was 228,858. In 2006, Missouri was continuing to increase its 201,892,185-cubic-yard landfill capacity, and it was ranked joint 22nd out of 44 respondent states for number of landfills. Yard waste, whole tires, used oil, lead-acid batteries, and white goods were reported as banned from Missouri landfills. Missouri has seven waste-to-energy (WTE) facilities, which processed 23,300 tons of MSW (28th out of 32 respondents). Missouri recycled 3,183,864 tons of MSW, placing Missouri 13th in the ranking of recycled MSW tonnage.

Environmental protection efforts in Missouri include a landmark smoke control law that passed in St. Louis in 1940, quickly spawning similar ordinances across the United States. The ordinance directed users of soft bituminous coal (found in abundance in bordering Illinois) to wash the fuel before incineration, reducing the dense, heavy smoke that plagued the city in winter months. Missouri waste management began the transition to modern standards in 1968 when Robert "Robby" Robinson was hired as the first state solid waste program director and tasked with creating a state solid waste plan. At this time, there were over 500 open dumps in Missouri. The state solid waste plan of 1972 set the elimination of open dumps as a major goal, and by 1980, only three remained.

Weldon Spring Conservation Area

Missouri is home to a highly successful reclamation project carried out under the Superfund program, the Weldon Spring Site. In 1941, the U.S. Army acquired 17,232 acres near Weldon Spring, St. Charles County, and was part of the war effort until 1945 as the Weldon Spring Ordnance Works. Following the war, ownership of some of the site was transferred to the State of Missouri, the University of Missouri, and other public bodies, with the U.S. Army retaining land for use as a training area. The state created the August A. Busch Memorial Conservation Area, and the university used its tract for agriculture.

The Atomic Energy Commission (AEC) was given 217 acres of the former ordnance works in 1956, on which the Weldon Spring Uranium Feed Materials Plant (later becoming the Weldon Spring Chemical Plant) was built. This facility consisted of 44 buildings, four setting basins over 25 acres known as raffinate pits, two ponds, and two former dump areas. A quarry four miles to the south had been used by the army for disposing of trinitrotoluene (TNT) residues. The AEC acquired this in 1958 to dispose of demolition waste contaminated with uranium and radium from a demolished uranium-ore processing facility in St. Louis, and a small amount of thorium residue. The army reacquired the site in 1967 when the AEC closed the plant. Having partially decontaminated some buildings and dismantled some machinery, the army converted the plant to produce Agent Orange, an herbicide used in the Vietnam War. Dwindling demand for Agent Orange and increasing cleanup costs closed the project in 1969 before production of the herbicide could begin.

In 1984, several buildings were repaired by the army; floor, wall, and ceiling surfaces were decontaminated, and contaminated equipment was isolated to stop contaminants from spreading beyond the site. Directed by the U.S. Office of Management and Budget, the army gave up custody of the chemical plant to the Department of Energy (DOE), which was responsible for the cleanup, to which the army was required to contribute. It was given the DOE "Major Project" designation and was known as the Weldon Spring Site Remedial Action Project (WSSRAP). Having requested cleanup funds from Congress, a project office was established in 1986 and onsite activity began. The Environmental Protection Agency (EPA) put the Weldon Spring Quarry on the National Priorities List (NPL) in 1987 on account of groundwater contamination having potential to affect 60,000 drinking water well users. The NPL coverage was expanded to include the raffinate pits and the chemical plant area in 1989; collectively with the quarry, they became known as the Weldon Spring Site. The DOE set a goal that went beyond the cleanup: to reinstate the site to its natural state and make it a publicly accessible area for recreational and educational use.

Work onsite involved dismantling 44 chemical plant features and disposing of radioactive and chemical-contaminated demolition waste, sludge, and soil. The DOE carried out this work between 1988 and 1994. As part of this phase, as much material as possible was removed from the raffinate pits, quarry, and properties in the vicinity. Bulk waste removal from the quarry was done between 1993 and 1995. To appropriately dispose of the contaminated material, the DOE constructed a 45-acre disposal cell in the former chemical plant area to provide long-term containment of the Weldon Spring Site material. Around 1.48 million cubic yards of waste material were deposited in the cell. The DOE completed construction of the 75-foot-high cell cap in 2001, and in 2002 a viewing platform and information panels were added to the roof of the cell to allow public access and provide a panoramic view of the surrounding area. Haul roads were converted to a hike-and-bike trail, which crosses Weldon Spring, linking the quarry, the chemical plant site and the wildlife center in the August A. Busch Memorial Conservation Area before joining the historic Katy Trail. Called the Hamburg Trail, the trail is named after one of the towns taken over by the army to construct the Weldon Spring Ordnance Works in World War II. There are 29.5 miles of hiking trails in the conservation area, not including the MKT Trail, which is part of the state park system.

Restoration of the quarry took place in several phases. Infilling was done with specially selected and prepared borrow material, the quarry water treatment plant was dismantled, the water collection system was reclaimed, and the haul road was restored before the final grading. Infilling reduced the physical dangers of open excavations and created a gentle slope to make rainwater flow over the surface of the Little Femme Osage Creek. The hike-and-bike trail and the quarry final grading were the last phase of restoration. The final grade, completed in 2002, returned the area to its natural contours and minimizes erosion. This done, the task began to create a biodiverse environment, and a prairie was built by seeding approximately 150 acres of soil surrounding the disposal site and extending as far as the site boundary. This was named the Howell Prairie after the original prairie where Francis Howell Sr. built his homestead in the 1880s. By 2004, nearly 80 species of native forbs and prairie grasses had been planted.

The history of the Weldon Spring Conservation Area was presented in a 9,374-square-foot Interpretive Center housed in a building converted by the DOE. A native plant educational garden has also been planted using species from the Howell Prairie and other plants found nearby. A long-term maintenance plan is in place to provide site monitoring and involves neighboring landowners. This plan covers the monitoring program, annual inspections, and institutional control areas (limited access for safety and environmental reasons) around the site.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Open Dump; Toxic Wastes.

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Mobile Phones

When the first mobile phone hit the market in 1983 for high-end business users, these devices were only used to make and receive telephone calls. Since then, they have morphed into hybrid devices that perform multiple functions, such as text messaging, e-mail, Internet browsing, music playback, radio, GPS, and gaming. Since their introduction, rapid advances in mobile technology have made these devices cheaper and more accessible to increasing numbers of people around the world. By the end of 2010, there were more than 76 cellular phone subscriptions per 100 people on the planet.

Today, the world's largest mobile network in the world is China Mobile, with over 500 million subscribers, and China alone manufactures nearly 600 million mobile phones annually. As with other forms of electronics, though, access to mobile phones is uneven: for every 100 people in the developed world, there are 116 cellular phone subscriptions, whereas in the developing world the figure is just over 67.

Practices of consuming and wasting mobile phones vary from place to place in culturally distinctive ways. In North America, it is increasingly common for such objects to be more about social distinction than use value. In the constant search for distinction afforded by such devices to their users, increasing rates of turnover and discard are caused. These are highly situated practices and it would be a mistake to understand them as universal. In Africa and Asia, mobile phones are consumed quite differently, while also being symbols of status. In these regions, the devices tend to have considerably longer useful lives and their basic functions, such as text messaging, are used in a much broader range of applications than they currently are in North America. For example, in Kenya and India, in lieu of widely available bank accounts, mobile phones are used to send and receive payments for everything from wages to purchases of daily sundries. Although around the world tens of millions of phones are disposed of annually, they do not necessarily end up as waste. Instead, they may continue to circulate in substantial recovery economies that include transnational commodity networks of trade and traffic.

Disposal Practices

As with the consumption of mobile phones, disposal practices vary widely. In Japan, for example, mobile phones are one of many inanimate objects that may receive formal mortuary rites once they have reached the end of their useful lives for their owners. In Canada and the United States, it is common for mobile phone consumers to have multiple mobile phones in storage awaiting some later decision about how best to be rid of the devices. North Americans and Europeans increasingly have access to formal recycling systems for mobile phones and other electronics.

Elsewhere in Asia and Africa, mobile phones circulate within complex informal recovery economies that refurbish, repair, and remanufacture mobile phones and other electronics as well as disassemble them into their constituent components and materials that are then fed back into the production economy.

The disposal and recovery of mobile phones is far from being a closed-loop system. Efforts to manage waste mobile phones emphasize industrial-scale recycling. In North America, Europe, and parts of Asia and Africa, these kinds of strategies are increasingly mandated by law. At the same time, just as more jurisdictions enact such legislation, there is serious debate around what these laws can actually accomplish. Industrial-scale recycling can recover substantial amounts of material and energy and reduce the need for mining new raw materials, yet industrial-scale recycling has its own impacts. For example, transportation for recycling over substantial distances adds carbon emissions and thus increases the overall impact of disposed mobile phones. Some

parts of the recycling chain, such as smelting for metal and energy recovery, have their own risks of toxic emissions. Most contentious is what some call the recycling trap, which describes the consequences of forgoing a multitude of options for the clean(er) production of original products in favor of recycling them as an alternative to disposal. The recycling trap risks implementing a recycling system to deal with mobile phone waste only after such waste has already been created, rather than reducing or eliminating the production of such waste in the first place.

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See Also: Computers and Printers, Business Waste; Computers and Printers, Personal Waste; Culture, Values, and Garbage; Television and DVD Equipment.

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Montana

A western state in the United States, Montana is named after the Spanish word for mountain, as more than a third of the state is covered by mountain ranges. The expansive vistas earned the state its nickname Big Sky Country. Montana is the fourth-largest state, with 147,042 square miles and the third lowest population density in the United States, with only 989,415 residents in the 2010 Census. Helena is Montana's capital, while Billings is the largest city and metropolitan area. The state borders three Canadian provinces to the north, Idaho to the west, Wyoming to the south, and the Dakotas to the east. The Continental Divide splits the state into distinct eastern and western regions; the western region is mountainous, but although 60 percent of the state is prairie, there are island ranges in the east. The valleys between the ranges contain important agricultural land and rivers and provide recreation and tourism areas. Home to Glacier National Park, three of the five entrances to Yellowstone National Park, and rivers featuring some of the most attractive fly-fishing spots in the world, Montana's natural amenities attract both residents and tourists seeking the Last Best Place (another state nickname).

Montana's many rivers are known for trout fishing and provide most of the state's water; man-made

reservoirs are common and include Fort Peck Resevior on the Missouri River, which is held back by the world's largest earth dam. The rivers are also a source of hydroelectric energy—six of the 10 largest power stations in the state are hydroelectric, producing a third of Montana's energy. Montana is also a massive exporter of energy to neighboring states. Coal accounts for nearly two-thirds of the state's energy, as Montana contains more than a quarter of the United States' estimated recoverable coal reserve and exports to more than 15 states. By a bill passed in 2007, Montana has a de facto ban on new coal-fired power plants; any new plants must be able to sequester 50 percent of the carbon dioxide they produce but this technology currently remains unavailable.

The Montanan economy is based mostly on services, with ranching, wheat farming, and fossil fuels in the east; and lumber, tourism, and hard rock mining in the west. Mineral resources include gold, coal, silver, talc, and vermiculite, with numerous ecotaxes imposed on extraction. Attractions such as Glacier National Park, Flathead Lake, the Little Bighorn battle site, and Yellowstone National Park draw millions of visitors annually to the state.

The 16th Nationwide Survey of MSW Management in the United States found the following: In 2006 Montana had an estimated 1,430,049-tons of (municipal solid waste (MSW) generation, placing it 41st in a survey of the 50 states and the capital district. Based on the 2006 population of 946,795, an estimated 1.51 tons of MSW were generated per person per year (ranking 11th); 1,189,539 tons were landfilled (ranking 38th) in the state's 79 landfills. The tonnage of exported and imported MSW was not reported. In 2006 Montana was increasing its 92,025,335-cubic-yard landfill capacity; it was ranked third out of 44 respondent states for number of landfills but has no waste-to-energy (WTE) facilities. Tipping fees across Montana averaged $25, the second-lowest in the United States, where the cheapest and most expensive average landfill fees were $15 and $96, respectively; 240,510 tons of MSW were recycled, placing Montana 38th in the ranking of recycled MSW tonnage.

In March 2011, the American State Litter Scorecard scored Montana joint 39th, ranking it among the worst states in the United States for litter. The state has a known problem with poor public space cleanliness, which is related to ineffective standards and performance indicators. Only a month later, Montana was listed in the five deadliest states for road traffic accidents caused by debris and litter dumped on the road. National Highway Traffic Safety Administration data showed that at least nine persons per year were killed in Montana when motor vehicles collided with nonfixed objects such as debris, dumped rubbish, animals, and animal carcasses.

Ninety percent of Montanans live within reach of recycling; aluminium drink cans, newspaper, cardboard, and nonferrous metals are the most widely collected materials. The low population density and remoteness of Montana make economically viable recycling difficult because there is not enough manufacturing of any one type of commodity for an in-state industry to use the recyclables. High transportation costs are also a barrier to recycling in Montana; there are virtually no recycling mills and materials have to be sent across the United States and abroad. Items of any bulk or weight are therefore particularly expensive to recycle in Montana. The small population generates less recyclable material, which involves the expense of storing material while it accumulates to reach the minimum amount a mill will accept. The state offers tax incentives to encourage businesses to utilize recycled material and stimulate in-state demand for recycled material.

Burning Season

Due to its low population and rural nature, Montana operates an open burning season that runs from the start of March until the end of November. This season does not apply in the Eastern Montana Open Burning Zone because there are ventilation differences between the mountainous western Montana and the flatter east. Inversion layers and stagnant air conditions are common during the winter and in western Montana pose a threat to air quality and public health. Only clean, untreated wood and plant material can be burned; burning other materials and dead animals or animal waste is illegal.

Bear Habitat

Like neighboring Wyoming, Montana is bear habitat and has the largest grizzly (or brown) bear population in the lower 48 states. Yellowstone National Park is one of six Fish, Wildlife and Parks

Service recovery areas for grizzly bears; black bears are also common. Bears are often attracted to garbage cans and dumpsters to feed, which becomes habit-forming and increases the chance of human-bear contact. This has become a problem in some areas of Montana and some bears have had to be euthanized after repeated incursions into residential areas. Bear-resistant garbage cans and electric enclosures have been implemented in "bear buffer zones" established in areas such as Missoula. In the Montana part of the Yellowstone National Park ecosystem, obtaining food from human sources contributes to more grizzly bear deaths than any other factor, leading to the slogans "a fed bear is a dead bear" and "garbage kills bears." Bears are discouraged and relocated using tranquilizer darts, pepper spray, rubber bullets, and Karelian bear dogs but often have to be euthanized or sent to zoos if the three-strike system of discouragement and relocation fails. Bear managers in Montana use DNA analysis and radio-tracking to monitor individual bears. Warden Jon Obst created a dumpster bear trap to capture and remove trash-raiding bears.

Discarded bear spray canisters have become a problem in Montana. Bear spray is meant to be disposed of as hazardous waste but many people either store the canisters until they are too old to be effective or throw them into regular garbage. Landfill employees have to retrieve the cans and treat them as hazardous waste. In waste processing, if the cans are pierced or run over by forklifts or backhoes, facilities have to be evacuated while the bear spray dissipates. Yellowstone has 3.3 million visitors a year, who are all advised to carry bear spray and usually discard the canisters before traveling home, often at the airport. All of Yellowstone's garbage ends up at a composting facility near West Yellowstone, where bear spray canisters are a regular nuisance. Three engineering students from Montana State University—Ashley Olsen, Seth Mott, and Kyle Hertenstein—created a bear spray recycling machine. The prototype machine removes the irritant chemical, then the refrigerant propellant chemical, before crushing the can, and processes three cans at a time in 30 seconds.

Butte

Butte is currently the fifth-largest city in Montana and the county seat of Silver Bow County; the city and county governments consolidated in 1977 to become Butte-Silver Bow. Historically, Butte was the largest city in the state. In its heyday in the late 19th century and peak production during World War I, it was infamous as the largest copper boomtown in the west, having hundreds of saloons and a red-light district. The city has experienced every stage in the development of a mining town, going from a camp to a boomtown, becoming a city in its own right, and a focus of historic and environmental preservation. From gold- and silver-mining roots in the Silver Bow Creek Valley, the soaring demand for copper in domestic electricity and new technologies saw the city attract workers from across the United States, Europe, and Asia to become the largest city for hundreds of miles.

Berkeley Pit

The Berkeley Pit was opened in 1955 by Anaconda Copper. Then the largest truck-operated open pit copper mine in the United States, it involved destroying thousands of homes in the old east side of Butte. After around 1 billion tons of material had been extracted, Berkeley closed in 1982, leaving a pit one mile long, half a mile wide, and 540 meters deep. When the water pumps were switched off on closure, the pit began to fill with water from the surrounding aquifers, filling to a depth of around 270 meters with heavily acidic (pH2.5) and contaminated water. The acidity of the water is similar to cola or lemon juice and contaminants include heavy metals and leachates such as arsenic, cadmium, copper, lead, sulfuric acid, and zinc. There is so much dissolved metal in the mine water that some material is mined directly from the water. The mine water has risen to within 150 feet of the natural groundwater level and the two bodies of water are predicted to meet around 2020. Plans to deal with the groundwater problem were evolved in the 1990s and the Berkeley Pit became one of the largest Superfund sites as well as a tourist attraction in its own right.

In 1995, a migrating flock of snow geese landed in the waters of the Berkeley Pit and died; 342 carcasses were recovered from the water, and the pit's custodian denied that the water's toxicity had killed the geese, claiming an acute aspergillosis infection was responsible. This claim was corroborated by Colorado State University tests but the state of

Montana found that the carcasses' insides were lined with burns and sores caused by the concentrations of copper, cadmium, and arsenic to which they had been exposed.

Recent developments on the Berkeley Pit site include the construction of a water treatment plant on Horseshoe Bend, which will be able to stop the mine water from contaminating the natural groundwater when it hits the critical 1,650-meter level in 2018. New extremophile fungus and bacteria species have been found inside the pit, adapted to the inhospitable, intensely competitive conditions inside. Highly toxic compounds discovered within these life forms include berkeleydione, berkeleytrione, and berkelic acid, compounds that have exhibited selective activity against cancer cell lines. Some of the new extremophile species can ingest metals and the possibility of using them to clean the mine water is being investigated.

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See Also: Mineral Waste; Mining Law; Open Burning; Recycling; Wyoming.

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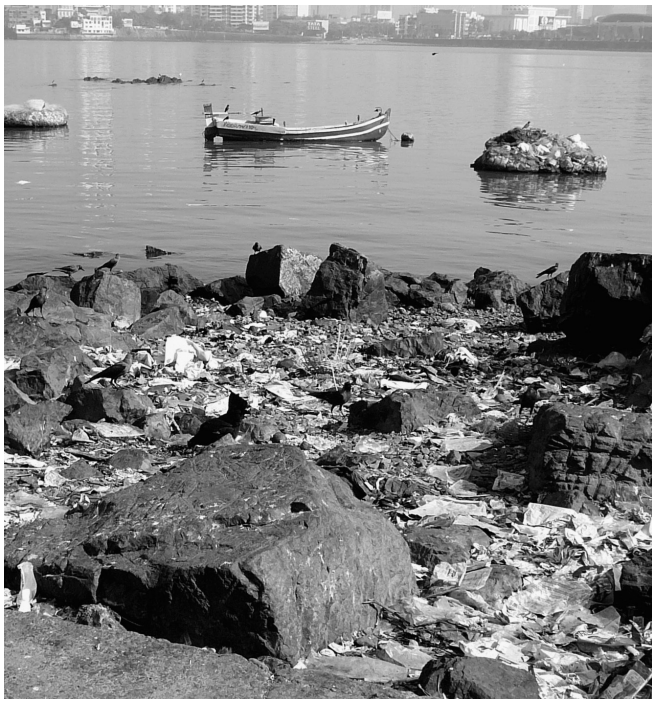
Mumbai, India

Famous for producing the glittery melodramas of Bollywood, Mumbai is a city that thrives on consumption and upward mobility. A creation of British imperialism, the city of Mumbai (previously known as Bombay) in the Indian state of Maharashtra is not only the center of one of the world's most prominent film industries but is also home to the Indian stock exchange and constitutes the financial heart of the region. The bulbous lights that curve along the Arabian Sea on Mumbai's Marine Drive reflect luxurious hotels and penthouses, but most city residents work for low pay and live in crowded and tenuous housing. Through the Oscar Award–winning 2009 film *Slumdog Millionaire*, people around the world got a taste of a dramatized slice of Mumbai life and the intense social inequalities that organize the city.

With a population of over 12 million people, central Mumbai occupies a 26-square-mile peninsula that juts out from India's western coast into the Arabian Sea. In comparison to Manhattan, which is around 22 square miles and home to just over 1.6 million people, the population density of Mumbai is more than six times greater. Including the metropolitan area, there are 22 million residents of Greater Mumbai, making it one of the most densely settled areas of the world. That Mumbai has developed on a small peninsula creates physical limits to expansion that do not exist in many other cities. This has created dramatic effects in the housing arena, including soaring real estate values and the development of sprawling, serpentine settlements like Dharavi, often called "Asia's biggest slum." The scarcity of land has put limits on the availability of areas for dumping accumulated garbage within the city.

Since India began introducing legislation to broaden the financial sector and encourage foreign investment in the 1990s, the ability of residents of Mumbai (known as "Mumbaikers") to consume has increased palpably. New retail stores have opened across the country, and the consuming classes have access to more goods and services than before, coupled with greater access to credit to purchase them. As a result, cars are choking city streets, and plastic bags are clogging city sewers. Grappling with an explosion of population and consumption, Mumbai faces many challenges in handling its increased production of waste. In just one decade, from 1991 to 2001, the amount of municipal waste swelled by around 50 percent, while the population increased by around 20 percent. As of 2010, the city produces approximately 6,500 tons of solid waste, along with



During the monsoon season in 2005, Mumbai officials reported that plastic bags and trash had blocked the aging storm drain infrastructure, intensifying flooding. The city is strongly motivated to modernize the city, starting with the waste management system.

2,500 tons of construction waste; over 10,000 tons of construction debris from flyovers (overpasses), road-widening, sewage and stormwater drains, and pipeline projects; and 8,000 kilograms of biomedical waste every day.

Understanding Mumbai's Waste

The explosion of plastic consumption was realized as a particularly destructive waste problem in Mumbai during the monsoon storms of 2005, when city officials charged that plastic bags and other trash had blocked the aged storm drainage infrastructure, compounding the flooding that had devastated the city. Adding to the blocked drains, new road construction had impinged on the heavily polluted Mithi River, which would have carried the floodwaters out to sea. Despite central and municipal bans on selling plastic bags, their widespread use continues. This event highlights the challenges the city has faced in managing its waste production in the 21st century. Old infrastructure and insufficient systems for handling the waste explosion pose daunting challenges for the city. In an act of Mumbai theatrics, members of the local Shiv Sena Party dumped mounds of garbage in front of several ward offices in the city in 2002, charging them with not cleaning up enough during monsoon season.

In addition to engineering demands, there is a prevalent desire to create Mumbai as a "world-class city," using cities like Shanghai as a model. Overhauling the waste management system in this paradigm is essential for creating a cleaner, better, and more globally dignified place to live.

Waste Policy in Mumbai

The responsibility for solid waste was granted to the Municipal Corporation of Greater Mumbai (MCGM) during British rule under the Mumbai Municipal Corporation Act of 1888, which assigned the corporation with responsibility for providing civic amenities. Section 61 of this act mandates that the municipal corporation maintain the area under its control in clean and sanitary conditions to ensure a healthy environment. With the rest of India's municipal authorities, Mumbai was issued normative standards for overhauling its solid waste management system in 2000 by the central government of India, referred to as the "MSW rules."

The MSW rules of 2000 laid out ambitious plans for India's cities to segregate, store, transport, process, and dispose of solid waste. The logic of these rules is that no garbage should be on the streets at any given time. Although the MSW rules laid out requirements along with implementation timelines, cities have responded by implementing the regulations to different degrees and through varied approaches. For instance, although the rules required cities to create long-term landfilling solutions by 2002, many cities had not completed this even as of 2010. And while some cities are approaching solid waste management comprehensively, others are implementing programs incrementally. In 2006, the Municipal Corporation of Greater Mumbai introduced the Cleanliness and Sanitation bylaws, which supplemented the central government's directive.

Mumbai's Waste Management System

Until the passage of the MSW rules in 2000, the city of Mumbai did not have an official comprehensive waste management system that served its

six administrative zones and 24 wards. In 2007–08, the MCGM budgeted a total of $232 million for its solid waste management programs. The MCGM has declared that its priorities include deploying mechanized vehicles for waste transport, involving nongovernmental organizations and the community, increasing the role of the private sector, changing the organizational culture of the municipality, and introducing the latest technology.

At the beginning of the waste management process, the city emphasized the importance of segregation and required that citizens separate no less than six types of waste: biodegradable organic waste (such as food waste), household hazardous waste (such as batteries or chemicals), biomedical waste, construction and demolition waste, horticultural waste, and all other nonbiodegradable materials. Although this directive exists across India, it is rarely practiced. In many households, residents sell waste to itinerant scrap buyers, who sell the material up the chain to be reprocessed, hence recycled, for future manufacturing. Apart from this, separation is not widely practiced. In response, the municipal corporation even declared in 2003 that it was considering a policy that would exempt residents from paying property taxes if they segregate their garbage according to the codes.

Across India, daily door-to-door collection has become the gold standard. This process has been institutionalized as the "Hyderabad pattern," named for a successful experiment in the city of Hyderabad, where cleaning contracts were awarded to NGOs and community-based organizations for specific geographic areas and fixed payments. To ensure the regular pickup of garbage, the government planned to get rid of all community bins and replace them with small bins and regular truck service instead. As one Mumbai official commented, the bins invite people to throw out their things "in a shabby manner," resulting in overflowing trash and "rag pickers scavenging through the pile for things they can sell, scattering the contents onto the street."

Daily door-to-door garbage collection in Mumbai was started in 2005 in the areas of Prabhadevi and Bandra (West). NGOs are tasked with managing the collectors and acting as intermediaries between them and the municipal corporation. The workers are called *sevaks*, meaning "service providers." This is part of a larger trend in India to create titles for garbage-collecting jobs that recognize the value of their service to mitigate the damning stigma of being from low-caste communities. Mumbai's four zones are covered by various NGOs; each employs *sevaks* and a supervisor. Apart from door-to-door collection, the NGOs have also undertaken composting and street and area cleaning. The NGOs have reported that they have had difficulties working with the MCGM, perhaps because of their lack of financial and legal capacity. In total, the MCGM employs over 28,000 sweepers and motor loaders and 1,500 managers.

Around the same time that formal door-to-door collection programs were begun in areas of the city, the MCGM initiated a separate program known as *Dattak Vasti Yojana* (Slum Adoption Scheme). This scheme was devised for slum housing, where door-to-door services are not provided and sanitation is a particularly serious problem because of high density and a lack of access to toilets, running water, and sewage systems.

Apart from the formal system, Mumbai has a complex informal sector system that includes street and dump site ragpickers, door-to-door collectors, and itinerant junk buyers. Estimates of how many people work in this sector are difficult to formulate. Some researchers have suggested that there are around 30,000 informal waste pickers in the city and nearly 15,000 itinerant junk buyers, while others have put the numbers as high as 60,000 and 100,000 people in each line of work. Estimates also vary for how much waste they recycle, but a reasonable guess is that 10 percent of all household waste is separated and sold for recycling by these groups. The informal sector earns its living by selling glass, metal, paper, and plastic for recycling.

For transporting waste, the city of Mumbai owns and contracts almost 1,000 vehicles, including large and small compactors, one- and eight-ton tippers, dumpster placers, and stationary compactors. Compactors were introduced for the first time in 2002, and the largest ones were bought in 2010. The waste comes through three refuse transfer stations at Mahalaxmi, Kurla, and Versova.

Dumpsites in Mumbai

Besides the fraction of waste that is recycled by the informal sector, all of Mumbai's garbage goes to

three dump sites at Deonar, Mulund, and Gorai, and a fourth has been proposed at Kanjur. The MCGM has emphasized developing the landfills as public–private partnerships.

Of all the dump sites, Deonar is the largest and the oldest. It has been operating since 1927 and, as of 2010, continued to receive 70 percent of all of Mumbai's garbage—4,000 tons every day—from the eastern parts of the city and suburbs. Waste is dumped at Deonar without any treatment, though the MCGM has prepared a plan to involve a private company to overhaul the site. The site has faced protest from local residents, who charge that their health has suffered as a result of living nearby. Claims have also been made that the site does not follow proper procedures, such as banning people from the dump, operating fire engines, using an air monitoring station, building watch towers, and employing dozens of security people. Regular methane fires have been a common problem, but the MCGM announced that it would no longer deploy city firefighters there. A 2003 report admitted that the municipal assistant health supervisor fell ill because of burning garbage at Deonar dump.

The dump at Gorai also acted as an important site in the city until its closure in 2007. It operated since 1972 as one of the smallest dump sites in Mumbai, receiving around 1,200 tons of garbage per day from the western suburbs. When the closure of the dump was demanded in 2002, the MCGM responded by saying that it would spray deodorant and disinfect the ground each day, plant 4,000 trees, and monitor air pollution. However, charges were raised that the dump was within 500 meters of a coastal zone, and mangroves were being destroyed as a result. In 2007, the site was closed down when it had spread over 50 acres and reached over 30 meters high. The closure of the dump has been hailed as a success story by the municipality, having successfully prevented leaching, and the city even received carbon credits for captured methane in the process. Before this, a dump site from the 1950s at Goregaon was closed in 2002 after the Supreme Court issued an order in response to health complaints from local residents.

The Mulund and Kanjur dumps are both situated in the eastern suburbs of the city along the Thane creek. Mulund has been operating since 1968, while the Kanjur site was still in the planning stages by 2010. In 2009, the city was working to gain permission to remove mangroves in order to get access to 20 acres of dumping grounds in response to public-interest litigation that had been filed to prevent this from happening. The plan includes making Kanjur a site for receiving the 4,000 daily tons of garbage that gets sent to Deonar. To deal with the growing garbage problem, other ideas have been entertained, including a proposal to make bricks from garbage for burning and incineration, but incineration has received protest from environmental groups.

In the early 21st century, a building complex housing large international and Indian information technology and finance companies, along with residences and a mall, complained that computers and air-conditioning units were inexplicably breaking. The complex, as it turns out, was built just next to a dump site, which was closed in 2002 without proper treatment, and garbage was used to fill in the land. One of the companies based there invited the National Solid Waste Association of India (NSWAI) to conduct testing to find out the source of their problems, and they reported that toxic gases were high enough to corrode the silver and copper components of appliances. Even though the MSW rules of 2000 state that no human settlement should be built at a dump site for at least 15 years after its closure, this structure sprang up almost immediately. As the city of Mumbai continues to grow within the confines of its restricted peninsula, the fragile divide between concrete buildings and the infrastructure below will continue to present conflicts and challenges with which the city will have to contend.

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See Also: Cairo, Egypt; Delhi, India; Developing Countries; India; Kolkata, India; Street Scavenging and Trash Picking.

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Encyclopedia of CONSUMPTION and WASTE

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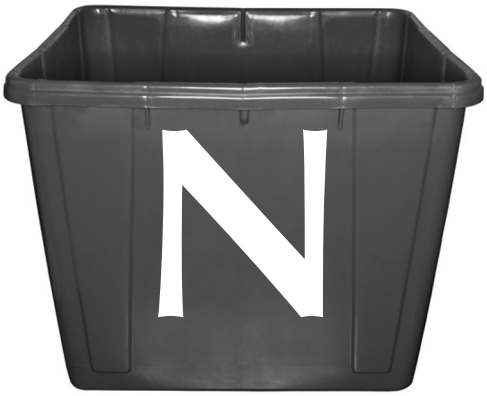

National Clean Up and Paint Up Bureau

From the 1900s through the 1970s, the National Clean Up and Paint Up Bureau sponsored community-wide spring cleanups across the United States, traditionally with parades and other town-wide activities. It impacted the national consciousness through television shows such as a 1950 episode of *Our Miss Brooks* titled "National Clean-up." Communities like Philadelphia, Boise, Helena, and Cincinnati competed for a "cleanest city" trophy. Merchants and civic organizations including Rotary, Ladies Auxiliary, Booker T. Washington's Health Week, and Boy Scouts promoted it in their local communities.

The city of Philadelphia held an annual "Clean-Up, Paint-Up, Fix-Up" campaign for more than 50 years and was named the "National Cleanest Town" for 12 consecutive years from 1947 to 1959. Started by the paint industry's first national professional organization, the National Paint, Varnish, and Lacquer Association, in 1915, the National Clean Up and Paint Up Bureau is more than a nationwide civic effort—it was one of the longest-running and most successful marketing and lobbying campaigns in the United States, a forerunner of 21st-century social marketing campaigns. Starting during World War I, the National Paint, Varnish, and Lacquer Association evoked neighborhood pride, civic responsibility, and patriotism to sell products. The most famous was a collaboration with the Federal Civil Defense Administration, a 1954 short documentary called *The House in the Middle*, which used a nuclear attack to demonstrate that a freshly painted house is more likely to survive in the atomic age.

National Paint, Oil, and Varnish Association

The National Paint, Oil, and Varnish Association was established in Saratoga, New York, in 1888. In 1933, it changed its name to the National Paint, Varnish, and Lacquer Association and is known in the 21st century as the American Coatings Association, which better includes all of its industry associations.

The majority of paint industry professionals are members. The organization functions as a professional lobby to the government and the public. Despite the name changes, the association has held firm to its mission and has occupied the same offices at the Brodhead-Bell-Morton Mansion building in Washington, D.C., since 1939.

According to a 1916 national painter's magazine, the National Clean Up and Paint Up campaign was a campaign to sell goods by linking all the individual selling campaigns to one that received more public support. In 1916, it found that paint sales increased 25–50 percent in the average town. However, this early attempt at social marketing, or using marketing to achieve specific behavioral goals for a social good, depended on the cooperation of local media. In towns where newspapers did not actively promote the campaign, sales and participation were lower. The National Clean Up and Paint Up Bureau campaign ended in the 1970s, but many communities continue to hold paint-up and clean up promotions through environmental organizations such as Keep America Beautiful. As of 2010, Keep America Beautiful is the largest community improvement organization in the United States, with more than 20,000 participating communities.

The U.S. Federal Defense Administration is most famous for its cold war–defining instructional film *Duck and Cover*, a safety technique taught to school children from the 1950s until the 1980s in response to an unexpected nuclear attack. The administration was started in 1951 to prepare the United States for the possibility of an atomic attack. In the 1950s, when *The House in the Middle* was made, the U.S. Federal Defense Administration was allotted a small budget mainly for education and reports.

This might explain why it collaborated with the National Clean Up and Paint Up Bureau to create a public information film that associated patriotism and civil defense behavior with a well-kept, freshly painted home. Along with *Duck and Cover* and other cold war educational films, *The House in the Middle* was identified as a culturally significant film by the U.S. Library of Congress National Film Registry in 2001. The National Film Registry was established by the National Film Preservation Act of 1988.

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See Also: High-Level Waste; Household Hazardous Waste; Uranium.

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National Survey of Community Solid Waste Practices

The middle of the 20th century saw the advent of major innovations in convenience (such as frozen, canned, dried, or boxed) or packaged foods, which dramatically increased the amount and changed the types of packaging thrown away. In 1965, the U.S. government recognized the importance of finding better ways of disposing of the trash, and passed the Solid Waste Disposal Act. President Lyndon B. Johnson also commissioned the first National Survey of Community Solid Waste Practices to be conducted in 1968. This was the first comprehensive data on solid waste since cities began to record amounts of waste.

Results and Conclusions of the First Surveys

Municipal solid waste (MSW) includes wastes such as durable goods, nondurable goods, containers, packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources. Examples of wastes from these categories include appliances, newspapers, clothing, boxes, disposable tableware, office and classroom paper, wood pallets, and food wastes. MSW does not include items such as construction and demotion wastes, municipal sludge resulting from water and wastewater treatment plants, combustion

ash from incinerators, and industrial wastes, all of which might also be disposed of in municipal waste landfills.

The first National Survey of Community Solid Waste Practices, conducted in 1968, found that average waste generation rates from residential households were 2.49 pounds (lbs) per person per day; commercial wastes accounted for 1.08 pounds per person per day. The total was 360 million tons per year, not including the 550 million tons of agricultural wastes and crop residues. Additionally, 1.5 billion tons per year of animal waste and 1.1 billion tons per year of mineral waste were found in the landfills. Cumulatively, it was estimated that over 3.5 billion tons of solid wastes were generated in 1968 in the United States. The study also indicated that low-income households generated more glass, metal, and food waste and less paper, textiles, plastics, leather, and rubber waste compared to average solid waste generated.

Franklin Associates conducted a national study of solid waste generated in 1981. Data on solid waste quantities in several cities revealed detailed waste-generation quantities by residential and commercial components. Residential solid waste generation was related to median household income. The amount of MSW generated in the United States in 1981 was 281 million tons, which was 4 percent less than the previous year.

Of the total solid waste generated, 15 percent was recycled, 12 percent was incinerated, and the remaining 73 percent was landfilled. The average per capita generation of residential waste was 2.38 lbs per person per day, while the recyclable materials discarded were 0.34 lbs per person per day.

The 1981 study also indicated that the per capita solid waste generation decreased slightly with increased population density. There was a 0.06 lb per person decrease for every person-per acre increase in population density. The lower-income households generated solid waste at about 1.75 lbs per person per day, while higher-income households generated 2.5 lbs per person per day. It was also shown that the residential waste generation rate (pounds per person per day) was directly proportional to median household income, and commercial waste generated was proportional to the total retail sales in that area.

Additional Studies

The 1985 study by Franklin Associates looked at MSW generation in several U.S. cities and examined the impact of seasonality on MSW. There appeared to be no significant relationship between annual waste quantities and weather factors; however, there was a pronounced impact on the seasonal variation of waste generation. A survey of 18 cities showed that a maximum generation of MSW took place in the spring or summer, and a minimum in the winter. The survey also examined the interstate dynamics of waste disposal. The 10,500 tons of New York City's daily commercial waste was disposed of mostly throughout 12 states, with five states receiving nearly 90 percent. Pennsylvania received approximately 35 percent, Ohio 19 percent, West Virginia 13 percent, and Indiana 11 percent. A combined total of 10 percent went to the states of Maryland, Missouri, Illinois, Connecticut, Virginia, Kentucky, and Florida.

Another study in 1990 looked at the generation of MSW in New York City compared with the U.S. average. The total waste in the city was reported to be 7.7 million tons. Of this total waste, 4 percent was reported to be yard waste, which was very small compared to the national average of 18 percent. On the other hand, the generation of food waste in New York City was 13 percent, compared to only 7 percent in the United States. The overall MSW growth rate between 1970 and 1990 was found to be 19 percent; 22 percent of this increase was attributable to population growth, 23 percent to employment growth, and 55 percent to waste generation per household and per employee. The projection of MSW for New York City in 2010 was 9.1 million tons.

According to the Environmental Protection Agency (EPA), by 2009, Americans recycled and composted 33.8 percent of the MSW stream, compared to a 6.4 percent recycling rate in 1960. The United States incinerated 11.9 percent of the waste stream and landfilled the remaining 54.3 percent. New York City's Fresh Kills Landfill was closed and the City Department of Parks and Recreation is converting it into one of the largest city parks. The largest landfills in the United States (by tonnage) are Apex Regional Landfill in Las Vegas, Nevada, and the Puente Hills Landfill in Whittier, California.

A 2008 study of waste reported that waste had decreased by 61 percent across the United States since the 1960s due to aggressive cleanup programs. Still, it found that an average of 6,729 pieces of waste per mile were left on roadways in the United States.

A major national not-for-profit group, Keep America Beautiful, did a major study of waste in the United States in 2008 by observing nearly 10,000 consumers in 130 locations in 10 states. The study found that waste had decreased by 61 percent nationwide since the 1960s, primarily due to aggressive, long-term public education and cleanup programs. However, it remains a costly and often-underestimated problem for the environment and quality of life into the 21st century. The study showed that 51.2 billion pieces of waste are left on the roadways in the United States, an average of 6,729 pieces of waste per mile. Individuals 30 years old and over wasted less than their younger counterparts, but there was no relationship between gender and waste.

The first Chinese national survey of pollution and waste was conducted in 2007. The study showed that the nation had deposited 30.3 million tons of pollutants in the water. The discharge of industrial solid waste was 49 million tons, over three times the original government reports. In the same year, 23.2 million tons of sulfur dioxide, nearly 18 million tons of nitrogen oxides, and 11 million tons of soot were emitted into the air. The country was, as of 2010, the top emitter of greenhouse gases, supplanting the United States.

Waste Produced Between Thanksgiving and New Year's Day

According to www.recycles.org, household waste increases by more than 25 percent during the holiday season (late November–December). The shopping bags, food waste, packaging, wrapping paper, and accessories add up to one million more tons per week being added to the landfills. Some reports predict a disposal of four million tons of giftwrap and shopping bags alone per season. Half of the paper consumed each year is used to wrap gifts. It is also estimated that the ribbons used for wrapping that gets tossed away per year cumulatively total 38,000 miles (by comparison, the Earth's circumference is 25,000 miles). The holiday cards that are sent and received total 1.9 billion per year. According to *Plenty Magazine*, those cards require 300,000 new trees to be harvested per year.

Fifty million trees are purchased each year, and about 30 million of them end up in the landfills. Over 20 million trees were cut in the United States in 2009. Customers spent over $15 billion on new holiday decorations, including tree ornaments and lights. It takes about five miles of wire to string the lights on the tree in New York City's Rockefeller Center, while the White House hangs 269 wreaths each year.

The average American spends $800 on gifts each holiday season. Forty percent of battery purchases are made over the holiday season. According to a national survey, 70 percent of Americans would welcome less emphasis on giving so many gifts. Nevertheless, gift giving will almost certainly always be a part of the holidays. To help reduce its effect on the environment, buying less is one option and shopping online is another way to help. Online shopping can reduce greenhouse gases from gas emissions by decreasing the number of miles driven by consumers.

Conclusion

Overall, the United States produced more waste than any other country by 2010. According to the EPA, each person in the United States generated 1,606 lbs of waste in 2006. In 2010, it was estimated to grow to 1,752 lbs per person per year. An increasing proportion of this is made up of nonbiodegradable components that are therefore harmful

to the environment. To effectively reduce the waste management problem, the following hierarchy has been suggested, listed in order of least-to-most adverse impact on the environment: (1) source reduction (on-site reuse of the products), (2) recovery (recycling and composting), (3) waste combustion (preferably with land recovery), and (4) landfilling. This hierarchy is slightly different from the EPA's integrated solid waste management, but the basic purpose in both cases is to reduce the toxicity of the waste stream as much as possible.

For effective implementation of integrated solid waste management, all stakeholders must be educated and committed to how products have to be disposed without causing harm to the environment. In addition to consumers, manufacturers should also concentrate on reducing manufacturing waste and take additional responsibilities for the final disposal. The land disposal component of an integrated solid waste system should be utilized only after all other steps have been taken to reduce, reuse, and recycle the waste stream.

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See Also: Construction and Demolition Waste; Environmental Protection Agency (EPA); Fast Food Packaging; Paper and Landfills; Recycling Behaviors; Residential Urban Refuse; Seasonal Products; Solid Waste Data Analysis; Solid Waste Disposal Act; Zero Waste.

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Nebraska

Part of what was referred to in the 19th century as the Great American Desert (in actuality, a highly productive prairie), Nebraska is one of the leading states in the United States for farming and ranching and is located in the Great Plains of the Midwest. The state is named after the Otoe or Omaha phrase for "flat water," as the phrase sounds similar in both Native American languages; it refers to the Platte River that flows through the state. Most of Nebraska lies above the immense Ogallala Aquifer, from which water feeds some of the most productive agricultural counties in the United States. The Nebraska Sand Hills cover much of the north-central quadrant of the state, hosting cattle ranches and a varied biodiversity of insect, bird, mammal, and plant species. Human population is most concentrated near the eastern border. Apart from agriculture, other important economic sectors are manufacturing, telecommunications, information technology, insurance, and freight transport. Nebraska has a rich railroad history and the world's largest train yard—Union Pacific's Bailey Yard—located in North Platte. Native American peoples who have inhabited Nebraska include the Omaha, Missouri, Ponca, Pawnee, Otoe, and various Sioux tribes. Lincoln is the state capital, Omaha is the largest city, and Omaha-Council Bluffs is the largest metropolitan area.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Nebraska

had an estimated 2,360,861 tons of municipal solid waste (MSW) generation, placing it 36th in a survey of the 50 states and the capital district. The tonnage of exported and imported MSW tonnage was not reported. Based on the 2006 population of 1,763,765, an estimated 1.34 tons of MSW were generated per person per year (ranking joint 18th). Nebraska landfilled 2,100,347 tons (ranking 35th) in the state's 23 landfills, and it was ranked 20th out of 44 respondent states for number of landfills and was continuing to add capacity as of 2006. Nebraska has no waste-to-energy (WTE) facilities. It recycled 260,514 tons of MSW, placing Nebraska 37th in the ranking of recycled MSW tonnage.

Great Nebraska Trash-Off

The Great Nebraska Trash-Off is an annual event held in April since 2009 in which volunteers clear rubbish from Nebraskan highways. In 1999, 3,756 volunteers in 226 groups cleared 904 miles of highway. At its peak in 2002, 1,908 miles of highway were cleared by 5,950 volunteers in 477 groups. The largest turnout was in 2004 when 6,554 volunteers cleaned 1,852 miles of highway. However, in 2009, volunteer turnout was down to 2,571 with only 720 miles of highway cleared. The Trash-Off is part of the Adopt-A-Highway program, a national scheme that has run in Nebraska since 1990 (having begun in Texas in 1985). Volunteer groups registered for the scheme agree to pick up litter along a section of highway 2–6 miles in length twice a year for two years. The state installs the volunteer group's nameplate at each end of the section and provides trash bags, traffic signs, high-visibility vests, and collected trash disposal. Around 1,379 groups cover one-quarter of Nebraska's 10,000 miles of road.

Used Tire Recycling in Nebraska

Nebraska generates 1.5 million waste tires per year, around one tire for every Nebraskan, at a total weight of 37,000 tons. However, a 2010 Rubber Manufacturers Association (RMA) report found that Nebraska was a leading state for handling used tires. In 1990, a $1 fee on every tire sold in Nebraska was introduced, which went toward tire disposal and funding tire recycling incentive programs. The Scrap Tire Reduction and Recycling Incentive Fund was subsequently established in 1994, and tires were totally banned from Nebraska landfills in 1998, when licensing was introduced for scrap tire collectors, transporters, and processors. The RMA report found that in eastern Nebraska, most used tires were processed into products with a higher end value or used as fuel in cement kilns; in less-densely populated western Nebraska, virtually all tires were being monofilled (deposited in a landfill that only receives one type of material), a practice thought to have no negative environmental effects. However, tire stockpiling in Nebraska still remains a problem in the 21st century, although less than one million tires remained in the state's stockpiles in 2010. A tire fire in Lincoln involving a pile 150 feet long, 50 feet wide, and 10 feet high required half of the Lincoln Fire Department's equipment and personnel to bring it under control. The amount of overtime paid to deal with this incident curtailed prevention and education programs for the rest of the department's fiscal year. In January 2002, a 12-day fire broke out at the EnTire Recycling plant in Nebraska City when four old grain bins filled with chipped and crumbed tire rubber caught fire.

Eagle International of South Sioux City has been creating tire-recycling equipment for 20 years and is a world leader in the field. It has developed machinery to remove tire rims, steel beads, and sidewalls and to cut tires and bale them into their Enviro-Block, which reduces a 10-cubic-yard stack of 100 tires into one two-cubic-yard bale, which can be used for multiple purposes: retaining walls, erosion control, leachate systems, fencing, impact barriers, or underwater constructions. The Enviro-Block system consists of three Eagle International products: an automated hopper for handling, a tire cutter, and a baler that can make four bales an hour, each of which contains at least 100 waste tires consisting of around 70 percent car tires and 30 percent truck tires.

The Storm Water Outfall Project in South Sioux City used over 3,000 tires made into Enviro-Block bales to create an outfall where the tire bales also function as a fish habitat. At the 10,000-Head Cattle Feedyard Project in Dixon County, Enviro-Blocks were used to create drainage along the feed pads and cattle mounds and to create windbreaks. Over one million waste tires went into this project.

The Titan II, produced by Eagle, is the largest tirecutter in the world, designed to break apart and cut large off-the-road (OTR) and mining vehicle tires for recycling, something virtually impossible to feasibly do until its creation. These tires weigh up to 10,000 pounds and can measure 48 inches across the tread and be up to approximately 12 feet in diameter. They are often left where they were removed or dropped down mine shafts, such was the difficulty in transporting and cutting them. A Titan II weighs 47,000 pounds, costs $400,000 per unit, and is made for Eagle by Brehmer Manufacturing of Lyons, also in Nebraska.

Eagle found that debeading tires halves the time and money spent on replacing tire-cutter blades and reduces tire shredder power consumption by 25 percent. It can remove 8–10 pounds of recyclable steel, which can be sold, from each tire, and the value of the steel-free tire shred also increases. De-rimming also provides an average of 15 pounds of recyclable steel from each tire.

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See Also: Automobiles; Recycling; Rubber; Tires.

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Needs and Wants

The relationship between needs and wants has typically been difficult to define and the subject of much debate. It is possible, however, to discern a common trend in understanding. Needs are generally seen as material and nonnegotiable, and a direct link is made between the satisfaction of needs and an individual's standard of living and well-being. Wants, on the other hand, are equated with desires, seen as symbolic, and prove elusive when it comes to satisfaction. However, the distinctions between the material and symbolic dimensions of needs and wants often prove false; in more trenchant critiques, the distinction between the two is seen to operate purely at the level of rhetoric.

Abraham Maslow

Perhaps the best known theorization of need appears in the form of psychologist Abraham Maslow's "hierarchy of needs," wherein needs at the lower levels in the hierarchy must be satisfied before those higher up receive attention. In Maslow's ordering of needs, physiological and security needs are lower down in the hierarchy, followed by belonging and esteem needs, whereas cognitive, aesthetic, and self-actualization needs are located at the top of the hierarchy. While this hierarchical approach to need satisfaction has been subject to a series of criticisms, it has proven an enduring typology for understanding the essence of human needs.

Measurement of Needs

The measurement of needs has been the subject of much debate. Broadly speaking, there have been two approaches to this measurement: absolute and relative. With the first, it is widely agreed that an absolute measure of need is almost elusive. However, a range of different measures have been developed to define minimum levels of well-being. A good example of these is the United Nations' (UN) development of a set of indicators of severe deprivation, which includes access to food, safe drinking water, sanitation facilities, health, shelter, education, information, and services. With relative measurement, an individual's standard of living is measured relative to others in the same society. For example, the Organisation for Economic Co-operation and Development (OECD) and the European Union (EU) use 60 percent of national median equivalized household income as a threshold for poverty. Problems with relative measures emerge, however, when comparing rich and poor countries. For example, an individual defined as poor in a country such as

Ethiopia would be on a vastly lower income than someone described as poor in Sweden.

Wants

Wants have typically been equated with consumer desire. In-depth considerations of wants can be found in branches of economic psychology and marketing. Psychologist and marketer Ernest Dichter is typically cited as the "father of motivation research." His work applies a Freudian perspective to understanding motivation in consumer behavior, arguing for a role for the unconscious in the creation of consumer desire. Here, and in other strands of interpretive consumer research, objects derive their importance from communicating symbolic meanings of attachment and belonging, which might be seen as equally central to consumer well-being as their functional material dimensions. Further, the distinction between needs and wants might be located purely at the level of rhetoric. Moral discourses of needs are used to legitimize specific consumer choices, and those of wants are used to condemn others.

Marketing

The location of needs and wants within the realm of the symbolic makes a consideration of the role of media and marketing in their promotion a pressing concern. Marketing activity plays a deliberate role in blurring the line between needs and wants, elevating desires into necessity and persuading individuals that their wants are, in actuality, needs. In tandem with marketing efforts, the media plays a central role in stimulating social comparison and thus encouraging individuals to want things that others have. In early periods of mass consumerism, this process occurred on a localized level where "keeping up with the Joneses" was largely based on social comparison within neighborhoods. This in itself might not be seen as too problematic, as it was likely the case that households within neighborhoods had similar levels of income. However, the lifestyles displayed as the norm in the contemporary media reflect the top 5–10 percent of incomes; using this as a benchmark for social comparison in consumption has induced an escalation in desires for luxury goods and a concomitant spiraling of consumer debt in developed economies. Even with rising incomes in developed economies, evidence suggests that consumers are becoming less, rather than more, happy and there has been a rise in conditions of anxiety and depression.

Environmental Impacts

The increasing consumption of goods brought about by the stimulation of consumer wants and desires has significant impacts on the environment. This impact results from increases in the volume of consumer products manufactured, in the actual use and consumption of these goods, and in the rate of disposal of these items. The goods that developed societies are consuming at increasing rates, as of 2010, are those linked to consumer wants and desires. These also tend to have a greater impact on the environment than those linked to needs.

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See Also: Consumerism; Materialist Values; Overconsumption.

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Netherlands

One of the wealthiest and most densely populated nations in Europe, the Netherlands lie largely near or

below sea level by the North Sea. In 2009, the World Bank reported 16,531,294 people living on 16,158 square miles of land in the Netherlands. Owing in part to scarce availability of land, the Netherlands feature some of the most advanced waste management practices in the industrialized world.

Wealth in the nation spans back half a millennium, as trade in the 15th century opened a Golden Age. In the Dutch Golden Age, travelers repeatedly commented on the overtly clean and tidy streets of towns in the Netherlands. Women are described as constantly scrubbing floors, washing the windows, and sweeping the streets. This cleaning was considered a collective, neurotic habit of the Dutch people in the 17th century. Historical studies of the Netherlands suggest that the obsessive cleaning in the 17th century was connected to a strong Calvinistic view of the world, interwoven with patriotism. Since the Dutch had just liberated themselves from occupation by the Catholic Spanish, their focus was firmly on solidarity and patriotism. This manifested itself in a new morality that permeated not only the public space but also the households and even the inner thought world. The commonwealth and its inhabitants had to be cleansed of their stains from the past subjection to Catholicism and Spain. Hence, scrubbing the floor was considered pious and patriotic, whereas forsaking it was considered a shame and a crime.

Historical Cesspits

Dutch archaeologists meet with the unique situation that medieval and early modern urban household waste is well preserved. From the 14th century up until the 19th century, households made use of cesspits for discarding their waste. The huge underground pits, made of bricks, were mostly located at the backs of houses. The pits contain not only human feces and urine but also household residue such as food, broken plates, cups, glasses, and textiles. Some cesspits were in use for centuries and, as a result, can contain unique chronological collections of pottery and glass. The contents provide information on typologies in pottery and glass and also are informative regarding the social status and consumption patterns of individual households.

Archaeologists are aware that the contents of cesspits provide only a fragmented view of the household furniture; wood, glass, and metal objects, for example, are rarely found. Also, regional differences in the availability and value of goods make it difficult to get a clear picture of how rich or poor each household was. Despite such distorting factors, reconstructing social status is one of the main goals of Dutch cesspit research. Pits loaded with valuable finds are interpreted as representing rich households, whereas pits containing little or poor material are thought to correspond with the lives of poorer families. However, this way of interpreting waste has come under serious criticism.

Looking at waste from a less functional and more contextual view, attention is shifting from what people threw away to how they threw it away. It is realized that there is yet little contextual information on how the discarding of waste was organized: who was responsible for discarding the waste in richer and poorer households? What possible categories of household waste were there? In some cities, it appears that members of poor households disposed different kinds of waste (such as pottery, food, textiles, and feces) together in one cesspit, whereas in rich contexts, some cesspits were solely used as a latrine. This might be the result of household activities being more spatially separated in rich homes and by the fact that servants and main household members often occupied separate living areas. From that point of view, a cesspit with few finds would not refer to poverty at all.

The cities of Delft and Leiden were both located in the province of Holland. In the 15th century, the city councils in these two towns, consisting mainly of the new bourgeoisie, were becoming increasingly powerful, challenging the traditional power of the church and the nobility. It appears that the propagation of cesspits in these towns was stimulated by the new urban elite; in both cities, a new legislation was decreed making it compulsory for every household to have its own privy. The primary goal of this legislation was to stimulate people to stop using the city canals as their rubbish bin and latrine. The canal water was used by brewers to produce beer, and both Leiden and Delft were trying to get a strong export position in the international beer market. Consequently, the smell and taste of canal water had to be suitable for beer production. This kind of specialization, on a city level, was new to

the province and its success was, because of the central role of canal water, intertwined with the daily routines and behavior of the citizens. Therefore, the increase in cesspits in Leiden and Delft seems to have been geared not only at the organization of waste disposal but also at aligning the conduct of the citizens.

In Dutch towns, the cesspit was a novelty because it was the first reusable waste structure designed to process human feces. By using the cesspit, urban households obtained a permanent, isolated space near the house to relieve themselves. Consequently, feces were now permanently collected underground in the yard. The combination of isolating, hiding, and, consequently, defining feces can also be detected in bourgeois literature in the Low Countries in this period. All aspects related to functions of the lower half of the body, especially defecating, began to be ridiculed and exaggerated as well as censured in texts and images, indicating a growing unease with the topic. This shift is thought to typify the rise of a new, urban, bourgeois morality. This urban "civilization process" also challenged the traditional centers of moral power: the church and the nobility. The specific function of the cesspit fitted neatly into this development and added to it as well.

Besides this, the medieval cesspit distinguishes itself from the 19th century door-to-door waste collection or a sewer (whether modern or antique) in that it organizes waste disposal on a household level instead of on a collective level. Even though the city councils were active in controlling the citizens' conduct, the practical organization of ventures such as waste management were left to individual citizens. As such, the cesspit technology enabled a bourgeois style of government that is considered typical for 15th-century Dutch cities, emphasizing self-reliance and personal responsibility.

Twentieth Century

Rising levels of consumption between World War II and 1980 increased pressure on the landscape. Beginning in 1979, the government and business sectors proactively developed the social response to improve environmental practices. Chief among these was a waste management hierarchy known as Lansink's Ladder (after Ad Lansink, the member of Parliament who proposed it) in which waste prevention is the primary goal, followed by product reuse, recovery, incineration (producing electricity and heat), and (as a last resort) landfill. In 1990, a coordinated Waste Consultation Council uniting national, provincial, and municipal governments was established to better coordinate the nation's waste management practices, and a National Waste Management Plan was established in 2002. It established a target goal of waste recovery of 83 percent in 2012. While that is ambitious, communities within the Netherlands have some of the highest recycling rates in the world, with some municipalities exceeding 50 percent. Many Dutch municipalities regulate their waste with pay-as-you throw (PAYT) systems and may be useful precedents for communities around the world to consider in developing sustainable waste management practices.

The present and future of waste management has important ties to the past, as the example of the 15th-century cesspits indicates. In short, it seems that cesspits were more than just a practical solution to waste problems. The dispersal of the technology seems to have been intertwined with the rise of the Dutch urban bourgeoisie in the 15th century, an elite that is considered to have played an essential role in the rise of the Netherlands as a successful international trading region, leading up to the famous Dutch Golden Age. Studying how people discarded waste, including waste technologies and cleaning habits, can give a unique vista into the construction of sociotechnical, religious, economic, and cultural power networks.

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See Also: Archaeology of Garbage; Human Waste; Pollution, Water.

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Nevada

Nevada is a mostly arid state in the American west. Most of the population (enumerated in the 2010 census at 2,700,551) resides in Clark County in the southernmost tip of the state. Clark County is home to Las Vegas, one of the most conspicuous sites for consumption in the world. Gambling and tourism dominate the economy, although historically, wealth was extracted from silver deposits. One can hardly characterize waste disposal for an area without a summation of the history and people who generated it. Nevada is a large territory that played significant roles in the economic development of the west, particularly with regard to mineral exploitation, financial support for the U.S. Civil War (the Comstock Lode at Virginia City helped finance the Union side of the war), agriculture and livestock, gambling, and tourism. All of these industries created their own subcultures and the material goods needed to sustain them. When discarded, replaced or abandoned, these items become trash, but more importantly, part of the historical record.

History

Exploration of Nevada's vast territories was undertaken by two government survey teams in the 1850s, although Native Americans and the Spanish, as well as trappers and traders, had established trails long before then. Settlement of the Nevada territory quickly increased during the mid-19th century as additional travel routes and mineral commodities were encountered. These early explorers and settlers usually left small, often-ephemeral scatters or isolates around water sources, mineral deposits, and temporary camps along travel routes. They are likely to consist of food containers (such as pontiled bottles, or cans with soldered tops and sides), and perhaps broken, unrepairable equipment or tools. Traveling on horseback, perhaps with a pack mule in tow, would not have allowed for the inclusion of many superfluous items.

However, on their way west through Nevada toward the goldfields of California, the so-called 49ers often jettisoned treasured objects, not because they were unwanted trash but often because they weighed down the heavy wagons that were difficult for emaciated and thirsty oxen to pull. These items often included otherwise valuable goods and family heirlooms. Many travelers salvaged discarded

Gambling dominates Nevada's economy, and Las Vegas is one of the most conspicuous sites of consumption in the world. This excessive use of resources has given rise to the state's other claim to fame: it is home to Apex Landfill, the largest in the United States.

items, picking up essentials or trading their lower-quality items for better ones found along the road. In the early years, the Mormons sent scavenging parties back along the trail to salvage as much iron and other supplies as possible and haul it to Salt Lake City, Utah, where supplies of all kinds were needed. In many areas, wagon ruts from these trails remain, and sometimes the surviving metal parts of objects, ceramics, or glass can be seen alongside them. Sometimes, the rectangular outlines of wagons are visible in the form of rusted metal that held them together.

Nevada was first settled in 1850 by Mormons from Utah, who created a fort on the old trail between Los Angeles and Utah. Other settlements followed quickly, as silver and other minerals were discovered. Overnight (in many cases, literally) population explosions at these mining enclaves meant that infusions of equipment, tools, building supplies, work animals, food, and liquor were necessary to fortify them.

Men (initially, but later with families) stayed put as long as the resources played out. At this point, garbage dumps would have appeared, with increasing numbers of food, liquor, and other specialty items, depending on what business or district they were near.

For example, the town of Rhyolite was once a bustling metropolis. At its peak just after 1900, this town housed almost 10,000 people. It boasted over 50 saloons, 18 grocery stores, eight physicians, and six barbers. There were over 15 hotels in town to accommodate visitors. A house built in 1905 entirely of bottles (51,000 bottles) is indicative of the disposable opulence once exhibited by its inhabitants.

Early mining technology consisted of the tools, methods, and knowledge used to locate, extract, and process mineral and metal deposits. Refuse from these endeavors may include stamp mills, smelters, steam engines, pumps, mine tailings, head frames (hoists), narrow-gauge rail lines, and other miscellany, as well as leach fields for a host of chemicals used for amalgamation (such as mercury, cyanide, chlorine, sodium, or calcium hyposulfite). These are perhaps the most ubiquitous historic "garbage" features scattered across Nevada's landscape.

Diverse Nationalities

By the 1860s, populations of Chinese and European Americans, including French Canadians, Armenians, Basques, Cornish, and Austrians served vital functions in mining, lumber, and sheepherding operations. Most worked as laborers, laundrymen, woodcutters, cooks, and servants. Many of the early towns had segregated areas, particularly for Chinese and Native American workers, and trash dumps from these specific locales belie their presence with items specific to those cultures.

For example, the 1880 census recorded over 5,000 Chinese in Nevada, edging out the Irish for the title of most numerous foreign-born in the state. The Chinese created social organizations based on clan lines. They also brought food, games, spiritual traditions, and vices. Physical remains include medicine or opium bottles and playing pieces from Renju (a form of tic-tac-toe), fish bones, and pottery remnants, which probably held jars packed with cuttlefish, squid, duck eggs, or other Chinese delicacies. The tops were sealed with wax and imported from the West Coast to the mining camps.

Ostatuak, or Basque boardinghouses, opened their doors as early as the 1860s. They served Basques who were engaged primarily in the sheep industry and in mining. Traces of Nevada's Basque sheepherders are still found in the form of arborglyphs among the aspens. Names, dates, and images were carved into their bark. Many *Harri mutilak* (stone cairns) built by sheepherders still stand, marking ranges now devoid of sheep. Scattered among them are small refuse piles and fire hearths.

The development of the Comstock took a toll on the northern Paiute population, but they adapted and even prospered in ways that seemed unlikely. Beginning in the late 1850s, Henry Comstock employed several to help him excavate his claim. Archaeologist Eugene M. Hattori's research examines Paiute adaptations to the new environment of the Comstock. Hattori concludes that the flexibility developed over thousands of years of climate and resource changes enabled them to adapt quickly. The Paiutes took advantage of the wasteful practices of many Comstock residents by scavenging for food and supplies. They usually preferred to live on the outskirts of Virginia City. Historical photographs show their houses at the base of mine dumps

close to discarded materials. Native structures were often supplemented by collected items; for example, kerosene cans were cut into sheets for roofing.

Starting in the mid-1850s, the Las Vegas Valley became an oasis for travelers on the Mormon Trail, thanks to the area's supply of water and relatively fertile ground for growing crops. From about the 1940s until 2003, Nevada was the fastest-growing state in the United States percentage-wise. Between 1990 and 2000, Nevada's population increased 66.3 percent, while the U.S. population increased 13.1 percent. As of 2010, over two-thirds of the Nevada population live in the Las Vegas area, which is a gambling destination for millions of visitors each year. This lavish economy and extravagantly excessive use of resources has, in part, resulted in Nevada "boasting" the largest landfill site in the entire United States: the Apex Landfill.

Landfills

The Apex, operated by Republic Services, stores nearly 50 million tons of trash. Another 9,000 tons or so come in every day. There is enough space at the 2,200-acre site to store all of the Las Vegas Valley's waste for the next 200 years, according to Bob Coyle, vice president of government relations for Republic Services.

As of 2010, Nevada has 32 landfills across the state. Four are operated by the U.S. Department of Energy, one is operated by the U.S. Air Force, and one by the U.S. Army. The remainder are regional landfills. Since the early 1990s, the trend in solid waste management has been moving toward a more regionalized infrastructure. Nevada landfills range in size from very small (three tons per day) to very large (over 11,000 tons per day). The two largest landfills (Apex in southern Nevada and Lockwood in the north) receive about 90 percent of all the waste disposed of. Reflecting the state's unprecedented population growth, the amount of solid waste disposed of in Nevada has steadily increased.

The governor as of 2010, Jim Gibbons, wants to require Nevadans to recycle 75 percent of waste, saying it will create new jobs and boost the economy (California has a 50 percent mandate). Lynn Hettrick, Gibbons's deputy chief of staff, stated that a California landfill company, Recology, (the San Francisco–based parent company of Jungo Land & Investments Co.) wants to export its waste to Nevada. Hettrick says that although they do not want to be "the landfill of the west," the importation of waste, including recyclables, can create jobs for Nevadans and bring about $1 million a year to Humboldt County and can "be an asset if properly utilized by the state." The Planning Commission in Humboldt County, Nevada, however, blocked Recology's landfill expansion application in Winnemucca. Nonetheless, the importation of solid waste to Nevada has increased significantly, gaining 700 percent for the period 1993 to 2005. The probability for waste importation to Nevada remains high as of 2010, as existing and potential new landfills become positioned to accept larger amounts of imported waste.

Rural Areas

Over 80 percent of the state's area is owned by the federal government. Because Nevada's population is aggregated in large cities, many thousands of acres of public lands are not settled (although utilized for grazing, agriculture, mining, and recreation). This creates opportunities for the illegal dumping of chemicals from drug labs and household, agricultural, and mining waste. Electronic waste is a rapidly growing phenomenon. Waste from camping and other forms of recreation is a growing problem as visitors access increasingly remote areas that are difficult to patrol. However, local community groups have made great strides in controlling illegal dumping by coordinating community cleanup projects, involving the local government, and producing public information campaigns. The Nevada Division of Environmental Protection's 2007 Solid Waste Management Plan specifically addresses these issues.

There are 28 tribal groups comprised of Shoshone, Paiute, and Washoe peoples on 17 reservations in Nevada. Tribes are defined in the Resource Conservation and Recovery Act as "Municipalities." Because of this definition, the courts have ruled that the Environmental Protection Agency (EPA) cannot approve solid waste programs for tribes. Tribes are responsible for implementing and enforcing the minimal requirements outlined in the Code of Federal Regulations, Title 40: Protection of Environment (parts 257 and 258). This, however, does not prevent a tribe from using its sovereignty to develop

a solid waste program, providing that the standards are at least equal to or exceed the minimal federal standards found in 40 CFR.

Many tribes are implementing their own policies, which include recycling and composting. In 2010, the Bishop Paiute Tribe provided vouchers for a waiver of landfill disposal fees at the Bishop Landfill for disposal of solid waste from the reservation. Their tribal public works department is working with an independent contractor to remove accumulated trash and abandoned vehicles from the reservation. There are also initiatives regarding the identification and removal of abandoned and derelict mobile homes and trailers.

Nuclear Waste

Perhaps no other form of waste generates more agitation and controversy than spent nuclear fuel. In 1985, the Nevada Commission on Nuclear Projects was established by law to advise the governor and legislature on matters related to the disposal of radioactive waste and to oversee activities of the Nevada Agency for Nuclear Projects. The Nevada Test Site is composed of approximately 1,350 square miles of desert and mountainous terrain. Nuclear testing at the Nevada Test Site began in 1951 and continued until September 23, 1992. The location is known for the highest amount of concentrated nuclear detonated weapons in the United States. The proposed Yucca Mountain Repository for the storage of spent nuclear fuel and high-level radioactive waste lies at the western edge of the Nevada Test Site. Debate over the controversial project has dominated state politics and was a major theme in the 2004 presidential election as John Kerry and George W. Bush vied to win the votes of this crucial swing state.

In the early 21st century, consumption concerns in Nevada increasingly revolve around water issues, as population growth in Clark County combined with extensive drought increase conservation measures in the state. Nevada entered into an agreement in 2007 with several other western states dependent upon the Colorado River to coordinate conservation efforts across the region, but sustainable water management remains a concern for the foreseeable future.

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See Also: High-Level Waste Disposal; Landfills, Modern; Mineral Waste; Uranium.

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New Hampshire

Nestled in northern New England, the U.S. state of New Hampshire boasts of its White Mountains, sparkling lakes, and beautiful autumn foliage. With its glorious state motto of "Live Free or Die" and Yankee attitude of self-reliance—it was the first of the original 13 colonies to declare independence from Great Britain—New Hampshire also prides itself on its independent thinking and way of life.

Residents of New Hampshire combine this deep respect and appreciation for nature with a "can-do" attitude toward problem solving. Perhaps nowhere is this union of self-sufficiency and environmental ethos more evident than in the state's efforts of dealing with the generation, transportation, and disposal of solid waste. Although one of the smallest of the U.S. states in terms of both population and area, the state of New Hampshire looms large in its proficiency in addressing the issue of solid waste. In a country where the average citizen generates 4.5 pounds of waste every single day, and in an era of consumption and waste, New Hampshire's success in maintaining a relatively low

level of solid waste generation is certainly worthy of note.

Source Reduction

Particularly striking is the fact that of the 50 states, New Hampshire ranks fourth in the estimated per capita generation of municipal solid waste. In other words, New Hampshire's estimated solid waste generation of 0.97, as measured in tons per person per year, is bested only by the states of Idaho, North Carolina, and Connecticut. New Hampshire's rate is below the U.S. average of 1.38 tons per person per year and significantly less than that of the state of Indiana which, with a rate of 2.15 tons per person per year, generates more solid waste on a per capita basis than any other state. This achievement was not unplanned; source reduction of solid waste has been a principal goal of the state of New Hampshire since the turn of the millennium. Source reduction received significant attention in both a 2001 report by the governor's Solid Waste Task Force as well as the 2003 publication of the State of New Hampshire Solid Waste Plan. Very similar to the concept of "hand-me-down" clothing that so many younger siblings receive from their older brothers and sisters, source reduction focuses on the reuse of a product before its ultimate disposal.

Recycling

Source reduction of solid waste is important in New Hampshire, though it is not the only success that the state enjoys when it comes to the issue of solid waste. In particular, the state's municipal recycling programs have made great progress since the 1970s. While there is no state-mandated recycling program, 228 of the state's 234 communities provide access to recycling at the municipal level. Over the years, the number of municipalities offering opportunity to recycle increased significantly along with the amount of material being recycled. From 1990 to 2008, the raw tonnage of commercial and residential recycling and composting has experienced a tenfold increase, swelling from approximately 40,000 tons to more than 400,000 tons. Paper and paper products, such as cereal boxes, are the leading portion of New Hampshire's recycling stream. Glass comprises far less of the total amount of recycling, perhaps in part because of the fact that New Hampshire has no bottle bill. With the three bordering states—Massachusetts, Vermont, and Maine—all offering $0.05 for each bottle recycled, the economic incentive to recycle glass is simply not as striking in New Hampshire.

Pay as You Throw

New Hampshire's success in recycling and source reduction lies, in part, with the increasing adoption of "pay as you throw" (PAYT) waste disposal by municipalities throughout the state. Rather than a single fee for everyone, the PAYT approach to solid waste disposal has people pay only for what they throw away. Saving money is a great motivator, and the PAYT system rewards recycling. The concept is simply that those who throw away less, pay less. The amount of solid waste can be significantly reduced by coupling free recycling with PAYT disposal. In New Hampshire, this system is appreciated because it puts control of disposal costs into the hands of the individual. In the nearly 50 towns and cities engaged in the PAYT system, the amount of solid waste disposed of has shown substantial declines. Some towns have also reached historic proportions in terms of recycling. The town of Peterborough, for example, can boast of a recycling rate of 78 percent. This number is made even more impressive in comparison to the national average recycling rate of about 33 percent.

Population Growth and NIMBY

These types of increases in recycling and reductions in solid waste disposal will only increase in importance as the state's population continues to grow and population pressures on the land are heightened. In 2010, New Hampshire had a population of 1,316,470 (a gain of nearly 100,000 residents since 2000), and the state is noted for having the highest rate of population growth in New England.

This population growth has not, however, been evenly distributed throughout the state. Due to its proximity to the Boston metropolitan area, southeastern New Hampshire has received a significant influx of migrants from Massachusetts and is growing most rapidly. This population growth, combined with a Not in My Backyard (NIMBY) attitude toward solid waste disposal, is leading to a potential problem in waste disposal in the

state. In-state disposal for residential and commercial solid waste is projected to reach full capacity in 2021. At that time, the state of New Hampshire will no longer have the capacity to handle the amount of projected waste. Despite projections that show the need for additional landfill space, no community in New Hampshire as of 2010 was volunteering as the site for a future landfill.

Indeed, while it may be identified as a "sanitary landfill," to most people it is simply "the dump." While they may acknowledge the need for additional landfill space, people simply do not want a new landfill to be located within their community because they worry about increased smells, truck traffic, litter, and the negative image that a landfill would bring. This is the NIMBY syndrome in its most classic form. In the early 21st century, the state continues its efforts at source reduction and increased recycling. This alone, however, will likely not prove a sufficient means to handle all of the solid waste generated in the future. Further exacerbating the situation is the substantial amount of tourism that the state receives, particularly during the fall foliage and winter ski seasons. As evidence, despite a population of only 278 residents, the ski town of Waterville Valley generates nearly 1,000 tons of solid waste annually. Thus, while tourism serves as an important economic boon to the state, it also contributes to the issue of solid waste disposal.

Electronic Waste

Another solid waste concern with which the state of New Hampshire has had to contend is the generation and disposal of an ever-increasing amount of electronic waste (e-waste). As the fastest-growing form of trash in developed countries, more than two million tons of e-waste products are discarded into U.S. landfills annually. Typified by cell phones, which are replaced on average every 18 months in the United States, e-waste also includes obsolete computers, VCRs, DVD players, and television sets. Other, more unlikely, sources may also contribute to e-waste, including greeting cards that contain an electronic device that plays music or that allows audible messages to be recorded. In 2007, the state of New Hampshire passed a ban on the disposal of video display devices, such as computer monitors and television tubes, in order to mitigate the issue of e-waste. The ban has had a twofold effect of reducing e-waste disposal into landfills and increasing e-waste recycling. The upshot of these efforts is that more than 95 percent of the state's population has access to e-waste recycling, with more than 4 million pounds of electronic waste collected annually.

Other Recycling Efforts

Through the efforts of the New Hampshire Department of Environmental Services (DES), the state is also an innovator when it comes to other forms of recycling. One such program affords customers the opportunity to recycle their fluorescent lamps at local hardware stores. Dozens of hardware stores have collected thousands of lamps and have thereby reduced the amount of potential mercury improperly disposed of in the state's landfills. Another DES program aimed at reducing the amount of mercury entering the environment is the Green Yards program. Focusing on auto salvage yards, the program works to prevent environmental contamination from potentially deadly chemicals found in the more than 50,000 vehicles that are recycled each year in the state. Recycling automobile parts reduces both the amount of waste sent to landfill facilities and the potential for chemicals to contaminate the biosphere. Along with source reduction, recycling thus stands as a principal component of the state's efforts to address solid waste.

Looking Into the Future

While the state of New Hampshire can point to a legacy of success, it is also faced with an uncertain future when it comes to the disposal of solid waste. Despite its best efforts, the state is facing a projected shortage of landfill space, in large part because of overall increases in both the resident and tourist populations. For New Hampshire, there are few options besides landfills and recycling. The number of functioning municipal incinerators is declining as federal Environmental Protection Agency air emission standards have forced several small incinerators to cease operation. Composting disposes of only a fraction of the total solid waste generated in the state. The answer may then lie in exporting waste to another state. As of 2010, New Hampshire was a net importer of solid waste. While this waste stream brings with it a revenue stream, the state

of New Hampshire will be faced with an absolute shortage of available landfill space in the early 21st century. Thus while the future of sustainable solid waste disposal in New Hampshire is by no means assured, New Hampshire may well build on its legacy of success and continue to be a national leader in consumption, waste collection, and disposal.

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See Also: Culture, Values, and Garbage; History of Consumption and Waste, U.S., 1950–Present; Household Consumption Patterns; Recycling, United States.

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New Jersey

Located between New York City and Philadelphia, New Jersey (nicknamed "the Garden State") is a complex landscape of suburban and highly industrial areas, with the New Jersey Turnpike (the heavily trafficked highway running north to south) as a defining feature of its geography. It is the most densely populated state in the United States; the U.S. census estimated that 8,707,739 people lived on 8,721 square miles in 2009. In popular culture, New Jersey's proximity to the media capital of New York City has led to several demeaning depictions. The state is often associated with pollution and waste (as seen, for example, in HBO's *The Sopranos*, where organized crime figure Tony Soprano's front business is a waste management enterprise). The reality is a diverse state, one of the wealthiest in the nation, and one with distinctive consumption and waste practices.

Since consumption can be described as the transfer of energy from one user unit to another, energy consumption can be considered a reliable indicator of overall consumption. New Jersey ranked 24th on the electricity total net generation in the United States in 2008, with an annual production of 4,365 thousand MWH, or 1.52 percent of U.S. energy. The state ranked 34th in per capita consumption with 304.39 million Btu.

Nuclear Energy

In New Jersey, nuclear power controls the electricity market, representing as much as 3.8 percent of the national nuclear market. The state currently hosts three nuclear power plants that supply more than half of the state's demand. As has happened to nuclear power around the world in the past, this source of energy has been troublesome in New Jersey. Environmentalists and the Department of Environmental Protection of New Jersey have expressed concern due to recent incidents in at least two of the nuclear plants. In 2010, water contaminated with tritium leached into catch basins at the Salem 2 nuclear power plant in Lower Alloways Creek in Salem County.

As with all ionizing radiation, exposure to tritium increases the risk of developing cancer. However, because it emits very-low-energy radiation and leaves the body relatively quickly, for a given amount of activity ingested, tritium is one of the least dangerous radionuclides. Tritium loses half of its radiation potency every 12.3 years. Nationwide, tritium has leaked at 33 of 104 nuclear plants. Concerns were also expressed after tritium-tainted water was found in an underground conduit as a result of a spill at New Jersey's Oyster Creek Nuclear Generating Station in 2007. Oyster Creek Station, which began operating in 1969 as the first large-scale commercial nuclear facility in the United States, cools its system by first pumping in about 662 million gallons

of water per day from Barnegat Bay, then pumping in another 748 million gallons to dilute the heated water before discharging it back into the bay. Two new spills in the Oyster Creek plant in 2009 sent at least 180,000 gallons of irradiated water underground. The contaminated water is, as of 2010, in a plume that migrates less than one meter per day. At this rate, it will take 14 to 15 years to reach the nearest residential wells in Lacey Township.

Natural Gas and Coal

Natural gas- and coal-fired power plants supply most of New Jersey's remaining electricity demand (47.1 percent). Natural gas is a greenhouse gas far more potent than carbon dioxide when released into the atmosphere, although natural gas is released in much smaller quantities. Natural gas in New Jersey is used primarily by the residential sector, as roughly two-thirds of New Jersey households use natural gas as their primary energy source for home heating.

New Jersey, along with much of the northeast, is vulnerable to distillate fuel oil shortages and price spikes during winter months due to high demand for home heating. Nearly one-fifth of New Jersey households use fuel oil as their primary energy source for home heating. In January and February 2000, distillate fuel oil prices rose sharply when extreme winter weather increased demand unexpectedly and hindered the arrival of new supply, as frozen rivers and high winds slowed the docking and unloading of barges and tankers.

In July 2000, in order to reduce the risk of future shortages, the U.S. president directed the Department of Energy to establish the Northeast Heating Oil Reserve. The reserve gives northeast consumers adequate supplies for about 10 days, the time required for ships to carry heating oil from the Gulf of Mexico to New York Harbor. The reserve's storage terminals are located in Perth Amboy, New Jersey, and Groton and New Haven, Connecticut. The storage terminal located at Perth Amboy is the largest of the three, with a capacity of almost 1 million barrels.

Coal-fired plants burn coal received primarily by rail and barge from neighboring states like West Virginia, Pennsylvania, and Virginia. Coal, a fossil fuel, is the greatest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide emissions.

Petroleum and Gasoline

According to the U.S. Energy Information Administration (EIA), New Jersey has no fossil fuel reserves, although it is (along with New York) the largest petroleum product hub in the United States. The New York Harbor area has a petroleum bulk terminal storage capacity of over 75 million barrels, making it the largest and most important petroleum product hub in the northeast. New Jersey is a major petroleum refining state and distribution center for petroleum products for the high-demand northeast states. The state's six oil refineries, clustered along the Delaware River near Philadelphia and in the New York Harbor area, process crude oil mostly imported from overseas. New Jersey is connected to major petroleum product pipeline systems along the East Coast. New Jersey also receives petroleum product imports by tanker and barge, principally from Canada, the Caribbean, South America, and Europe.

New Jersey requires the statewide use of reformulated motor gasoline blended with ethanol, and the New York Harbor area is the primary northeast distribution hub for ethanol supplies. A large ethanol storage facility in Sewaren receives ethanol rail shipments from the Midwest and marine imports from Brazil and the Caribbean, and then redistributes these supplies to markets throughout the northeast.

Renewable Energy

Although it contributes only minimally to net generation (less than 2 percent), New Jersey is a major producer of electricity from landfill gas and municipal solid waste.

In April 2006, the New Jersey Board of Public Utilities approved regulations that expanded the state's renewable portfolio standard, requiring utilities to generate 22.5 percent of their electricity from renewable sources by 2021, with solar sources generating at least 2 percent of this standard.

New Jersey has high wind power potential located onshore and offshore along its Atlantic coast. In October 2008, Garden State Offshore

Energy was approved by the New Jersey Board of Public Utilities as the developer of a 350-megawatt (MW) wind farm off New Jersey's coast and will evaluate the project's environmental impacts and wind resource quality as well as begin the permitting process at state and federal levels. The project consists of 96 wind turbines arranged in a rectangular grid 16 to 20 miles off the coast of Cape May and Atlantic counties.

New Jersey hopes to develop 3,000 MW in wind energy by 2020. Legal barriers mostly related to incentives and regulations for private generators have delayed its development. In June 2010, the governors of 10 states lining the Atlantic Coast agreed with the federal government to work for a safe and responsible development of offshore wind farms. The memorandum of understanding established an Atlantic Offshore Wind Energy Consortium to take a regional approach to developing wind power around the outer continental shelf. New Jersey's Offshore Wind Economic Development Act, also enacted in 2010, sets up a program to provide a guaranteed income for companies that build offshore wind farms in the state. Under this program, state utilities are required to buy a proportion of power from offshore wind projects to meet their state renewable energy targets under an energy certificates program run by the Board of Public Utilities. The act also provides $100 million in tax credits to help offshore wind energy developers.

The marine environment presents a relatively untapped energy source, and offshore installations are likely to produce a significant proportion of future energy production. By 2010, wind power was the most advanced, with development of wave and tidal energy conversion devices expected to increase worldwide in the near future. Researchers warn about the potential impacts on biodiversity of marine renewable energy installations (MREI), including habitat loss, collision risks, noise, and electromagnetic fields. These factors have been posited as having potentially negative environmental impacts. At the same time, researchers suggest that if appropriately managed and designed, MREI may increase local biodiversity and potentially benefit the wider marine environment. Installations have the capacity to act as both artificial reefs and fish aggregation devices (which have been used previously to facilitate restoration of damaged ecosystems) and de facto marine-protected areas, which have proven successful in enhancing both biodiversity and fisheries.

Waste Management

In 2008, New Jersey generated a total of 22.1 million tons of waste compared to 15.7 million tons in 1998, and 14 million tons in 1988. The state's Department of Environmental Protection has predicted 33 million tons of waste by 2015. To process such amount of waste, there were a total of 12 operating municipal solid waste (MSW) landfills in 2008 with a total landfill capacity remaining of 40 million tons. A free market system allows solid waste generated within a county to be disposed at whatever disposal facility agrees to accept the waste, based on terms freely agreed to by the generator, transporter, and disposal facility operator. The average landfill tip fee was $60 per ton. There were also five waste-to-energy (WTE) plants in New Jersey in 2008 with a surcharge per ton of $60 and enough capacity for waste processing from neighboring states. For example, most of the residential-Manhattan-generated waste is transported to the Essex County WTE in New Jersey.

It has been calculated that operating utilizations of facilities are 72–94 percent for MSW incinerators, 36–65 percent for landfills, and 75 percent for transfer stations. In New Jersey, domestic treatment works generated about 233,300 dry metric tons of sewage sludge in 2003, of which about 6 percent was disposed out of state, 27 percent was incinerated, and 67 percent was beneficially used, either in or out of state. The Solid Waste Management Act has provided the framework for the collection, transportation, and disposal of solid waste in New Jersey since the 1980s.

In the United States, most states have set goals to recycle from 25 to 70 percent of MSW. Rhode Island (70 percent) and New Jersey (60 percent) have set the highest recycling goals of all the states.

New Jersey in particular became a leader in the waste management field in 1987 when the Statewide Mandatory Source Separation and Recycling Act was promulgated. The act required New Jersey's counties to develop recycling plans that mandated the recycling of at least three designated

recyclable materials, in addition to leaves. County recycling plans were also required to designate the strategy to be utilized for the collection, marketing, and disposition of designated recyclable materials. Other provisions of the Recycling Act required municipalities to adopt an ordinance based upon their county's recycling plan. The act called for the recycling of 15 percent of the MSW stream in the first year of the program followed by the recycling of 25 percent of the MSW stream thereafter. That goal was challenged in 1995. A new amendment established a goal to recycle 50 percent of the MSW stream and 60 percent of the overall waste stream by the end of 1995.

Among other important provisions of New Jersey's recycling legislation were the establishment of a tax of $1.50 per ton on solid waste disposed at landfills and transfer stations statewide to be used for promotion of recycling programs statewide; the requirement that all counties and municipalities designate a recycling coordinator; the requirement that municipal master plans be revised to require that provisions for recycling be incorporated into new residential, commercial, and industrial development; the requirement that municipalities submit a tonnage grant report every year; the requirement that municipalities publicize the provisions of the local recycling program at least once every six months; the establishment of a tax credit program for the purchase of new recycling equipment; specific provisions pertaining to plastics and bimetal beverage containers, scrap tires, and motor oil; and the provision of funds for recycling market development studies.

It has been calculated that the quantity of goods recycled as a result of New Jersey's Mandatory Recycling Act amounts to approximately 0.5 million tons per year. As of 2008, only 33 percent of counties had reached the goal of 60 percent of total waste recycling. Cumberland County (72.6 percent) was the one that recycled the most and Hunterdon County the least, with 46.8 percent.

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See Also: Car Washing; Emissions; Engine Oil; Gasoline; Recycling; Tires.

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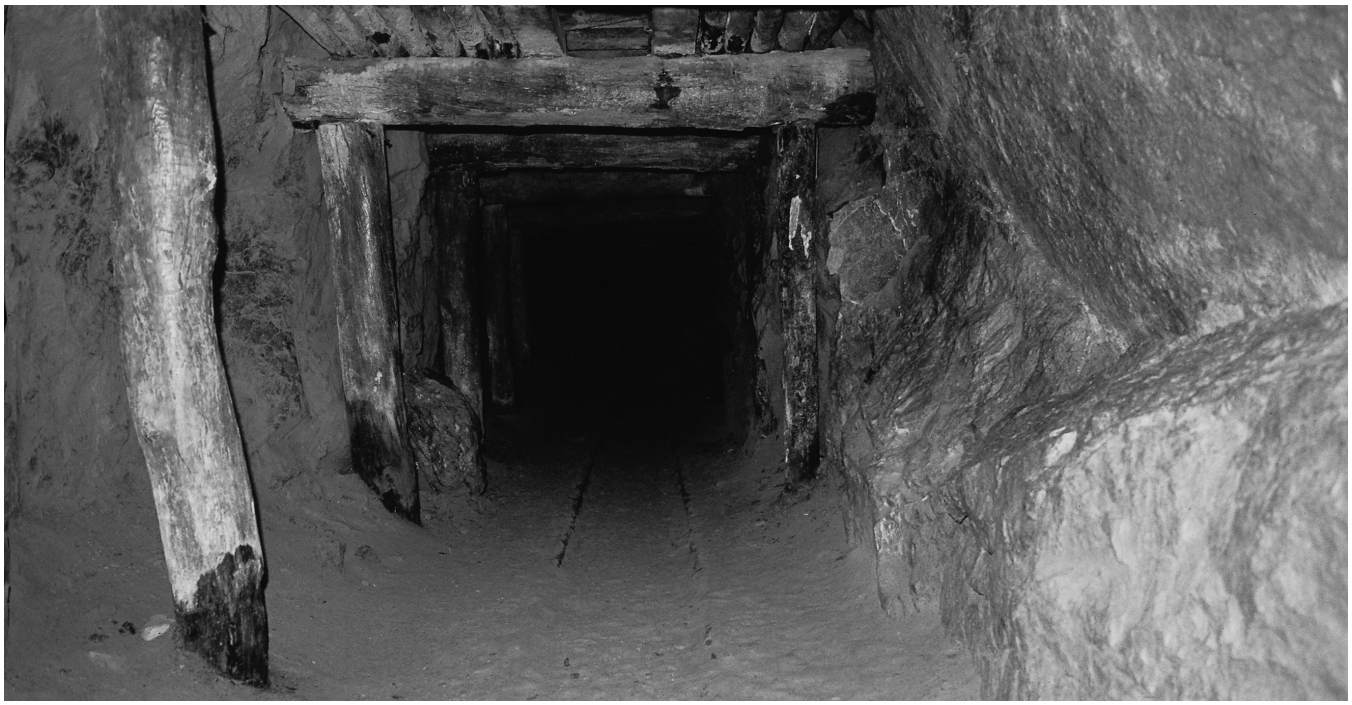
New Mexico

One of the mountain states, New Mexico is located in the southwest and western regions of the United States. The state had previously been part of the Spanish Empire and part of Mexico, and it was inhabited by Native Americans prior to European colonization. New Mexico has the highest percentage of Hispanic people and one of the highest Native American populations, mainly Navajo and Pueblo tribes. The demographics and culture of the state are unique in their strong Hispanic, Mexican, and Native American influences, but the state is one of the most sparsely inhabited in the United States. The southern border is shared with Texas and the Mexican states of Chihuahua and Sonora, while the northwest corner of New Mexico joins with Colorado, Arizona, and Utah to make the Four Corners region. Crude oil, natural gas, tourism, and federal spending (mainly military) are prime factors in the New Mexico economy.

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, New Mexico had an estimated 2,125,052 tons of municipal solid waste (MSW) generation, placing it 38th in a survey of the 50 states and the capital district. Based on the 2006 population of 1,942,302, an esti-



There are around 15,000 abandoned mine features in the landscape of New Mexico, including shallow prospecting pits, 500-foot-deep shafts, and piles of mine waste known as "coal gob." Abandoned mines are often-overlooked areas of potentially hazardous waste such as discarded dynamite, but are also potential archeological treasure troves: Many mine camps dating back as early as the 1880s have associated deposits of trash, which have offered up information on mining and mining ways of life in territorial New Mexico.

mated 1.09 tons of MSW were generated per person per year (ranking joint 38th). New Mexico landfilled 1,933,451 tons (ranking 36th) in the state's 33 landfills, and it was ranked joint 18th out of 44 respondent states for number of landfills and was continuing to add to its capacity. It imported 625,247 tons of MSW, and the export tonnage was not reported. New Mexico has no waste-to-energy (WTE) facilities. It recycled 191,601 tons of MSW, placing New Mexico 40th in the ranking of recycled MSW tonnage. Landfill tipping fees across New Mexico were an average $28 per ton, where the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively. New Mexico was the first state to limit landfill permit terms to 10 years for private-sector landfills, while allowing public landfills to have 20-year permits. New Mexico's six private-sector MSW facilities handle more than 20 percent of the state's waste; all are designed and operated within New Mexico Environment Department (NMED) and Environmental Protection Agency (EPA) standards. The public landfills have fallen short of this standard, drawing criticism of the permit term difference.

Abandoned Mine Land Program

The New Mexico Energy, Minerals, and Natural Resources Department has an Abandoned Mine Land Program, which uses the state Department of Cultural Affairs' Office of Archaeological Studies (OAS) to survey abandoned mine workings, an often-overlooked area of mine waste. There are around 15,000 abandoned mine features in the landscape of New Mexico, including shallow prospecting pits, 500-foot-deep shafts, and piles of mine waste (known as "coal gob"). The program and others across the United States were formed by the Surface Mining Control and Reclamation Act of 1977 (SMCRA). Funding comes from the Abandoned Mine Reclamation Fund, which is raised by fees paid by active coal mines to reclaim mines abandoned pre-SMCRA. The surveys target abandoned mines that are considered a hazard to the public or livestock and may need remediation. Many mine camps

date back as early as the 1880s and have associated deposits of trash, which have considerably advanced knowledge of mining and mining lifeways in territorial New Mexico. The OAS measures, maps, and GPS-locates the sites, makes a photographic record, tries to categorize and date the site, and records data on access and safety. One of the most dangerous aspects of abandoned mines are old explosives that have been discarded and left behind, such as dynamite. The ingredients of explosives deteriorate with age and become highly unstable, needing little provocation to detonate.

White Sands

White Sands Missile Range (previously known as White Sands Proving Ground) is the largest military installation in the United States, a 2-million-acre rocket and bombing range in the Tularosa Basin. During construction work on a new commissary building, a previously unknown dump was found, which may be the earliest such deposit at White Sands. Dates on bottles suggest that the dump was used from July 1945 to 1947. The dump assemblage provides an insight into the daily lives of the soldiers and scientists stationed in the temporary quarters on the edge of the desert working on the V-2 missile program. *Jewels of the Desert*, the monograph on the assemblage, is one of the first studies of material culture from a cold war military site.

Mike Reynolds Earthships

Mike Reynolds is a New Mexico–based architect and promotes a "radically sustainable living" practice he calls Earthship Biotecture. He has criticized traditional architecture for not addressing the amount of waste created in the development process. Reynolds began his work while still at the University of Cincinnati. In 1971, his thesis was published in *Architectural Record*, and shortly after he built his first house from recyclable materials.

Rather than use traditional building materials, Reynolds' constructions reuse drink cans, plastic bottles, and tires, but employ them as they are, without the energy-consuming processing of conventional recycling methods. The realization that any synthetic object becomes a durable insulating building unit when filled with earth is credited by Reynolds as the epiphany that launched his career. The Thumb House, built in 1972, was made from beer cans wired together to make brick-like building units, which were then mortared together and plastered. The design was awarded a U.S. patent in 1973.

Continuing to build and improve his Earthship structures by trial and error, Reynolds was hailed as a hero of the green movement in the 1980s. The houses were bought by celebrities and environmental activists and became increasingly advanced and self-sufficient, with features such as solar panels and geothermal cooling. Eventually, they became entirely off-the-grid homes with no need for connection to utilities or fossil fuels. Despite Reynolds' cautions that the homes he created were experimental and that an element of trial and error was involved as they were the first of their kind, he was sued by several disillusioned clients. Grievances about leaking roofs and climate control problems manifested themselves as official complaints and lawsuits and the New Mexico State Architects Board was forced to move against Reynolds. In 1990, after one year of disputes with clients, Reynolds voluntarily gave up his New Mexico architect and construction licenses.

In 2007, Reynolds's license was reinstated, and his life and work were celebrated in the *Garbage Warrior* documentary. Although the requirements of licensing restricted the amount of experimentation in new designs, Reynolds started building Earthships again. The packaged Earthship is sold as a kit, which comes with construction plans and details for sustainable living. It can be delivered anywhere in the world and has performed in many different climates. The homes can be very economical or extremely lavish, customized dream homes according to taste. Many have been built near Earthship Biotecture's base in Taos in a place that has become known as the "Greater World Community."

Waste Isolation Pilot Plant

After Germany closed the Morsleben Repository and the Schacht Asse II Salt Mine, the Waste Isolation Pilot Plant (WIPP) in Carlsbad, Eddy County, became the third deep geological repository for 10,000 years disposal of transuranic nuclear weapon waste. The WIPP started operating in 1999 after 25 years of research, public input, and regulation requirements. Operations are expected

to continue until 2070, with active monitoring for another 100 years. By 2010, the WIPP had already received 9,000 shipments of waste.

Transuranic nuclear waste from the Department of Defense accepted at the WIPP must meet strict criteria. Radioactivity must exceed 100 nCi per gram and produce alpha radiation with a half-life greater than 20 years. The waste acceptance criterion includes plutonium, uranium, americium, and neptunium. The WIPP also accepts mixed waste containing both radioactive and hazardous contents—this area is under the joint regulation of the EPA and the NMED. The amount of liquid in containers is limited, as radioactive energy disassociates water into hydrogen and oxygen, creating a potentially explosive environment in the container. Containers must also be vented to prevent the buildup of explosive gases.

Beneath the WIPP, the waste is placed in rooms 655 meters underground that have been excavated in the 1,000-meter-thick Salado and Castile salt formations, which have been tectonically stable for 250 million years. The plasticity of salt means that salt and water will flow into any cracks that appear and seal them. As any excavation or drilling in the area will be hazardous long after the WIPP's active use, the center is part of the Department of Energy's efforts to create a future warning system for radioactive waste. This project involves a group of linguists, scientists, science fiction writers, anthropologists, and futurists working to devise a warning system for the distant future when the area's language may have completely changed. The system envisioned for the WIPP will involve markers called "passive institutional controls," a four-mile outer square perimeter of 32 25-foot-tall granite pillars. Inside these pillars will be an earth embankment 10 meters tall and 30 meters wide within which will be another 16 granite pillars. At the center, directly above the waste site entrance, will be a roofless 15-foot granite room. Engraved on the granite pillars and the walls of the central room will be warning information in the six official languages of the United Nations (English, Spanish, Russian, French, Chinese, and Arabic) and the Navajo language of the region. Additional space is provided for translations in languages that may develop in the future. Pictograms will include stick figures and the iconic face from Edvard Munch's iconic painting *The Scream*. The plant's compete details will be distributed to archives and libraries around the world on closure. The future warning team's final plan is due to be submitted to the U.S. government around 2028.

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See Also: Mineral Waste; Mining Law; Radioactive Waste Disposal.

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New York

With almost 20 million inhabitants and the largest city in the United States, New York State represents a variety of consumption patterns due to its distinct regions. The southeastern tip of the state where New York City is located and spills into Connecticut and New Jersey is the most populous metropolitan area of the United States and was historically a center of trade and manufacture. Other major cities were previously industrial production centers that began to see a period of decline starting in the 1970s. New York State also contains large portions of land that are sparsely populated, as well as considerable amounts of protected open space. New York State faces the challenges associated with maintaining waste collection and disposal for a large urban area as well as finding new uses for post-industrial areas and supporting rural and agricultural communities.

Early History

Starting in the colonial era, New York held an important position due to the strategic position of Manhattan Island, which became a focal point of trade both within the 13 colonies as well as with Great Britain and the rest of Europe. Upstate New York was also an important zone for agriculture, fur trading, and—as the population moved westward—access to the Great Lakes became crucial. Much of the goods consumed came from local farming and fishing because of the high cost of imported products and the lack of manufacturing. The growth of New York City was accelerated after the colonial era because of its excellent natural harbor and vibrant commercial activity in Lower Manhattan. Cities in upstate New York gained geographic importance after the completion of the Erie Canal in 1825. This canal connected the Great Lakes with the Atlantic Ocean in what was the largest public works in the history of the United States at the time. The canal increased the manufacturing potential of cities like Albany and Buffalo and created new investment in industry in many upstate cities, drawing mostly immigrant laborers from New York City.

Economic Growth

As the composition of New York State changed after the Civil War from primarily agricultural production to a mix of farming and industry, consumption patterns also changed. Newly wealthy industrialists began importing goods from Europe and building elaborate homes in New York City, which required extensive amounts of stone and timber. While large homes were built in neighborhoods such as Lower Fifth Avenue, there was also a rush to provide dwellings for the tens of thousands of immigrants who arrived each year and were often housed in densely populated row houses and tenements. New York began to utilize previously underdeveloped spaces for housing, while Manhattan became a hub for trade, light industry, and shipping. The textile industry became particularly important as consumer demand for clothing increased and cheap immigrant labor combined with new sewing technology allowed for quicker and cheaper output. Garment workshops, mostly employing women in crowded and often-dangerous conditions, became prevalent in Lower Manhattan starting in the 1870s. As New York City became the country's premier metropolis and its most important center for trade, upstate New York rose as a powerful industrial corridor. Following the Hudson River and the Erie Canal, factories were built that became centers of U.S. manufacturing, aided by hydroelectric power and high demand in New York City and for export to Europe.

No longer was employment based on nonintensive land uses, and pollution from factories became a serious issue in major cities, particularly in areas of New York City such as the Brooklyn waterfront, where industry often dumped refuse directly into the East River. In New York City, neighborhoods such as the Lower East Side also faced extraordinary difficulties disposing of residential waste because of the high population density, which was by some measures the densest in the world at the turn of the 20th century. As the city expanded high-density housing to the outer boroughs and neighboring states, it also began to export garbage to farther landfills, beginning a trend that reached crisis proportions in the early 21st century and necessitates the shipping of garbage long distances in order to find open landfills.

By the mid-20th century, New York City had become the world's largest population center and Americans began to buy manufactured goods in vastly greater quantities. World War II had further sped up production, and many factories that had been provisioning the Allied armies turned to domestic demand for household goods to keep production high. Levittown, Long Island, became the new model for suburban consumption across the United States, and southeastern New York was a particularly dense and populous example of this new suburban lifestyle. Increased home construction came in tandem with the production of furniture, appliances, and automobiles. As consumption cycles accelerated, the need to dispose of old products, from toasters to automobiles, became a key issue in New York. Land disposal served well for areas with open spaces, but protected natural areas, agriculture, and high-density urban areas proved critical problems in New York.

Waste Disposal

New York State also began to resolve the problem of refuse collection by providing both public and

private collection services for residents and businesses. Depending on the municipality, these services operated under specific contracts that often allowed companies to bid for semi-exclusive rights. In several instances, these practices were found to be corrupt and sometimes connected to larger criminal syndicates. While many private contractors bid to remove conventional and hazardous waste, metropolitan areas still shouldered the majority of the responsibility for disposal. New York City's Sanitation Department (founded in the 1880s) continues to be the world's largest sanitation department and has steadily expanded its responsibilities.

The treatment and disposal of New York City waste has long been a contentious political and economic issue in New York State. Because state authorities regulate much of the industrial and environmental agencies located in New York City, jurisdiction and sometimes financing of urban projects often falls upon the state rather than the city. The need to pay for what are by some seen as downstate urban problems of pollution, waste management, and large-scale transportation initiatives has created conflicts with other areas of the state in which more rural and sparsely populated constituents feel indignant about their share of the tax burden. State environmental management has also been complicated by the borders of the New York City metropolitan area, which include parts of Connecticut and New Jersey and thus require interstate cooperation to deal with problems of environmental degradation, transportation, and commerce. While some of these problems have been addressed through the coordination of state laws and formation of partnerships, such as the Port Authority between New York and New Jersey, matters regarding state authority still remain a challenge for environmental policy.

Deindustrialization

Starting in the 1970s, upstate industrial regions of New York began a slow and steady decline common to most Rust Belt manufacturing areas, in which factory jobs became scarce due to outsourcing and foreign competition. This trend meant less industrial waste to handle in the short term but a long-term problem of abandoned industrial sites that had to be cleaned and managed. Many of these former factories were simply shuttered and awaited new land uses for years. Other industrial areas were extensively cleaned and immediately transferred to new land uses, such as housing developments. The problem of industrial decline in New York State came as New York City increasingly participated in industries such as entertainment and finance, rather than manufacturing. New York City was able to quickly transform some industrial areas to residential and commercial uses, but others on the periphery of the city lay dormant. These "brownfield" areas were usually located in low-income and largely minority areas that suffered other environmental troubles, such as high levels of air and water pollution.

As New York State dealt with deindustrialization and a generally difficult economy in the 1970s, it faced challenges financing adequate waste disposal and treatment facilities. This was particularly true in New York City, where a garbage strike crippled the city in 1968 and streets became corridors of stacked refuse. Often, informal methods of collection had to serve the beleaguered city. Private garbage collection, sometimes through organizations such as business improvement districts, has steadily risen as the state has found it difficult to finance adequate collection. Also, bottle collection, often by the homeless in order to collect recycling rebates, remains a key method in which recycling incentives mix with urban poverty. Finally, as municipalities struggled to meet their waste disposal responsibilities, community groups often organized cleanups of neighborhoods and portions of state highways in order to show civic pride and address the problem of increased litter.

Love Canal

New York State also came into the national spotlight after toxic waste was found buried under the Love Canal neighborhood in Niagara Falls, New York. The scandal and evacuation of the neighborhood that ensued called attention to unprecedented environmental hazards and the inability of public enforcement to protect residents from harm. The incident helped to reshape national environmental laws, as well as those of New York. The federal government was spurred to act in order to create a comprehensive response system to better address

environmental disasters and to tighten regulations in order to ensure more thorough compliance. The result was the Environmental Protection Agency's Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), more commonly known as the Superfund. The act made resources and capital available for large-scale cleanups in order to avoid toxic waste disasters like Love Canal and Times Beach, Michigan. New York State also became one of the few states to create its own superfund in order to encourage toxic waste removal and redevelopment.

Environmental Movements

By the 1980s, key environmental movements in the United States had become rooted in New York City. These included groups opposed to nuclear power, communities organized against development, and increased demand for recycling programs. New York State began to shift from landfills to incineration and treatment. The state also imposed taxes on the disposal of hazardous waste meant to offset the cost of recycling programs. As new technologies became more readily available, New York began programs to limit buried waste in favor of incineration for gathering energy and other more efficient techniques. However, with high consumption—particularly in New York City—it has been difficult to realize any significant decrease in the quantity of waste needing disposal every year.

Another particularly influential environmental movement in New York was the environmental justice movement, which, starting in the 1970s, tied concerns over pollution to issues of race and class. Especially in low-income neighborhoods in the Bronx and Brooklyn, as well as formerly industrial cities like Buffalo, residents started to protest high levels of toxic contamination. Often, grassroots groups contended that their area had not been given adequate resources for cleaning up industrial waste, and high toxicity in groundwater and poor air quality was causing a number of negative health effects, such as higher rates of asthma among children. Mobilized by health concerns and frustration with government inaction, those involved with the environmental justice movement claimed that their neighborhoods were not only already far more contaminated than wealthier areas but were also chosen by government agencies for planned development of undesirable and potentially dangerous uses, such as sewage treatment and trash incineration. Activists argued that, because of economic vulnerability, their neighborhoods were neglected or misused because government and businesses knew they could not muster the resources needed to fight for their neighborhoods in the ways in which wealthier citizens both accessed environmental funds and practiced a Not in My Backyard (NIMBY) approach to potentially toxic land uses.

Conclusion

New York State continues to face some of the greatest challenges in waste disposal and treatment. The attack on the World Trade Center on September 11, 2001, caused not only loss of life and tremendous damage to Manhattan's financial district but also a nearly catastrophic issue of waste disposal that was only solved by filling local hazardous materials sites and shipping debris to other states. The state now faces a growing population, most of which is concentrated in the New York City metropolitan area, as well as limited space for landfills and sizable public opposition to creating more incineration facilities. The safe and environmentally sustainable disposal of waste continues to be an important issue in the country's fourth most populous state.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Environmental Justice; Love Canal; New York City; NIMBY (Not in My Backyard); September 11 Attacks (Aftermath).

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New York City

The most populous city in the United States, New York City is a global center of commerce and trade. With limited land available and public health concerns relating to the dense population, New York City has hosted some of the most elaborate waste management systems in the world, including the world's largest Department of Sanitation and the iconic Fresh Kills Landfill on Staten Island.

Garbage has always shaped New York's physical topography, political dynamics, and daily life. The first edict about solid waste was passed in the 1600s. By the mid-19th century, garbage crises had crippled the city. Reforms initiated near the turn of the 20th century established protocols that were imitated around the world and continue to be part of the city's waste management strategies in the 21st century.

Early History

In 1657, when nearly 800 people lived at the tip of Manhattan Island in the Dutch settlement of Nieuw Amsterdam, trash-related problems were serious enough to require legislative attention for the first time. Residents were prohibited from throwing "any rubbish, filth, oyster shells, dead animals or anything like it" into the streets. Householders had to sweep in front of their homes once a week, load the sweepings into carts, and dump their garbage only in specific locations.

After the town came under British control, the frequency with which similar laws were passed suggests that they were only intermittently enforced or obeyed. Chamber pot contents, offal, and household trash were regularly tossed into the streets. Trash ended up in the East and North rivers because residents dumped it there, but garbage was also used to help create bulkheads and piers, expand the shoreline, and fill marshes. In the 21st century, half of Manhattan below Chambers Street is "made land," and the banks of the East River are a full three blocks from the island's original edge; much of that geography was created with trash.

Early Industry and Disease

At the turn of the 18th century, when New York was home to about 5,000 people, a combination of private and public labor was used for sweeping and garbage collection. Problems with regular garbage—most of which spent time moldering in the alleys and avenues—were exacerbated by growing commercial concerns like breweries, slaughterhouses, and tallow chandlers. Some of these businesses opened next to residential dwellings and freely added their wastes to the streets, while others preferred a small lake called the Fresh Water (or Collect) Pond, just north of the city proper. It had been a source of potable water long before Europeans arrived, but it was becoming a convenient place for "noxious trades" to discharge spent dyes, acids, and entrails.

This situation was a factor in one of the city's first widespread public health disasters. Yellow fever, then known as "pestilential distemper," struck in the summer of 1702, claiming more than one-tenth of the city's population. Throughout the first decades of the 18th century, yellow fever killed many New Yorkers, as did diseases like smallpox, whooping cough, and measles. After a careful citywide survey in 1740, a physician named Cadwallader Colden pointed out that such scourges were most devastating in the dirtiest neighborhoods and argued for cleaning up odiferous swamps, effluent-laced gutters, damp cellars, and sloppy markets. The Common Council agreed. Slips were dredged, markets were moved, nuisance trades were forced away from residential areas, and sanitary codes were mandated. As Colden had predicted, diseases that occurred after these reforms found fewer victims.

Water Management

The city's chronic water shortage kept it dirtier than many other colonial towns. The Tea Water Pump, which drew from springs deep below the Fresh Water Pond, was a reliable source only for those who could pay the steep prices charged by

the family that controlled it. The Common Council embraced an ambitious plan by an engineer named Christopher Colles to pipe water from the bucolic rivers of Westchester, an area north of the city, but his timing was unfortunate. He demonstrated his prototype pumps and a modest reservoir in the spring of 1776.

New York was decimated by British occupation throughout much of the War of Independence, but when it ended in 1783, the city rebounded fast. This was good news for commerce, but an infrastructure inadequate before the war was even more severely stressed afterward. The entwined problems of waste management, street cleanliness, water scarcity, and public health grew more serious. Another yellow fever epidemic swelled the city's graveyards, while even the deep springs that fed the Fresh Water Pond had become too tainted to drink.

In 1799, Aaron Burr formed the Manhattan Water Company to solve the problem. Using Colles's plans from two decades earlier, Burr promised plentiful, clean Westchester water for drinking, fighting fires, and cleaning streets. Once the company was chartered, however, he declared the scheme too expensive and decided to draw from the Fresh Water Pond instead. A few miles of pipe were laid, but the liquid that flowed through them was not potable, and Burr's true intentions were finally clear. The Manhattan Water Company was merely a front for a bank. The scheme was but one example of corruption that surrounded problems of garbage management and public health, a trend that became more pernicious as New York grew.

The "White Wings" gathering garbage under police protection in New York City during the garbage strikes of 1911. Appointed commissioner of street cleaning in 1895, Col. George E. Waring Jr. revolutionized garbage collection and street sweeping in the city.

Rapid Growth

When the Erie Canal opened in 1825, prohibitively slow and expensive trade with the Midwest was suddenly fast, cheap, and easy. The city's economy and its population boomed. A town of 33,000 in 1790 was home to 200,000 by 1830.

The resulting waste crises were badly met. When cholera struck in 1832, wealthy New Yorkers escaped the city, while many of those who were too poor to move became afflicted with the disease. In 1835, there was no way to fight a conflagration in the business district that devastated 50 acres of property and took two weeks to fully extinguish. Water finally flowed into the city from Westchester in 1842, but there was no system in place to carry it back out. Privies leaked into many pipes, and cellars flooded as shallow water tables were overwhelmed. Regulations governing nuisance trades became outdated as the city grew north around these and similarly toxic businesses. Garbage collection, which relied on an uneven arrangement of city workers for some neighborhoods and private cleaners for others—with scavengers working around the edges—was consistently haphazard and ineffectual.

By the end of the Civil War, New York was one of the filthiest, most crowded cities in the world. A group of reformers and physicians spent two years in a meticulous, block-by-block study of living conditions, street cleanliness, and health issues; the resulting publication chronicled horrors in

every ward. Worst of all, in 1866, the mortality rate from preventable diseases was equal to that of medieval London.

Sanitation Efforts

The city had the resources to solve the problem, but by the 1870s, a political organization known as Tammany controlled all city finances, appointments, and elections. Tammany leaders made sure that a significant portion of the street cleaning budget supported various forms of graft. Contracts for garbage collection, street sweeping, ocean dumping, and landfilling went to low-bidding insiders more concerned with getting rich than with doing the work.

It took a massive investigation of the police department in 1894 to finally loosen Tammany's grip. The Lexow Committee collected more than 10,000 pages of testimony and brought indictments against officials at every level of city government. Even people accustomed to New York's extravagant corruption were aghast, but it meant that the call for real reform finally had a chance. That year, a dry-goods merchant named William Strong defeated the Tammany candidate for mayor.

Strong tapped Col. George E. Waring Jr., a Civil War veteran and self-made sanitary engineer, to be commissioner of street cleaning in 1895. The colonel agreed to take the post only if the mayor promised to let him do the job as he saw fit, an unprecedented request in an age when political appointees existed to serve the whims of their bosses.

Waring divided the entire city into districts, then split the districts into sections, and the sections into lines (a line is one side of a street). Garbage collection and street sweeping were organized around regular schedules, and workers responsible for those tasks were held accountable. The labor force was structured as a military hierarchy complete with uniforms, insignia, and ranks. In the winter, snow was shoveled and hauled away immediately. Perhaps most famously, Waring dressed his sweepers in white to help the public recognize their essential role in safeguarding public health. The sweepers were soon nicknamed the "White Wings."

The effect was quick and dramatic. Avenues buried in muck for decades were scrubbed clean, with the dirtiest tenement districts getting the same attention as the wealthiest neighborhoods. Within a few months of taking office, and despite a loud chorus of detractors who said it could never be done, Waring transformed one of the nation's dirtiest cities into one of its most sparkling. Journalists, social commentators, citizens, and visitors marveled at his accomplishment. When he staged a parade down Fifth Avenue for his White Wings, the men passed cheering crowds all along the route.

Waring was the head of street cleaning for only three years, but he set the standard by which New Yorkers judged the competence of their government ever after. Never again could politicians claim, as they had for so long, that the city was too big, too complex, and too crowded to clean. Never again could they argue that there was not enough money. When commissioners who succeeded Waring did a poor job managing New York's solid waste, the public knew it was because of incompetence or malfeasance, not because it was impossible to do well.

Modern Waste Disposal

The Department of Street Cleaning was renamed the Department of Sanitation (DSNY) in 1930. The military structure that Waring established in the late 1800s is still in place in the 21st century. The work of the 21st-century DSNY, the world's oldest and largest uniformed sanitation force, is performed by a small army of 7,216 sanitation workers, officers, and chiefs. Supporting them are the department's 2,065 civilian employees, including clerks, lawyers, analysts, and tradespeople. The DSNY collects, transports, and disposes of 11,000 tons of municipal garbage and 2,000 tons of recyclables every day, using a fleet of 2,000 rear-loading trucks to service a population of 8.4 million, while the city's 6,300 miles of curbs are swept by 450 mechanical brooms. In the winter, collection trucks become plows and are used with salt spreaders and front-end loaders to clear streets and highways of snow.

Curbside recycling was mandated in 1989, and it was expanded over the next decade under a contract with Waste Management. Due to fiscal problems in 2002, the city announced a suspension of glass and plastic pickups. The resulting public outcry caused the city to enter into a new contract with area scrap dealer Hugo Neu, and, in 2004, a new recycling facility opened in Brooklyn. The original categories of paper, metal, glass, and plastics (numbers 1 and

2) were expanded in 2010 to include textiles, rigid plastics, and some household hazardous wastes. The change is part of the city's 20-year Solid Waste Management Plan, approved in 2006, which aims to reduce the residential waste stream, improve waste transportation options by eliminating 6 million truck miles a year and using alternative fuels for DSNY vehicles, strengthen recycling protocols, and take a close measure of commercial waste. Roughly 13,000 tons of commercial and industrial waste are generated throughout the city every day, but it is the purview of private carters, not the DSNY. Because there is no central organization or government agency that monitors the exact quantity and content of commercial waste, it is not as well documented nor as closely tracked as household waste.

Over the years, many of the city's most vexing waste management challenges have been solved, but 21st-century New York City faces a new set of problems. City garbage is no longer heavy with coal ash or ripe with horse carcasses, but residents create a larger volume of it than ever before. The success of the Solid Waste Management Plan depends in part on building new sanitation facilities within the city, but community residents often succeed in stalling them indefinitely. The Department of Sanitation's annual budget is more than $1 billion. Disposal is particularly expensive; because its last landfill closed in 2001, all of the city's waste is exported to the larger metropolitan region and to other parts of the country. The leadership and clarity that George Waring brought to New York's solid waste crisis in the 19th century suggest a model that might be useful for similar 21st-century struggles.

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See Also: Economics of Waste Collection and Disposal, U.S.; Fresh Kills Landfill; New York; September 11 Attacks (Aftermath); Waring, George.

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NIMBY (Not in My Backyard)

NIMBY, or *Not in My Backyard*, is a term that refers to citizen-led opposition to locally unwanted land uses (LULUs). Locally unwanted land uses around which NIMBY politics have become important include landfills, hazardous waste facilities, toxic waste incinerators, radioactive waste disposal sites, petrochemical processing facilities, the use of tailings ponds to hold waste, various kinds of power plants, intensive livestock production operations, offshore oil rigs, sour gas production rigs and pipelines, and other new technological developments.

The term, which entered the lexicon around 1980, originated in local protests against waste dumping. Predating the acronym were organized movements involving Chicago's Hull House against waste dumping in the immigrant-dominated Back of the Yards neighborhood in the early 20th century. Landmark community protests against hazardous waste occurred between 1978 and 1982. Outrage over toxic waste in Love Canal, New York, and Warren County, North Carolina, led community groups to adopt the term in protest, popularizing its use in the emerging environmental justice movement.

NIMBY then became a common term in the 1980s when numerous grassroots groups in the United States and Great Britain increasingly opposed LULUs. *NIMBY* has become a common term in the media to signal an adversarial situation where local people, often those closest to a proposed development, try to prevent a government or

private firm from constructing or expanding a land development near their home.

Definition

NIMBY is currently used to describe those who might oppose other kinds of development, such as wind turbines, desalination plants, power lines, roads, passenger railways, mobile telephone network masts, high-density housing, homeless shelters, and funeral homes, where the motives of the opponents are seen to be more narrow about "backyard" interests in contrast to those LULUs mentioned above. NIMBY can therefore be used to describe parties opposed to a development to maintain their privileged position, where people consider others as undesirable neighbors (e.g., low-income or homeless residents) and view them as threats to the race, class, or lifestyle norms of their neighborhood or the expected aesthetics of their neighborhood. For example, the construction of unsightly or unattractive human structures (e.g., wind turbines, cell towers, or billboards) may threaten the perceived status quo and character of residents in a neighborhood and elicit resistance.

The origins of the term *NIMBY* can be traced to various incidences where wastes were left or are proposed to be disposed of in a place where people have little to gain from their presence but a great deal to lose. In the early Warren County case, a waste-hauling company tried to avoid paying the costs of legally disposing polychlorinated biphenyls (PCBs) under the then-new U.S. Toxic Substance Control Act (TSCA) by illegally dumping them on state roadsides in rural North Carolina and remote sections of the Fort Bragg Military Reservation. In response to the discovered contamination, the state of North Carolina proposed to construct a landfill in Warren County to provide an affordable, "safe" alternative for the state's waste producers. State officials were able to buy land from an economically strapped rural landowner in Afton in Warren County, NC. In Warren County, a local group tried to stop the proposed landfill, expressing concerns about the PCBs it would contain—toxic chemicals that had been linked to seabird and fish declines and mutagenic effects in living organisms. Their concerns were about possible contamination of their groundwater and diminished opportunities for new business development given the expected stigma of a community housing a hazardous waste facility.

After three years of legal battles, their resistance was unsuccessful. In 1982, as the state began the construction of the landfill, Warren Country residents mounted a disruptive collective action at the landfill site and shifted their rationale for the fight to the unfair selection of the site on the basis of targeting a predominantly African American and poor county. Their fight against racial injustice resonated with various civil rights leaders and poor people of color across the United States. While they were unsuccessful in the short term, in 2003, 10 years after the environmental justice movement led by the community, North Carolina began a process to destroy the PCBs in the landfill. The state government also stopped any shipment of contaminated materials to another county.

Love Canal

In the Love Canal case, citizen opposition centered around 21,000 tons of toxic waste, including dioxin waste, that had been buried in an abandoned yet clay-lined canal between 1940 and 1953 by Hooker Chemical Company. In the late 1950s, under pressure to find land to build a school, the Niagara Falls city school district built a school on the site and later sold off the adjacent land to a housing development company that built homes on the site. These developments punctured the clay liner put in place by Hooker Chemical Company to keep the toxic waste in the canal bed, and the toxic chemicals migrated through groundwater to seep into soil in the school playground and into the basements and yards of the nearby city residents. In 1976, after a reporter published a local newspaper article about the presence of toxic waste in sump pumps in the area, a subsequent reporter-led informal door-to-door survey revealed that the Love Canal neighborhood was characterized by abnormally high levels of birth defects, anomalies such as enlarged feet, heads, hands, and legs, and other health problems. This informal survey was followed by a New York State Health Department study that found an abnormal incidence of miscarriages. The area was declared a federal health emergency in 1978 by President Jimmy Carter. During that same year, Lois Gibbs, a local mother who called an election to head the

Love Canal Homeowners' Association, began to further rally homeowners around the cleanup of the site and restored safety to the citizens. Eventually, the government relocated more than 800 families and reimbursed them for their homes, and the U.S. Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or the Superfund Act, that holds polluters accountable for their damages.

Opposition

Despite the serious negative consequences of the landfills and buried toxic waste issues in the cases above, the term *NIMBY* has often been used to cast opponents to LULUs as ignorant, irrational, and selfish. Many of the criticisms of NIMBY opposition suggest that citizens are parochial, and thereby less informed and/or broad minded about a safely designed, perhaps "state of the art" development that could provide collective benefit (such as access to greater and cheaper energy production, less costly waste disposal, or an economic boon to the community), and instead seek to push the development to anywhere other than the area in which they live. NIMBY can be used by development proponents, for example, as a summative rhetorical frame that discredits people who refuse to be complicit to a proposed development, despite the property rights that the proponents hold or the regulatory rules with which they agree to comply.

Counterclaims from NIMBY protesters often include exposing the lack of rigorous science and regulatory clarity to address potential environmental and health risks of a development and, moreover, the narrow interests of project proponents and their use of influence through social position. In their NIMBY responses, citizens are generally arguing for greater local autonomy over the development in their town or region, which prompts them to find indeterminacy in various laws as written and interpreted. In NIMBY politics, citizens often question the biases of decisions that appear to favor economic growth at any cost as unfairly led by powerful collaborations between government and industry and as supported by the nature of the developments' incalculable risks. Citizens against the development might also point to noxious smells, the likely increase of transport accidents, risks of increased flooding, potential community disruption from the presence of hired laborers, and overburden to existing inadequate infrastructure. Thus, the argument many grassroots groups have made is that no community should have to absorb multiple risks in exchange for the benefits that, aside from a few more local jobs, generally flow to outsiders.

Global Approach

For these reasons and others, the opposition to NIMBYs has abated in the last two decades, given the North American popular cultural rhetoric to "think globally, act locally," which can justify protecting one's community in the face of various increasingly publicized technological and pollution risks. This same global citizen approach calls for greater transparency and authentic democratic decision-making processes in the approval of such local developments. Under this counter-rhetoric of protecting the home place—home community—from unwanted negative impacts, NIMBY criticisms are less valid. In fact, NIMBY politics have become a formidable obstacle to hazardous waste siting across North America and petrochemical processing facilities around the world. NIMBY politics are currently a common feature of community planning in North America.

NIMBY politics have led to a much richer democratic debate about fairness, in particular, the various ways in which industrial processes disproportionately disadvantage residents who by virtue of race, income, or historical oppression continue to face greater environmental "bads," such as pollution, risk of being victimized by a technological accident, and risk of harm in waste-related work settings. More importantly, several scholars have emphasized the outgrowth of environmental justice frames from NIMBY politics, where groups move from opposing a site-based risky development to examining distributive justice, or the spatial advantages and disadvantages of various economic development activities that channel development and associated opportunities and risks in their region of residence to certain people. For example, in the Warren County case, citizens linked the siting issue to issues of racial equity and differential government investment in poor, black communities compared to white communities.

Similarly, NIMBY politics have led to a greater awareness of and demand for procedural justice, or the "distribution of power and influence among stakeholders in the facility siting process," where differential access to information, agenda setting, decision-making processes, and negotiated settlements are recognized by citizens to influence environmental burden outcomes. Greater attention to the fairness of procedure has led to early public involvement in LULU siting considerations, more community opportunities for information gathering outside than provided by the project proponent, greater demands for the use of layperson language in the description of projects and scientific studies associated with the risks, greater inclusion of those who have standing as directly affected by siting decisions, and continuous back-and-forth dialogue as siting deliberations are under way.

Opposition groups have also increased their power by showing disagreement among the proponents' experts and, moreover, hiring their own experts and calling on citizen scientists and scientists who are local citizens to report on documented risk-related studies, including studies that show that LULUs may result in lowered property values and stigmatize regions as undesirable places for diverse economic investment. Citizens are also more vigilant about the composition and structure of boards and other decision-making bodies for the siting of LULUs and the role (advisory or with binding decision-making authority) local bodies have to truly influence the final siting decisions. Thus, NIMBY politics have also led to a greater citizen demand for procedural equity in siting decisions.

Not in Anyone's Backyard

More recently, NIMBY politics have been followed by NIABY responses, or community pleas for "Not in Anyone's Backyard." NIABY responses explain that the reason for opposition is not only to protect one's interests but also to protect intergenerational human welfare and long-term ecological health. Developments that are viewed as unjustifiably risky are often questioned by citizens who are linking hazards with higher-level decisions around production and the ways in which the larger political and economic system supports risky technologies. NIABY responses prompt citizens to ask bigger-picture questions, such as: Is this facility really needed? What is the risk associated with the facility size, location, and type? Was the issue of fairness weighed into this proposal in regard to where the waste is produced and by whom, and who lives with the risk of the waste (spatial equity), especially over time?

Increasingly, citizen groups who started out with a NIMBY frame, but moved to a NIABY frame, have called for greater research and development in technologies that minimize risks by attending to the beginning of the life cycle of hazardous waste. Similarly, NIMBY responses have led to a greater public discussion around creating less waste and pollution so that there is less pressure to find ways to process and dispose of such waste. In other words, NIMBY politics have forced greater attention to the pitfalls of end-of-pipe solutions, also criticized in other movements such as the anti-toxics movement, that fail to control or regulate the generation of waste at the point of production. Therefore, NIMBY politics have also led to greater discussions of the necessity to address industrial ecology, or the ways in which industrial processes can be altered to minimize risk to living systems. What might start with a NIMBY response has increasingly led to greater demands for fairness that "entails full democratic participation not only in decisions affecting distributive outcomes but also, and more importantly, in the gamut of prior decisions affecting the production of costs and benefits to be considered."

Not in My Body

Another acronym that has followed from NIMBY is NIMB—Not in My Body—which refers to the refusal to allow certain chemicals or substances into someone's body, such as genetically modified food or artificial sweeteners. The recent growing health movement, alongside the anti-toxic and environmental justice movements of the 1980s, have led to greater skepticism and scrutiny in more-developed countries about the current costs of production and the limited societal commitment to reduce waste at the source.

Finally, the NIMBY response has allowed citizens to work together across sites to better identify and articulate their risks, develop opposition strategies, interpret laws, advance their expectations for emergency response and potential compensation, call

for the enforcement of various environmental laws, and, in essence, challenge the balance of power in both siting and production decisions.

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See Also: Clean Air Act; Clean Water Act; Environmental Justice; Environmentalism; Love Canal.

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Noise

In relation to environmental pollution, noise is normally associated with annoying sound waves in communities, but noise is also a threat to public health. As asserted by Dr. William H. Stewart, former U.S. Surgeon General, "Calling noise a nuisance is like calling smog an inconvenience. Noise must be considered a hazard to the health of people everywhere."

Environmental noise is any combination of sounds that disturbs desired actions and the health of individuals or groups in a particular geography. There is an inherently subjective emphasis in the definition, since uniqueness of the perceptual experience makes noise differently perceived by each person. To make things more complicated, the invisibility of sound waves and the cumulative nature of their effects make noise a slippery pollution issue for regulators, industry, environmental groups, and the general public. Community noise (also called environmental noise, residential noise, or domestic noise) is defined as noise emitted from all sources except noise at the industrial workplace. Main sources of community noise include road, rail, and air traffic; industries; construction and public works; and the neighborhood. The main indoor noise sources are ventilation systems, office machines, home appliances, and neighbors.

Noise Pollution

For researchers like Arline L. Bronzaft, from the Council on the Environment of New York City, noise is arguably the most widespread and least controlled environmental pollutant. Noise from vehicular, rail, and air traffic; city construction sites; household appliances; and an increasing number of mobile noise-polluting devices contributes to high levels of air pollution in most cities.

Noise became consubstantial to economic development during the Industrial Revolution. High noise levels are directly related to the construction of new roads and the consequent increase in the amount of motorized traffic in cities and suburbs. It is also an indicator of environmental injustice. Its chronic effects are unevenly spatially distributed, affecting minority populations and low-income populations in particular. For some, noise has been intentionally relegated to the background in the agenda of environmental problems. For Garret Keizer, author of the 2010 book about the politics and history of noise, *The Unwanted Sound of Everything We Want*, noise is a weak issue because most

of those it affects are perceived—and very often dismissed—as weak. Those who dismiss them, in addition to being powerful, are often the ones making the noise. But it is also true that acute effects of noise cover wider segments of the whole population. For example, a study conducted in Switzerland by V. Mercier and colleagues, and reported in the journal *Noise and Health* in 2003, showed that the individual sound exposure during a typical concert was on average 95 dB(A), although 8 percent of the participants were exposed to sound levels higher than 100 dB(A). Only 5 percent of the audience wore ear plugs throughout the concert, while 34 percent used them occasionally. Some 36 percent of the people interviewed after the concert reported that they had experienced tinnitus after listening to loud music.

Effects

The effects of noise on communities' health have been asserted by several experts and expressed in specific regulations, but those effects are difficult to measure in a reliable, replicable way. For example, the Law of the People's Republic of China on the Prevention and Control of Environmental Noise Pollution defines "Environmental noise" as the sound produced in industrial production, construction, traffic and transportation, and social life so as to "disturb" the living environment in the neighborhood. That definition lacks precision in terms of what is considered "disturbing," and therefore its practical validity is severely limited.

According to the World Health Organization, there is a mix of physical and psychosocial effects considered in terms of community noise, including interference with communication, noise-induced hearing loss, sleep disturbance effects, cardiovascular and psychophysiological effects, performance reduction effects, annoyance responses; and varied effects on social behavior.

The cumulative effects of noise are particularly harmful, although direct effects of high levels of acoustic pollution on hearing loss have been barely demonstrated. In the 21st century, it is widely accepted that hearing loss can be considered a multicausal phenomenon involving dissimilar sources like noise exposure, stress, diet, and genetic components. Nonetheless, noise has been associated with several adverse effects such as disturbed communication, disrupted sleep, impaired cardiovascular function, interference with teaching and learning, reduction in productivity, damaged interpersonal relationships, unwanted violent behaviors, and increased rate of work-related accidents. Studies on the association between community noise and cardiovascular risk have shown an increase in risk with increasing noise levels above 60 dB(A).

Regulation

Attempts at federal regulation on noise levels in the United States led to the authorization of the Noise Control Act of 1972, but it was dismissed after a decade of controversy. The Environmental Protection Agency (EPA) did not have any regulatory authority governing noise in local communities as of 2010. Federal regulation exists, but it is spread into several offices' procedures. Many states run noise pollution programs, but enforcement comes from local governmental authorities with limited budgets.

The problem of noise has been constantly recognized at the highest level in the United States. In President Barack Obama's speech to the joint houses of Congress in February 2009, he noted that "I think about Ty'Sheoma Bethea, the young girl from that school I visited in Dillon, South Carolina—a place where the ceilings leak, the paint peels off the walls, and they have to stop teaching six times a day because the train barrels pass their classroom." Federal law has long required train operators to sound their horn at all crossings passing through developed areas, but these laws are being relaxed in places where communities have established official quiet zones through safety improvements. In June 2010, the San Diego City Council approved what at the time was among the nation's largest quiet zones, entailing $20.9 million in spending to improve downtown railroad crossings and prevent freight trains from blaring their horns at all hours. Hopes are still high for Ty'Sheoma.

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See Also: Noise Control Act of 1972; Population Growth; Public Health.

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Noise Control Act of 1972

Regulation of pollution in the United States hit its highest achievement at the end of the 1960s with the establishment of the Environmental Protection Agency (EPA). One of the major tasks faced by the recently created EPA was working on the abatement of aviation noise, a serious public issue in the 1960s due to the introduction of jet turbofan engines in commercial aviation.

Policy and Regulation

Although most states had their own noise control regulations, the U.S. Congress considered it necessary to regulate the pollution coming from national sources like aviation, interstate transportation, and railroads. For Congress, it was clear at that time that (1) inadequately controlled noise was a growing danger to the health and welfare of the population, particularly in urban areas; (2) the major sources of noise were transportation vehicles and equipment, machinery, appliances, and other products in commerce; and (3) while primary responsibility for control of noise rested with state and local governments, federal action was essential to deal with major noise sources in commerce, control of which required national uniformity of treatment. In 1972, Congress declared, "it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare." To that end, it created the new Chapter 42 of the U.S. Code. The new legislation, which was signed by President Richard Nixon on October 28 of that year, gave the EPA the primary role for controlling environmental noise. It is the purpose of the act "to establish a means for effective coordination of Federal research and activities in noise control, to authorize the establishment of Federal noise emission standards for products distributed in commerce, and to provide information to the public respecting the noise emission and noise reduction characteristics of such products."

The act established three major fronts of action for the EPA against noise pollution: (1) providing the means for the coordination of federal research and activities in noise control, (2) the establishment of federal noise emissions standards for products distributed in commerce, and (3) providing information to the public respecting the noise emission and noise reduction characteristics of such products.

The new act gave the EPA complete control over noise issues at the national level. Under the new authority, the EPA had the responsibility for coordinating all federal programs in noise research and control. Each department, agency, or instrumentality of the executive, legislative, and judicial branches of the federal government having jurisdiction over any property or facility or engaged in any activity resulting, or which may result in, the emission of noise was required to comply with federal, state, interstate, and local requirements respecting control and abatement of environmental noise. The EPA had to be consulted by other federal agencies prior to publishing new regulations on noise.

Upon request from the EPA, each federal agency had to furnish information regarding the nature, scope, and results of the noise research and noise-control programs of that agency and had to consult with the EPA in prescribing standards or regulations respecting noise. Certified low-noise-emission products had to be acquired for use by the federal government in lieu of other products if the administrator of general services determined that reasonably priced, reliable substitutes existed. If the agency considered that any proposed new or existing federal regulations did not adequately protect the public health and welfare, it could call for public review of them. Citizen suits were also authorized, whereby any person may commence civil action against the United States or any governmental instrumentality or agency alleged to be in violation of any noise control requirement.

One critical point enabled by the act was that the EPA also had the authority to set standards for any product or class of products that had been identified as a major source of noise. Categories of equipment covered by the legislation included construction, transportation (including recreational vehicles), motors or engines, and electrical and electronic devices. Another critical issue was the mission assigned to the EPA of overseeing the Federal Aviation Administration (FAA). Although the FAA retained authority to set aircraft noise regulations, the EPA was required to recommend to the FAA any regulations it considered necessary.

Regulatory Actions

During the 1970s, the EPA initiated a series of actions under the Noise Control Act of 1972. Some of those actions were controversial—in particular, those related to aviation noise control, which at the time caused pollution problems for 6–7 million Americans, according to the FAA. Official records from the EPA estimated that 6 million Americans were subjected to "a wide range of aircraft noise." According to the EPA, such noise interfered with the normal use of homes and yards and posed a particularly serious problem for such institutions as schools and hospitals. One of the first responsibilities set by the act of 1972 was to start a working group (under the EPA's responsibility) including the Department of Commerce (the National Bureau of Standards), the Department of Defense, the Department of Transportation, and the Department of Housing and Urban Development to conduct a major study of existing airport flight and operational control regulations. The study concentrated on five major areas: existing legislation and institutions; source abatement technology and costs; methods of characterizing the problem; present and proposed FAA regulations; and airport operations, including monitoring, enforcement, safety, and costs. Recommendations included retrofitting of dated engines and substitution with new equipment. This cost operators hundreds of millions of dollars.

In 1981, the Ronald Reagan administration argued that noise issues had to be handled at the state or local government level. As a result of that decision, the EPA phased out the Office of Noise Abatement and Control (ONAC) funding in 1982 as part of a shift in federal noise control policy. However, the Noise Control Act of 1972 and the Quiet Communities Act of 1978 were not canceled by Congress and remain in effect in the 21st century, although essentially unfunded.

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See Also: Noise; Population Growth; Public Health.

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North Carolina

North Carolina is a fast-growing state in the U.S. South. The 2010 U.S. census enumerated 9,565,781 people living in the state's 53,819 square miles. The state hosts wealth, including the university and technology center Research Triangle (Raleigh, Durham, and Chapel Hill) and banking center Charlotte. It also is home to pockets of extreme poverty, and the economic disparities have manifested as environmental inequalities.

Waste in North Carolina influences citizens' sense of justice, their economy, and pride in statehood. Since the early 1960s, North Carolina has prided itself on being a place welcoming to retirees and others interested in a clean and waste-free environment. One tourism jingle touted North Carolina as a place of "Scenic highways, coast to mountains, it's great to be right here in North Carolina." Tourists and potential homesteaders flocked to the beautiful and clean beaches and retirement sites in North Carolina as well as to the booming scientific industry of the Research Triangle Park near the capital

of Raleigh. Historically known as an agrarian state where tobacco, pine trees, and farming (especially hog farming) ruled, North Carolina was one of the most beautiful states in which to live.

Waste Disposal

In the 1970s, blighting of this state occurred in the form of toxic waste dumping along the highways of Warren County. This illegal positing of waste on the highways of the state led to jail time for the perpetrators Robert J. Burns and Robert Earl Ward of Raleigh-based Ward Transfer Company and growing concern over the locations of landfills and poisonous waste as a matter of economic justice for African Americans and poor people in the state. Governor James B. Hunt settled the waste dilemma by directing the toxic waste dump site to Afton in Warren County, North Carolina. With waste landfill siting in Rowan County, the Not in My Backyard (NIMBY) movement began to take hold, and the location of waste dumps and waste management became such a large concern that the National Waste Management site came to Raleigh's North Carolina State University in 2003.

Highway cleanups and legislation to prevent littering came about to maintain the image of the state as a visitor-friendly and clean place to live. In the 21st century, many communities have mandatory recycling and waste regulations to cut down on unsightly and unhealthy waste. On a given day, one might see dark green or brown 30-gallon garbage pails on wheels at curbside next to an environmentally green tub for plastics and another for paper. The recycling movement has been instrumental in lessening some of the massive amounts of waste at local landfills. These landfills are a matter of concern in the development of cities and the capital city as well because property values depreciate based on proximity to odorous and unsightly garbage dumps. These waste dumps and wetlands still pose problems to the environment and to the economy of the state.

Legislation

From 2006 to 2007, environmentalists, waste management lobbyists, and state politicians waged a battle over the fate of incoming waste fill sites for North Carolina counties. Many opponents felt that the importation of waste from other states as far north as New York would doom North Carolina to become the "garbage capital" of the United States. Although the immediate advantages to the impoverished rural counties targeted included jobs and a boost to the economy, the forward ingress of out-of-state garbage was halted with the help of the Teamsters Union, which represented over 271 sanitation and garbage workers in the state. In 2007, the state House and Senate voted to approve a 17-month moratorium on intake of garbage so that the environmental, economic, and social impact of the move could be studied. North Carolina was targeted because of its flat, rural terrain, and interstate commerce laws prevented states from totally banning other states from importing garbage. The legislation allowed North Carolina to place a surcharge on intake of interstate

Paper milling and logging have been critical to North Carolina's economy but have had a negative impact on the environment. For example, temperature fluctuations caused by water discharges into rivers from the paper mills can cause severe fish kills.

garbage, as other states had already been doing, and waste managers were required to clean up filled sites before abandoning them. Allowances were also made for lining landfills so that drinking water and sources would not be polluted in the process. On the downside, the state had to pay waste managers who were already in the process of transferring garbage into the state when the moratorium came about.

Industrial Waste

While paper milling and logging industries have been critical to the economy of the state, their waste products have likewise been challenged for their negative impact on the environment and beauty of the state. As tobacco farming has declined because of the harm to consumers' health of tobacco products, many farmers have turned to food-based farming and hog farming—major industries in the state. Unsightly and odiferous wastes make hog farms not only eyesores, but also cause them to detract from the image of the beautiful, environmentally clean farming state. Since the 1990s, increased attention has been given to hog farming waste in regard to air pollution, water pollution, and declining property values of homes within the vicinity of the hog farms. The Waste Management Center has studied the economic impact of hog farming waste management on the state and found that waste not only adversely affects the beauty of the state but also its economy.

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See Also: Environmental Justice; Farms; NIMBY (Not in My Backyard); South Carolina; Toxic Wastes.

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North Dakota

An outsider will typically give one of two similar responses when the state of North Dakota comes up in conversation: either "Where is that?" or the slightly less desirable "Oh, North Dakota—isn't that out in the middle of nowhere?" It seems North Dakota is both somehow there and nowhere.

At least this was the predicament in which Steve Buscemi's character found himself in the 1996 film *Fargo*. Frantically looking to hide an item among the frost-bitten snowscape, Buscemi finally picks one of hundreds of fence posts running infinitely in a straight, taut line. He buries the item and looks both ways. It quickly becomes apparent that nothing about the spot he picked sets it apart from any other. Every fence post is the same. He has chosen a place that is just like every place. He is at the same time there, everywhere, and, in effect, nowhere identifiable. In fact, this dark but clever film is probably the most popular device used to explain roughly where and what North Dakota is. And while the idiosyncrasies of the charmingly naive locals in the story are not without their stereotypes, the directing duo of the Coen brothers was still tactful and poignant, probably because of personal experiences (they are from neighboring Minnesota). It is true that when driving down the wintry highways of North Dakota, one can experience a flash of the sublime; the straight gray path stretches to a horizon that is no longer discernable among the fuzzy meeting of clouded sky and flat snow-covered Earth. Everything is soft white, and nothing is recognizable.

Energy

Because most of North Dakota is unimpeded by dense forests or mountainous terrain, its surface is relatively flat and open. While on the one hand, this opens itself to what visitors take pleasure in calling a "big sky," on the other, it ushers in undisturbed arctic winds and the blizzards with which locals are so familiar. But the state is trying to utilize its open landscape to generate energy. Wind farms are popping up sporadically but more frequently in the 21st century as North Dakota is recognized as best in the nation for wind-collecting energy potential. However, its brutal winter weather places the state fourth

in the nation for total energy consumption, mostly because of heating expenses. North Dakota produces as much as it consumes, however. The small town of Beulah, for example, is home to the largest synthetic gas plant in the nation. Coal is abundant in the central part of the state, dividing the fertile soil of the flat lands to the east from the rolling prairies and Badlands in the west, which have seen a surprisingly successful oil boom in the 21st century.

Agriculture

Approximately 90 percent of North Dakota's land (39.7 million acres) is dedicated to agriculture. The only reason that percentage is not higher is the presence of the beautiful but virtually unfarmable Badlands in the west. The stunning cavernous lowlands—a virtually inhospitable place for humans—calm abruptly into rolling hills met by the Missouri River, which bisects the state flowing from Lake Sakakawea through the Garrison Dam south toward South Dakota. Small lakes, ponds, and potholes cover the central stretch, eventually flattening out into the Red River Valley that defines the entire eastern third of the state. North Dakota's wheat production makes up 16.5 percent of the national production, and its barley is a staggering 35.7 percent of the national production.

Population Density and Travel

The state's high agricultural yield is all the more impressive in relation to its incredibly small and sparse population. Even though North Dakota consists of 2 percent of the United States' total land area, its population claims a mere 0.2 percent of the national total. Bordering Minnesota to the east, Fargo is the largest city at over 100,000 people, making up nearly one-sixth of the state's total of 672,591 residents in 2010. Bismarck, the capital and second-largest city, is 200 miles directly west; the disparate placement of the two is representative of the constellation of cities and towns overall. The United States is populated by about 80 people per square mile, compared to less than 10 per square mile in North Dakota. When the state's large (but dwindling) rural population needs to buy domestic goods, it goes to the cities.

About once a month, depending on family circumstances, the typical rural North Dakotan household bundles up and hops into a warm car (preheated by being started roughly 15 minutes in advance). The trip to town might take anywhere from a half hour to two hours. Domestic goods are cheap and available in large quantities. The culture of buying in bulk from the larger commercial chains in the cities has dissolved any sense of small-town economic solidarity. Anything from coffee to whiskey can be purchased by the case. Ironically, the only small towns that seem to thrive are the ones with a bar, and even their income is heavily dependent on outsiders—usually hunters. It might not be surprising, then, that a state with so few people per square mile is having difficulty maintaining its roads; when commerce is far and few between, most working hours are spent driving. With diminished state and federal support, the counties have been forced to opt for cheaper materials than the more expensive asphalt. Instead, the overdriven surfaces are mulched and mixed with gravel, once again resembling the old trails of pre-interstate America.

But the aggregate pebbles thrown into the air crack the windshields of many automobiles. The "booze cruise," while always popular, has become a larger problem in North Dakota. Careening down county roads with some friends and a case of beer is seen as a more desirable evening than sitting at home. In this way, being in the middle of nowhere comes in handy for underage drinkers. In 2000, North Dakota ranked first in the nation for teenage binge drinking. The cost for such behavior (the "booze cruise" is only one manifestation of the drinking culture) goes beyond the obvious health and welfare put at risk. Every injured survivor of an alcohol-related crash in North Dakota costs an average of $67,000, over $20,000 more than the median household income. Asphalt or gravel roads, for work or play, driving is a fixed practice in North Dakota.

Mining

Government attention to North Dakota in the 20th century was in large part due to its mineral deposits, including uranium found throughout the southwestern portion of the state and mined extensively in the 1950s and 1960s. Management of these now-inactive mines is done by the state's Public Service Commission's Abandoned Mine Lands Division. The state's Department of Health has a Radiation

Control Program to regulate radioactive material, including mining waste, coal ash, and slag. While the uranium mines have closed, the consequences of this activity continue to affect waste policies in the state.

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See Also: Alcohol Consumption Surveys; Automobiles; Farms; Uranium.

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Nuclear Reactors

A nuclear reactor is the core component of a nuclear power system. Just as a conventional power plant uses the thermal energy from burned fossil fuels to generate electricity, nuclear power uses a nuclear reactor to convert the energy released from an atom's nucleus. Nuclear reactors in the 21st century do this through nuclear fission; experimental work on nuclear fusion reactors has been conducted since the early atomic age in the 1950s. The environmental desirability of nuclear power has always been subject to debate. While they produce little to none of the same kind of pollution as fossil fuel power plants and do not consume finite resources, they generate dangerous radioactive nuclear waste. On the other hand, the total amount of waste produced by a nuclear plant is significantly less than that of many conventional power plants. Nuclear plants have, however, received more public attention regarding pollution and present a more vividly imagined danger. Public opinion particularly turned against nuclear power in the 1980s in the wake of high-profile nuclear plant accidents like Chernobyl (Ukraine, 1986), Three Mile Island (Pennsylvania, 1979), and Fukushima (Japan, 2011).

Early History

The first nuclear reactor was constructed by Enrico Fermi's team at the University of Chicago in 1942. Chicago Pile-1, as it was called, achieved a sustained nuclear chain reaction—a point called "criticality" or "critical mass," referring to the smallest amount of fissile material required for such a reaction—on December 2, 1942. Reactors built for the Manhattan Project followed in order to produce plutonium for use in nuclear weapons. In the years after the war, nuclear reactor technology was shared by the military with the scientific community. U.S. President Dwight D. Eisenhower's 1953 speech "Atoms for Peace" emphasized the benefits of using nuclear technology for peaceful ends—as a power source—rather than focusing scientific endeavor purely on developing nuclear weaponry.

Nuclear Fission

Nuclear reactors depend on fissile materials as fuel. Fissile materials are those that can sustain a chain reaction of nuclear fission; fissionable materials are those that can undergo nuclear fission. All that is fissile is fissionable, but much of what is fissionable is not fissile. Fissile materials include uranium-233, uranium-235, plutonium-239, and plutonium-241. When used in documents dealing primarily with nuclear arms, such as treaty proposals, "fissile" confusingly means something slightly different: materials that can be used in a nuclear weapon to sustain a fast-fission chain reaction, which does not include all fissile materials used as fuel. The atomic nucleus of such a fissile material splits into two or

more nuclei when it absorbs a neutron, producing fission products consisting of gamma radiation, kinetic energy, and free neutrons. Some of the neutrons released are then absorbed by other fissile atoms, which split and release more fission products, including free neutrons: a nuclear chain reaction. This chain reaction is controlled through the use of neutron moderators (usually water, but sometimes graphite), which reduce the velocity of fast neutrons and make them more likely to be absorbed, and by control rods composed of neutron poisons (also called "neutron absorbers"), which absorb the excess neutrons left over.

The energy fission products produce heat, which is used to generate electricity. Typically, a coolant (usually water, but molten salt, liquid metal, and gas are alternatives used in some reactors) carries the heat away from the reactor where it produces steam that drives a turbine.

Types of Reactors

All commercial nuclear reactors are fission reactors, but there are multiple kinds of fission reactors. They may be either thermal reactors or fast neutron reactors. Thermal reactors, the more common type, use neutron moderators to slow neutrons considerably to the level at which they are called "thermal neutrons" because their kinetic energy is similar to the kinetic energy of the particles in their surrounding environment. This makes them more likely to fission uranium-235, plutonium-239, and plutonium-241 and makes it possible to use low-enriched uranium or natural uranium as reactor fuel. Frequently, the water used as the neutron moderator is also the coolant.

Fast-neutron reactors, on the other hand, use fast neutrons and require a more highly enriched fissile fuel. More complicated in construction and more expensive to operate, fast-neutron reactors also produce less transuranic waste material. The overall radio-toxicity of fast-neutron reactors is considerably lower than thermal reactors, and the lifetime of the nuclear waste produced is a few hundred years—some of the transuranic isotope waste produced by thermal reactors can last for tens of thousands of years. The even-numbered transuranic elements produced as waste material in the operation of thermal reactors can actually be used as fuel by fast-neutron reactors. The drawbacks are the expense and the care that must be used in design and construction. Fast-neutron reactors do not use moderators, and control rods work too slowly to stabilize them, so they must be designed so that the need for adjustments is minimal. Liquid metal is typically used as the coolant, which is more expensive than the water used by thermal reactors. When molten salt is used, it carries the risk of causing operational difficulties because of its corrosive properties. As of 2010, there were a small number of fast-neutron reactors in operation in France, Russia, Japan, India, and China. No such reactor has been in use in the United States since the partial deactivation of the sodium-cooled Fast Flux Test Facility, which operated from 1982 to 1992 at Hanford, Washington. The decommissioning of Fast Flux has been subject to numerous legal wrangles and course corrections, having been ordered at one point to be maintained in standby condition. Decommissioning has stopped and started several times while the courts and the Department of Energy sort out the future course for the reactor. The reactor is notable for having established a world record for fuel performance, while producing extremely high-quality radioisotope samples for use in medicine, demonstrating the commercial viability of many of its experimental components, and keeping the radiation exposure of its operators to levels approximately 1 percent of those at commercial thermal reactors. Further, Fast Flux demonstrated that the radioactive technetium-99, an element of nuclear waste, can be transmuted into a nonradioactive element as part of reactor operations.

Waste Disposal and Safety

Spent fuel from nuclear reactors is stored underwater at the reactor site in spent fuel pools (SFPs) at least 40 feet deep. The water cools the fuel and acts as radiation shielding. The bottom 14 feet are used for the fuel storage; the rest of the volume of water is used as shielding and allows the stored fuel assemblies to be moved and manipulated without operators, needing additional shielding. Every 12–18 months, a portion of the total fuel load of the reactor—usually about one-quarter of it—is removed and replaced with fresh fuel. Spent fuel rods continue to generate intense heat and radiation and are usually moved from the reactor to the

pool by automated systems. Metal racks hold fuel rods in safe positions to avoid a chain reaction from occurring in storage, and water quality is strictly overseen and maintained in order to prevent fuel degradation. Periodically, the spent rods are rearranged in order to maximize the storage capacity of the SFP. The fuel rods experience their most significant drop in temperature between their second and fourth year, and another smaller drop in the two years after that. The water of the SFPs must be continuously cooled in order to shunt the heat away, and the air is always monitored and treated because of the danger of radiolysis (the production of hydrogen gas due to radiation splitting water molecules). Failure to sufficiently cool reactors may result in damage to the core in a partial or complete meltdown that releases radioactive material into the environment. Public concern about potential meltdowns grew after a partial meltdown at the Three Mile Island, Pennsylvania, facility in 1979. Seven years later, a meltdown at the Chernobyl plant in the Soviet Union forced the creation of an uninhabited exclusion zone around the reactor. More recently, in 2011, an earthquake and tsunami triggered the meltdown of three reactors in a plant in Fukushima, Japan. This disaster released cesium hundreds of kilometers into the Pacific Ocean.

Other safety systems in place at reactor sites include radiation shielding, primary and secondary containment systems, emergency core-cooling systems, ventilation systems, and fuel cladding. Cladding is the protective layer surrounding fuel rods, usually ceramic or metallic layers designed to prevent corrosion of the fuel and to trap fission products that are gaseous at reactor temperatures.

Classifications

Reactors can also be classified according to their generation. Most 21st-century nuclear power plants are Generation II, which were built up through the 1990s. Generation I reactors were the early prototypes and experimental reactors. Generation III reactors are those that represent the technology of 2010; they have an operational life of 60–120 years, compared to the 40-year lifespan of Generation II; less-frequent core damage; significant passive safety systems; and increased thermal efficiency. The first Generation III reactors were built in Japan. The United States has proposed an international Generation IV project aimed at putting the next generation of commercial nuclear reactors online after 2030, preceded by a working prototype called the Next Generation Nuclear Plant, expected to be completed by 2021. Goals of the Generation IV include minimized waste and natural resource consumption, maximum safety, and a plant model that is not prohibitively expensive to build or to operate.

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See Also: Atomic Energy Commission; Environmentalism; Fusion; Hanford Nuclear Reservation; Hazardous Materials Transportation Act; High-Level Waste Disposal; Japan; Radioactive Waste Disposal; Radioactive Waste Generation; Uranium.

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Ocean Disposal

Oceans cover nearly three-quarters of the Earth. Humans have relied on oceans for thousands of years as a source of food, transportation, mineral and energy resources, and recreation. People have also used the ocean as an unlimited dumping ground for all varieties of refuse. Humanity's collective neglect over centuries is causing a 21st-century crisis.

There is growing awareness that overfishing, pollution, acidification, and cast-off solid waste are impacting human life on a large scale. Various treaties and agreements have been created in the hope that disaster can be averted. Planning, regulation, and oversight of waste disposal in the ocean can help to assuage the problems of the 21st century.

Using the ocean to dispose of society's waste began before the dawn of agricultural civilizations. Human settlements expanded along the shores of rivers, lakes, and seas because they were convenient sources of food, water for drinking and irrigation, and transportation. Dumping wastes in these same waters was also historically an inexpensive way to rid a community of unwanted materials. Animal carcasses, shells and other food waste, trash, and sewage were all removed by flowing water. After industrialization, factory wastes and by-products were also funneled into the nearest water to be carried out of sight.

Coastal cities used the volume and convenience of oceans to dispose of wastes. New York City dumped more than 1 million cartloads of collected wastes into the Atlantic Ocean in 1886 alone, and the city practiced ocean dumping as a primary method of waste disposal for decades. Half a century later, the city was sued by several New Jersey coastal towns to stop polluting the ocean, and the U.S. Supreme Court ruled in 1934 that dumping of municipal wastes in oceans was illegal. That decision did not end ocean dumping in the United States. As historian Martin Melosi has observed, industrial and commercial wastes were exempt from the decision, and annually more than 50 millions tons of waste were dumped into the ocean in the late 1960s. The U.S. Coast Guard supervised 120 disposal sites in the mid-1970s.

Sources of Ocean Debris

Marine debris is classified as either point source or nonpoint source pollution. Point source pollution comes from a single, identifiable source. A ship dumping garbage at sea or a factory discharging industrial waste directly into the environment are examples. Nonpoint source pollution is more difficult to trace

because the origin is not distinct. Windblown debris and rainwater runoff from urban or agricultural land are examples of nonpoint pollution.

Marine litter is found in every ocean. Winds and currents carry debris over vast distances, and the slow rate of decomposition in that environment combined with the large quantity of items discarded each year leads to an increase in the quantity of materials found in the oceans and along shorelines around the world. While some countries legally dump certain types of garbage from ships into the ocean in approved areas, there is a lot of illegal and unregulated dumping. It is impossible to know exact quantities, but it is estimated that several million tons of litter are disposed of in the oceans each year. Natural disasters like earthquakes, hurricanes, and tsunamis pick up materials on land and wash them out to sea. Storms sweep thousands of containers of goods off cargo ship decks yearly.

The great volume of debris dumped into the ocean in the 21st century overwhelms the ocean's ability to decompose solid waste. The problem is exacerbated by the widespread use of plastics. Most plastics are very durable and do not decompose like organic materials. Sunlight breaks plastics down into smaller bits of plastic through a process called photodegradation. As the pieces get smaller, they remain polymers. Eventually, the plastic bits become small enough to be ingested by sea life. As polymers decompose and break up in the water, potentially toxic chemicals may be released.

Ocean Currents

Physical debris can be carried vast distances by winds and ocean currents. Garbage dumped in one area can wash up and pollute a shoreline hundreds of miles away, creating a hazard for animals and beachgoers. Invasive species of plants and animals sometimes hitchhike on pieces of garbage and are transported to new shores. Plastic fishing nets, packaging materials, fishing line, and even innocuous materials like dental floss can entangle and trap birds and sea life.

There is a large, relatively stationary area of the North Pacific Ocean called the North Pacific Gyre. It is a large, remote area created by the rotational pattern of the wind-driven ocean currents. These currents have swept a great deal of detritus, mostly plastics, into the gyre where they have become trapped. The possibility of the existence of a "Great Pacific Garbage Patch" was predicted in the late 1980s by the National Oceanic and Atmospheric Administration of the United States, and it was confirmed to exist with sightings in 1997 by researcher Charles J. Moore, who was sailing through the gyre on his return from a race. The exact size of the Pacific or Eastern Garbage Patch is unknown, but it is often stated to be "approximately twice the size of Texas" in the media. Most of the pollution trapped there consists of small plastic particles floating at or just below the surface. More recently, another garbage patch was discovered in the North Atlantic Gyre. There are other major gyres in the South Pacific, the South Atlantic, and the South Indian oceans that may be experiencing similar accumulations.

Oil Spills

Oil is one of the most reported ocean pollutants in the media, but in reality, oil spills are not the leading source of oil in ocean waters. Globally, nearly half of the oil in the ocean originates on land. Air pollution, urban and industrial wastewater, and runoff all contain oil and petroleum products. Marine transportation also causes nearly half, but most of that is from routine ship operations. Small leaks that are not repaired, discharge of bilge and ballast water, drilling operations, and natural cracks in the sea floor that leak oil collectively release millions of gallons of oil into the ocean annually.

Agricultural Waste and Domestic Wastewater

Agricultural wastes are generated by the cultivation of crops and breeding of animals. These materials pollute soils, streams, and groundwater, which are eventually released into the oceans. Chemical fertilizers and pesticides are regularly applied to the land. Livestock produce five times as much waste per pound as humans, and nearly all waste carries infectious agents. Agricultural runoff is the major source of contaminated sediment, plant nutrients, and pathogens found in coastal waters.

Domestic wastewater is the primary source of raw sewage in the ocean. Sewer and septic tank leaks release oxygen-demanding waste into the environment. Historically, cities drained untreated or undertreated waste through pipes directly into rivers, lakes,

The Southeast Regional Marine Mammal Stranding Network removes a rubber debris that was wrapped around the head of a bottlenose dolphin in 2008. Plastic debris such as packaging, fishing line, and even dental floss can entangle and trap sea life.

or the sea. Even in the 21st century, many developing nations continue this practice. However, recent rapid growth of coastal areas has overwhelmed the ability of the ocean to purify the water naturally, resulting in polluted waters returning to shore. Waste consumes oxygen when it biodegrades. When oxygen is removed from the water, fish die off or leave the area.

Ship Debris

All ships contribute to the large volume of debris and contaminated water released into the oceans, but cruise ships have unique problems to address. Cruise ships are essentially floating cities, transporting up to 5,000 passengers and crew per voyage. Ships use less water to flush waste, creating highly concentrated sewage. Graywater, which comes from sinks, showers, kitchens, and cleaning activities, can contain food, detergents, oil, and grease. An eight-day cruise can dump over 1 million gallons of graywater directly into the ocean. Hazardous wastes are also produced on cruises. Ships now provide access to print shops, dry cleaning services, photo-processing labs, and X-ray machines to passengers in addition to crew using solvents, paints, and other chemicals. Cruise ships are currently allowed to dump untreated waste directly into the ocean as long as they are more than 12 miles from shore. Most cruise lines claim to voluntarily maintain rigorous waste management standards to protect the marine environment. While there may be some companies that deliberately pollute, most do not do it deliberately. The Cruise Lines International Association (CLIA) sets high standards for waste management in an effort to keep the ocean as pollution-free as possible.

Industrial wastes and by-products are no longer dumped into the ocean off U.S. coasts, but before the 1990s, it happened regularly. Other developed and developing countries still release these materials in the 21st century. Industrial wastes include dredge spoils (contaminated silt and debris scraped out of harbors and waterways to maintain shipping channels); manufacturing by-products, which often contain heavy metals and chemicals; and construction debris. The mining industry is also responsible for dumping its processing debris into the ocean. Mine tailings have been disposed of in shallow coastal waters directly or through pipelines since the 1800s. Tailings are the crushed rock, minerals, and chemicals used to process them that remain after the ore is removed. Underground mines create a lot of waste, but in modern, open-pit strip mining, approximately 99 percent of the rock that is moved and processed ends up as waste. Managing the storage and disposal of this debris is expensive. For many companies, especially in developing countries, deep-sea disposal is argued to be the most cost-effective solution.

Military Waste

The bottom of the sea has also been used as the final resting site for military waste for decades. Since the end of World War II, over 1 million tons of defective, obsolete, and surplus munitions (conventional, chemical, and nuclear) have been dumped into the oceans by various countries. These maneuvers tend to be classified, so the precise details including type of weapon, quantity, and precise location are rarely made public. The United States ended its practice of dumping nuclear waste into the ocean in 1970, but by this time, most major industrialized nations were

using the ocean as a repository for their nuclear by-products. Guidelines were established in the 1970s for handling and depositing radioactive waste in specific locations at great depths. These guidelines ended with a voluntary moratorium on all radioactive waste disposal at sea in 1983, and the agreement was made binding in 1993. The long-term impact of chemical or nuclear materials on ocean life is hard to predict. Elevated levels of radioactivity have been found in sea life in the vicinity of shallower dump sites, however, showing that the containers have been compromised and are leaking. As nuclear stockpiles are reduced around the world, isolating these materials will become even more problematic. There are proposals to reconsider ocean disposal as an option to contain hazardous materials. Deep burial in stable mid-ocean sediments may be the solution to long-term storage needs.

Whether careless, accidental, or deliberate, the amount of waste that is deposited into the oceans is staggering. The detrimental effects of these practices are visible. Plastics and other debris, chemicals, and oil are harmful to all forms of life. Refuse that depletes oxygen in the water kills sea life. Toxins poison fish and the humans that eat them. Plastics, fishing lines, and nets trap birds and animals, causing injury or death. Since the 1960s, various groups have been illuminating the detrimental effects of disposing materials in the oceans.

Legislation: Global

The nature of ocean disposal requires international cooperation. Once materials enter the marine environment, they have no boundary. A body of regional and global legislation exists that focuses on protecting the oceans. In many ways, the era of marine pollution legislation officially began with the London Convention in 1972. Delegates attending the United Nations (UN) Stockholm Conference on the Human Environment in June of that year planned for the Intergovernmental Conference on the Convention on the Dumping of Waste at Sea, to be held later that year in London. The United States was one of 72 nations to ratify a global treaty. The London Convention worked to identify and manage the sources of marine pollution. It then established regulations to restrict and monitor the direct disposal of wastes at sea by ships, aircraft, and oil rigs. Land-based sources of ocean pollution were not addressed at this conference. Many individual nations since have created their own regulations involving dredging and waste disposal, but they must minimally meet the standards set forth in international regulations.

The battle to control marine pollution gained momentum in 1973 with the formation of MARPOL (which stands for "marine pollution"). The MARPOL convention established the most encompassing regulations as of 2010, because it regulated the discharge of oil in addition to solid waste. MARPOL has been revised several times, expanding the scope of pollution included. Annex V, added in 1978, was the first attempt to control the disposal of plastics. Annex V restricted the disposal of trash at sea and banned the dumping of plastic products. MARPOL was an ambitious attempt to control a growing problem but was hampered by lack of enforcement. Building on the successes and challenges of the London Convention and MARPOL, additional UN Conferences on the Law of the Sea (UNCLOS) were held. A final agreement was reached in 1982, and UNCLOS was fully implemented in 1994 after being ratified by 148 countries. UNCLOS is comprehensive, outlining regulations for all marine environments and including all sources and types of pollution. Enforcement continues to be challenging, despite its thoroughness. Coastal waters are well regulated, especially in populated areas, but little is done to address ineffective waste management policies on land, where it is estimated that 80 percent of marine debris originates.

Numerous regional environmental conventions also address ocean disposal. The Oslo Convention, Paris Convention, Barcelona Convention, Helsinki Convention, and the Bonn Agreement are some of the largest that regulate the pollution of regional waters. The UN Environment Programme has also established the Regional Seas Programme, which encourages the protection of marine resources through pollution control. By 2010, there were 10 regional seas programs supporting highly trafficked areas, like the Mediterranean Sea.

Legislation: United States

There is a considerable body of legislation in the United States that aims to reduce waste entering the environment and requires treatment of the wastes

that are disposed of. One example is the Marine Protection, Research, and Sanctuaries Act (1972), which regulates ocean dumping and limits and prohibits the disposal of hazardous materials. It was amended in 1988 by the Ocean Dumping Act, which put even greater restrictions on waste disposal. The Clean Water Act (1977) amended the Water Pollution Control Act of 1972 and made it illegal to dispose of any material in the ocean without a permit issued by the U.S. Army Corps of Engineers. The Coastal Zone Management Act (1972) is a voluntary program that encourages coastal states to develop and implement coastal zone management plans.

Conclusion

Despite local, regional, and international agreements, oceans remain threatened. This is demonstrated by the tons of debris that are collected and weighed in beach and coastline clean-up efforts each year. Implementation and enforcement in any appreciable form are costly endeavors beyond the scope of many nations. To combat marine debris in any sustainable form, nations must address the management of pollution at its source and place top priority on strict measures of solid waste management on land.

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See Also: Clean Water Act; Mineral Waste; Pollution, Water; Rivers and Harbors Act.

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Ohio

Ohio is located in the American midwest, bordered by Michigan, Indiana, Kentucky, West Virginia, Pennsylvania, and Lake Erie. The seventh most populous state, Ohio is home to approximately 11.5 million residents and is a bellwether of political sentiments. As a major industrial power, Ohio works to balance a healthy business environment with policies that encourage sustainable practices, especially with regard to waste collection and disposal. To that end, the Ohio legislature has established a number of initiatives regarding the disposal of solid and infectious waste, with the intention of encouraging residents to recycle, reduce, or reuse solid waste generated in the state.

Centrally located in the United States' industrial heartland, Ohio has important links to both the northeast and midwest. Ohio became a state in 1803, and since that time, has been one of the larger states in terms of population. Its central location has resulted in Ohio's importance to the nation's transportation system. Ohio has over 300 miles of coastline, which provides for numerous seaports that facilitate the importation of natural resources and the export of manufactured goods. Located within a day's travel of 50 percent of the U.S. population and 70 percent of the nation's manufacturing capacity, Ohio has a strong network of highways and railroad tracks that permit a tremendous amount of business and cargo transportation through the state. Ohio has been a transportation and trading center since the 18th century, when the French established a series of trading posts in the region to assist in the control of fur trading in the area. As part of the Treaty of Paris, signed in 1763, the region was ceded to British control in settlement of the conflicts that led to the Seven Years War between the British and the French. After the American Revolutionary War, claims to the Ohio country were vested with the United States.

In 1787, the United States created the Northwest Territory under the auspices of the Northwest

Ordinance. The Northwest Territory, which contained Ohio, prohibited slavery and was first settled by a group of Revolutionary War veterans, who founded Marietta in eastern Ohio in 1788. Becoming a state after President Thomas Jefferson signed an act of Congress setting Ohio's boundaries and approving its constitution, Ohio grew rapidly during the first half of the 19th century. During the American Civil War, Ohio grew into a powerful manufacturing and transportation center for the nation. Ohio's central location in the conflict made it a vital conduit for federal troops. Ohio's railroads expanded rapidly during the Civil War, as did many of the ancillary industries needed to support these, such as manufacturing infrastructure. Since that time, Ohio has continued as a manufacturing leader, with this status continuing to the present day. If it were an independent nation, Ohio would have the world's 20th-largest economy, according to forecasts from the World Bank. Ohio has strengths in a variety of sectors, including aerospace and defense, automobile manufacturing, bioscience, healthcare, iron and steel, logistics, nanotechnology, and rubber and plastics. These industries have driven Ohio's decisions regarding waste collection and disposal.

The geography of the state encouraged industrial variety, including extensive coal mining in the mountainous Appalachian southeast, extensive agriculture in much of the state that benefit from Ohio River transportation along the south, and heavy industry that concentrated in the northern half of the state along the coast of Lake Erie in the late 19th and early 20th centuries. Cuyahoga County, containing the city of Cleveland, hosted the birth of Standard Oil in 1870 and a host of manufacturing and petroleum processing industries. Just south, in Summit County, Akron became the "Rubber Capital of the World," hosting the four major tire companies: Goodrich Corporation, Goodyear Tire and Rubber Company, Firestone Tire and Rubber Company, and General Tire. Industrial use of the land and water had significant environmental effects, including periodic fires emanating from oil slicks on the Cuyahoga River in the 19th and 20th centuries. A 1969, blaze was commemorated in *Time* magazine, drawing national revulsion and contributing to the U.S. Congress passing the Clean Water Act of 1972. Although deindustrialization has affected many communities in Ohio, the consequences of industrial production remain in the form of several brownfield and Superfund sites scattered across this section of the Rust Belt.

Waste Collection and Disposal

Waste management practices in Ohio vary considerably between industrial and developing areas, as well as for rural, suburban, and urban areas. Waste management practices in Ohio vary considerably between industrial and developing areas as well as for rural, suburban, and urban areas. Residential and industrial producers of waste have different responsibilities regarding the waste they produce. Waste from residential sources in Ohio, if nonhazardous, is often the responsibility of local municipal governments. Commercial and industrial generators of waste, however, are usually responsible for management of their waste's transport, handling, disposal, and reclamation. While a certain amount of waste must inevitably be disposed of, most Ohio generators seek cost-effective ways to reuse, reclaim, or recycle as much waste as possible.

As Ohioans have experienced the consequences of their wastes, they have attempted to manage them. Most municipal solid wastes are landfilled, with wastes from hospital systems such as the extensive Cleveland Clinic often incinerated. Attempts to regulate industrial pollution extend back to local nuisance regulations against smoke as early as the 1850s, although smoke continued to plague urban areas into the 20th century. In Cleveland, the middle-class Women's City Club pressured the city to create a Division of Smoke Inspection in 1926 that measured soot from the smokestacks of steel mills and factories and contributed to more stringent regulations after World War II. In the wake of the 1969 Cuyahoga River fire, several community-based environmental groups and programs developed, including the Ohio Public Interest Action Group, Ohio Citizens for Responsible Energy, Cleveland Recycling Center, and regional chapters of national environmental organizations. Local activism on environmental issues led to several communities establishing recycling programs between the 1970s and 1990s, as well as Cleveland's 1985 hazardous materials right-to-know law. (Voters defeated a similar statewide ballot referendum in 1992.)

The Ohio Environmental Protection Agency (Ohio EPA) has established the Division of Materials and Waste Management (DMWM) to make certain that solid waste within the state is handled and disposed of properly. DMWM seeks to encourage individuals and businesses to reduce, reuse, or recycle solid waste generated in Ohio. To that end, DMWM regulates composting facilities, construction and demolition disposal sites, scrap tire facilities, infectious waste generators (such as hospitals), landfills, waste incinerators, and transfer facilities. DMWM conducts this regulation through the issuance of permits and oversight of state and local planning related to long-term solid waste management. In an effort to reduce the amount of waste Ohio residents and businesses generate, DMWM has instituted several initiatives to encourage recycling and improve its efficacy.

Recycling and reclamation services in Ohio predate the great push of the industrialization that followed the American Civil War. In the era before mass production, the high cost of new goods and the difficulty of acquiring raw materials made reusing products a necessity. Periods of financial downturns and resource shortages have also made reclamation and recycling popular, as these times made purchasing new products difficult for many. Wars and other conflicts frequently affected international shipping or the supply of certain resources. In the years following World War II, however, reclamation and recycling faded as alternatives.

Only during the 1970s, with their increased emphasis on the adoption of ecologically friendly practices, did more Ohioans become interested in increasing reclamation and recycling. Ohio's history as an industrial juggernaut has led to a variety of problems, many related to waste disposal. During the 1980s, for example, the Environmental Protection Agency (EPA) placed a number of landfill sites in Ohio on its National Priorities List (NPL), creating concern.

As a result, popular interest in reclamation and recycling grew as a way to reduce these risks. Governmental subsidies designed to increase the use of recyclable products became popular in Ohio during the 1990s and continue to this day. A large portion of waste in Ohio is generated from industrial sources. When industrial and commercial concerns consider waste reclamation services, cost effectiveness is a key concern. One of the most common waste products reclaimed is cardboard, as this item is common in all companies that deal in packaged goods, including retail stores, manufacturers, warehouses, and transportation services. Other substances that can be easily recycled, such as glass, metal, and plastics are collected and recycled when feasible.

The Ohio EPA is also served by a Division of Environmental Response and Revitalization (DERR), which oversees investigations related to possibly contaminated sites, including federal facilities, and cleanup of these sites if necessary. DERR responds to toxic waste emergencies within Ohio, and assists companies and individuals who are dealing with environmental regulations or cleaning up sites that have suffered environmental harm. Finally, the Ohio EPA Office of Compliance Assistance and Pollution Prevention (OCAPP) helps customers adopt pollution prevention measures that can allow companies to save money, increase profitability, and benefit the environment.

Despite a variety of state, county, and municipal authorities regulating waste, Ohio continues to be plagued by postconsumer and postindustrial wastes. Data from a 2009 U.S. EPA report ranked Ohio the state most affected by toxic air pollution. This is due to the state's reliance on coal and oil-fired power plants, as well as continued industrial activity from the likes of AK Steel Holding Corporation and Procter & Gamble. Recent innovations in solid waste management include a garbage collection fee implemented by the city of Cleveland in 2010 to generate revenues and discourage unfettered disposal, and proposals to build waste-to-energy facilities that have spurred debate among policymakers and environmental advocacy groups about sustainable waste management policies. As Ohio continues to grapple with the consequences of 20th-century production, it is working to develop methods of managing wastes that work for the 21st century.

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See Also: Clean Air Act; Clean Water Act; Economics of Waste Collection and Disposal, U.S.; Sewage Treatment.

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Oklahoma

From its beginning, Oklahoma's stance toward governmental policies has been largely populist with traditionalistic overtones. From the Land Run to the Dustbowl to the controversies more recently involving Tar Creek and poultry operations, Oklahomans struggle to square their political culture with the needs of the environment.

Consumption Statistics

Oklahoma's size in land area is just above average in the United States as the 20th-largest state; but as a rural state, it ranks only 36th in population, with 3,751,351 residents enumerated in the 2010 census. Conversely, while the state's populace is sparse, its residents consume more than average for its size. For example, the U.S. Census Bureau in 2004 found that Oklahoma is actually ranked eighth in total energy consumption. This overconsumption may stem from the state's populist heritage, based on its rugged individualism from the Dustbowl along with its abundant oil and natural gas production. Daniel Elazar characterizes this traditionalist and individualist political culture as one resistant to change, placing a premium on a "business as usual" mentality. It is not surprising, then, that the Resource Renewal Institute's "State of the State" report finds that Oklahoma ranks only 46th in its policy innovation to improve the state's environmental programs. Furthermore, Oklahoma rates only in the bottom five states in pollution prevention performance in a study by the Environmental Defense Fund. In addition, *Governing Magazine* reveals that Oklahoma ranks 45th in environmental spending per capita, with more than $660 million in 2004. On the city level, Tulsa and Oklahoma City's ecological footprints rank a mere 90th and 93rd out of 100 cities, respectively, measuring the human demand on the Earth's ecosystems, according to SustainLane's 2008 Sustainability Ranking.

Waste Disposal

Governing Magazine also finds that Oklahoma—at 3.8 percent—beats only Mississippi and South Dakota in the percent of residents' garbage recycled, which is less than one-tenth of Minnesota (42.3 percent), the nation's top recycler. Oklahoma's negative sentiments toward recycling reflect the fact that the state's landfill tipping fees are the lowest in the nation, at an inexpensive $18 per ton, compared to Vermont's hefty $98 per ton, which gives the state with the highest tipping fees much more incentive to recycle. In lieu of recycling, Oklahoma is fond of landfilling and is the country's 10th-biggest landfiller per capita.

Sustainability

Although sustainability is not a top priority for the average Oklahoman, there are organizational programs across the state, including the Metropolitan Environmental Trust (MET) in Tulsa, the Oklahoma Department of Environmental Quality (DEQ), and the Oklahoma Sustainability Network, all of which promote programs emphasizing sustainability statewide. In addition, some of the state's universities are at the forefront of sustainability. For example, the Environmental Protection Agency (EPA) recognized the University of Central Oklahoma as the "2009–2010 Individual Conference Champion" for using more green power than any other school in the Lone Star Conference. Similarly, Oklahoma State University (OSU) saved $11.5 million by reducing energy and water con-

sumption over the course of three years, according to the university's Website. As of 2010, OSU was in the process of replacing more than 45,000 lights with more efficient bulbs in 97 buildings. OSU was also working to retrofit heating, ventilation, and air-conditioning (HVAC) systems.

Tar Creek

Oklahoma has nearly one dozen National Priorities (Superfund) sites. However, the state's Tar Creek is well known as one of the nation's largest and highest-ranking Superfund sites. It was designated by the EPA because the children of Picher, Oklahoma, were found to have elevated levels of lead in their bodies, leading to learning disabilities and other problems.

The site contains a 40-square-mile area and is part of the Tri-State Mining District, including portions of Kansas and Missouri. The Superfund site affects a total population of roughly 30,000 residents from the Oklahoma communities of Picher, Cardin, Quapaw, North Miami, and Commerce. Although Tar Creek in northeast Oklahoma was once a vibrant mining area where many citizens in the area patriotically produced lead and zinc for the soldiers in World War II, it is basically a ghost town in the 21st century. Eighty-three abandoned water supply wells along with dozens of exploratory drills mined the Boone Formation, which was an area particularly rich in zinc and lead. Despite the mineral riches found, the drills punctured the underlying deep Roubidoux aquifer, which served as the drinking water for much of northeastern Oklahoma. The drill holes provide pathways for abandoned toxic metals left by the mining companies as late as the 1970s, when mineral deposits were exhausted. Underneath nearly 2,500 acres of this area are nearly 300 miles of tunnels and 1,300 mineshafts.

By 1980, the contaminated water flowed down the stream, turning it bright orange, bringing media attention to the plight of Picher for the first time. A $100-million EPA effort removed lead from residential yards, damaging many homes; furthermore, the region's status as a Superfund site further devalued properties. A 2006 federal study by the U.S. Army Corps of Engineers found that large areas in and around Picher could collapse at any time. That finding triggered the $50 million buyout of more than 700 properties. Funding for the Picher residential relocation was approved in 2006, and the town is now largely abandoned, leaving behind vacant buildings.

Illinois River

The Illinois River, also in northeast Oklahoma, is considered a prized, scenic river. It serves as a source of drinking water for the region and irrigates plant nurseries and farms in the area. It also provides a home to an abundance of wildlife, including several threatened and endangered species of plants and animals. It is also a popular tourist and recreation attraction and was the first river designated as a Wild and Scenic River by the state. Nearly 200,000 tourists annually float the Illinois River by raft, canoe, or kayak. Recreation brings millions of dollars into the local economy, attracting tourists from not only Oklahoma, but also nearby states.

Despite these benefits, damage to the watershed is manifest. Since the 1990s, many farmers in the economically depressed northeastern section of Oklahoma have eagerly contracted with corporate chicken operations because this type of work is a much more lucrative alternative to traditionally marginal crop farming. Increased large-scale poultry feeding operations are on the rise, with chickens in the area numbering nearly 50 million as of 2010. Studies have indicated that the water quality in the Illinois River has deteriorated, particularly from chicken-waste nutrients, especially phosphorous, which seep down into the soil and then run off into the river. The impact is tremendous; Oklahoma is the seventh-largest producer of animal waste. Excess nutrients in the river harm both humans and wildlife. High phosphorus levels in drinking water can cause a shortage of oxygen in the bloodstream, leading to blue baby syndrome, a condition that is sometimes fatal to humans. In the river, these increased nutrient levels can also create algal blooms that take up a great deal of oxygen in the river water, killing other aquatic species and damaging the river's biodiversity. The nutrients from chicken waste trickle into the water from multiple places but are not seen by the naked eye. Such a phenomenon is what policy experts call "nonpoint source pollution" because it is undefined. Since nonpoint source pollution takes time and is invisible, people who live in the affected areas often blame one another, creating conflict.

In 2005, Attorney General Drew Edmondson brought a lawsuit against several out-of-state poultry operators, declaring that they were polluting the state's rivers and, in turn, its drinking water and public health. His lawsuit alleged multiple violations of federal law, as well as state and federal nuisance laws, trespass, and Oklahoma Department of Environmental Quality state regulations. By 2010, the poultry industry was starting to ship poultry waste out of the watershed, but a lawsuit was pending.

The state is dealing with the poultry issue with a voluntary program on public and private land of riparian buffers along the river. Riparian buffers are the planting of native vegetation along stream banks to filter nutrients before they enter the stream.

Conclusion

Oklahoma's great seal glistens in the stained glass skylight, mirroring its twin in Tennessee marble 255 feet below. In the seal's center stand a cowboy and a Native American shaking hands, symbolizing the Oklahoma and Indian Territory marriage as one state. Above these two figures is emblazoned Oklahoma's populist motto, "Labor Omnia Vincit," or "Labor Conquers All."

Oklahoma's motto rings true in the 21st century as it did more than 100 years ago, where its citizens' focus is more often than not on making a living over environmental sustainability. From a populist standpoint, this threatens to undermine entrepreneurship through environmental regulations.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Farms; Post-Consumer Waste; Recycling; Sustainable Development.

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Open Burning

Open burning involves burning any material or substance, including garbage, wastepaper, wood, vegetable material, or other flammable material, in the ambient air or any open premises such as a public street, alley, or other land adjacent to such premises. Burning in a receptacle where emissions are released directly to the air without passing through

a chimney or smokestack is also considered a type of this process. Usually, any lighting of a fire outdoors is considered open burning.

Open burning laws are usually regulated at the country level. In most countries, including the United States, there are further regulations at the state and local levels. In order to promote efficient burning and reduction of smoke emissions, it is helpful to assure that all material is dried to the greatest extent practicable. Piles should be built as tall as they are wide. As a pile burns down, it is important to move unburned and smoldering material from the perimeter of the pile to the center of the fire. It is also helpful to burn on days with moderate winds or during heavy snowfall, as this provides good smoke dispersal.

In the United States, businesses and residents must obtain the appropriate permits before conducting any open burning activities. Fires used for noncommercial cooking of food, for instructional training or recreational purposes, safety flares used to indicate danger, and agricultural open burning activities usually do not require governmental permits.

Agricultural open burning involves the burning of cover vegetation for the purpose of preparing the soil for crop production, weed control, maintenance of water conveyance structures related to agricultural operations, and other agricultural cultivation purposes. Open burning of animal parts or carcasses is typically not considered agricultural burning, except if the state Agricultural Commission declares a public emergency that requires the burning of diseased animal carcasses. Similarly, open burning of household garbage, wood, and yard debris on agricultural land is typically not considered agricultural burning and is not exempt from state permitting requirements.

With an appropriate permit, specific types of open burning are permissible, including burning of yard waste that does not include salvageable wood or tree stumps and burning of slash piles. On the other hand, the types of open burning that

The types of open burning that are strictly prohibited include burning of material that contains plastic, rubber, tires, insulated wire, motor oil, aerosol cans, hazardous or toxic materials, or materials that produce large amounts of smoke and particulates. Open burning causes air pollution and poses the risk of serious health problems, obscured visibility, damaged surfaces, and noxious odors. Even burning wood and vegetative products can produce several harmful chemicals like carbon monoxide, hydrocarbons, formaldehyde, and dioxin.

are strictly prohibited include burning of material that contains food wastes, plastic, coated or treated wood products, rubber, insulation, tires, car bodies, insulated wire, motor oil, aerosol cans, hazardous or toxic materials, or other materials that produce substantial amounts of smoke and particulates.

Most states consider several factors when issuing an open burn permit. They look at whether or not a practical alternative for the disposal of the material is available. They also consider the potential contribution of the proposed burn to air pollution. Another issue is the potential impact from the smoke on the health and welfare of the public. The permit-issuing authorities usually like a guarantee that no public nuisance will be created and that no occupied buildings will be impacted by air contaminants from the burning. The location and proximity of the proposed burn to other structures is also considered, as are the meteorological conditions on the day of the proposed burn. No traffic hazards should be created, and the burning must be attended and supervised at all times. Finally, compliance with fire protection and safety regulations is also required.

Open burning laws help protect public health and the environment. Open burning pollutes the air and poses a fire hazard, which in turn can cause serious health problems, obscure visibility, soil surfaces, and create pungent odors. Burning wood and vegetative products produces several harmful chemicals like carbon monoxide, hydrocarbons, formaldehyde, and dioxin. Burning plastics, tires, and other man-made materials releases even more harmful toxic chemicals into the air and can be damaging to one's lungs. The pollutants have been linked to several health problems, including asthma and other respiratory conditions, nervous system damage, kidney and liver damage, and reproductive and developmental disorders.

Alternatives to Open Burning

National, state, and local organizations as well as nongovernmental organizations (NGOs) have tried to promote several alternatives to open burning. The most effective way is to reduce consumption by looking for products with less packaging or items with packaging that can be reused or recycled. Furthermore, consumers can be encouraged to donate products such as old clothing, furniture, and toys to charity. Reusing old lumber whenever possible and chipped yard waste as landscaping mulch also helps cut down on the need to burn. Bringing reusable bags to the store, reusing plastic bags, and using coffee mugs instead of disposable cups also helps alleviate the problem.

Additionally, recycling materials such as paper products, plastics, cardboard, aluminum, steel, glass, and electronics is helpful. Furthermore, yard debris and kitchen scraps can also be composted into a nutrient-rich substance that can later be used as mulch or fertilizer. Finally, the items that cannot be reused or recycled should be taken to an active solid waste facility for disposal.

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See Also: Biodegradable; Composting; Open Dump; Paper Products; Pollution, Air; Recycling Behaviors; Solid Waste Disposal Act; Tires; Toxic Wastes; Wood.

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Open Dump

In many countries in Africa, Asia, and Latin America, as much as 30 to 50 percent of solid waste produced in urban areas is left uncollected. Land disposal of waste has become an inevitable component of the solid waste management system. *Open dump*, *dump site*, *dump*, *uncontrolled dump*, and *uncontrolled waste disposal site* are terms used to describe a designated or undesignated site where wastes are either deposited on land, burned, or buried without supervision and without precautions regarding human health or the environment. Thoughtless dumping and uncollected wastes, which characterize the management of solid wastes in cities in low- and middle-income countries, is often aggravated by weak governance institutions, corruption and lack of transparency, low level of public awareness of the potential public health and environmental impacts of waste dumping, and poor attitudes and behaviors towards waste.

Open dumping is the practice of disposal of wastes in open dumps. Over one billion people living in low- and middle-income communities and slums lack appropriate waste management services. As a result, open dumping has become the world's most common method of disposal of wastes. Despite its many disadvantages, individuals and communities have continued to rely on open dumps for the disposal of their waste. Open dumps in low and middle-income countries are also "resource recovery centers," where hundreds—sometimes thousands—eke out a living from the recovery and sale of what other people have chosen to discard. There is an urgent need to phase out open dumps and put in their place sanitary landfills as a method of waste disposal in developing countries of Africa, Asia, and Latin America.

Characteristics

Open dumps are generally associated with some or most of the following characteristics: (1) no planning, (2) no responsible person on site, (3) no access control, (4) no control of waste deposition, (5) no confinement of waste body, and (6) uncontrolled burning.

There is widespread use of open dumps in communities with inadequate refuse collection and disposal. Such places as street corners, open public spaces, uncompleted or abandoned buildings, vacant lots, wetlands, burrow pits, or even drainage systems are utilized as dump sites. There is often co-disposal of night soil and hazardous waste with municipal refuse at open dump sites, whether sanctioned or unsanctioned by the municipality. Open dumps may be legal or illegal. Legal open dumps are places designated by city authorities for open dumping of solid or hazardous wastes. On the other hand, illegal dumps spring up within cities without the consent of responsible authorities. Open dumps occupy the lowest rung in the waste hierarchy, and they represent the existing method of disposal of wastes in most countries that do not have a well-developed control system. Open dumping abounds in many low- and middle-income countries because of the mistaken belief that it is the cheapest disposal method.

Hazards

While appearing cheap and convenient, open dumping is fraught with many environmental and public health consequences. Nobody likes to live near an open dump—an attitude known as Not in My Backyard (NIMBY). However, some poor and disadvantaged segments of the urban population in developing countries often live near open dumps. Such groups are at risk of exposure to contaminants and from inhalation of aerosols and volatile compounds. Leachates from open dumps enter surface and groundwater sources, and the contamination may affect drinking water supplies and the aquatic food chain. Grazing animals on open dumps can transmit diseases and pests to humans. Open dumps also encourage poor sanitation habits, such as open defecation and urination. The overall effect of open dumps is that aesthetics of a neighborhood and property values easily deteriorate with their presence.

Open dumps often exacerbate the incidence of urban flooding and can form breeding grounds for insects and rodents. They also attract birds, flies, and vermin. Fires also break out periodically from open dumps, generating billows of smoke and contributing to air pollution. In the Mexican city of Tampico, a fire burned for over six months at the local open dump. Sometimes, dump managers encourage the fires and resist efforts to eliminate the fires.

Open dumping is neither safe nor hygienic and there have been some cases of disasters at dumpsites. For example, major landslides having devastating effects and engulfing communities living and working in open dumps have also been recorded; for example, a February 2005 landslide in Bandung, Indonesia, killed at least 40 people; a July 2000 landslide in Payatas, Metro Manila, in the Philippines killed 200 people. A case of a plague-like disease that occurred in Surat, India, in 1994 was linked to uncollected solid wastes blocking drains. Further, cholera outbreaks have been reported in the vicinity of open dumps during the rainy seasons in Conakry, Guinea.

Electronic Waste

Open dumping of electronic waste (called e-waste) is prevalent in many low-income countries. Millions of pounds of e-waste (mostly obsolete computers and computer products, refrigerators, television sets, and mobile phones) are generated in some Western countries and exported to developing countries with justifications of "building bridges over the digital divide." These e-wastes often end up in "digital dumps." Such digital dumps are found in many cities of Africa, Asia, and Latin America with implications for human health and the environment. E-waste recycling by the informal sector is thriving in cities in China, India, Pakistan, and Africa as a result of the unregulated importation and dumping of e-waste.

Unrest

Open dumping of waste has also led to incidents of social unrest. In 2008, mountains of solid waste lined the streets in the Campagna (Naples) region of Italy when collectors stopped picking up the garbage because all of the region's landfills were full. Violent protests occurred, both by residents forced to live side-by-side with the stinking heaps of waste in the streets and by neighbors protesting at attempts by the authorities to forcibly reopen the "full" landfills.

Scavenging

Some notable open dumps in cities of Africa, Asia, and Latin America are the Smokey Mountains (which closed in 1995) and the Payatas dump in the Philippines; Dhapa dump in Kolkata, India; Santa Cruz Meyechualco dumps in Mexico City; Ojota dump site in Lagos, Nigeria; and Nakuru dump in Kenya, among many others. These open dumps are home to thousands of waste pickers who survive on the recovery of materials from refuse. Scavenging at landfills and open dumps is a major driver for waste recovery and recycling. In the absence of statutory requirements for the recovery of materials from refuse in most of these cities, recycling of waste remains an informal waste sector activity in low- and middle-income countries.

Regulation and Management

With increasing awareness of the risks associated with operation of open dumps and the health and environmental benefits of modernization of waste disposal, a growing trend in many developing countries in the 21st century is the closure of open dumps and upgrading to sanitary or controlled landfills. For example, the Mutuail landfill in Dhaka, Bangladesh, which operated for many years as an open dump, serves about 3.5 million people in the city. With investment from a Japanese debt cancellation program, the City Corporation of Dhaka decided to upgrade the standard of waste disposal at the site. Over a two-year period, Matuail was transformed from an open dump subjected to closure during flooding to a controlled landfill with perimeter drainage, site roads, leachate management, landfill gas venting, site control offices, and electronic weighbridge. Site staff, cleaners with low qualification, were trained in landfill management and assumed the daily tasks for site operation. The Matuail landfill is now an example of a controlled landfill in south Asia; incredibly, all of the upgrading work was done while receiving 1,500 tons per day of waste input to the site.

Invariably, the disadvantages of open dumps outweigh any perceived benefits, namely, the recovery

of materials. Development interventions must be aimed at modernizing the solid waste sector in low- and middle-income countries through phasing out dumps and upgrading them to sanitary landfills. Landfilling remains the most reliable method of waste disposal in the world, perhaps until a better method of waste disposal is developed. As informal-sector waste picking is an inevitable phenomenon in developing countries' waste management systems, care should be taken in the planning of the landfills to account for waste pickers and their activities if the landfills are not to quickly revert to open dumps as recently reported in Karachi, Pakistan, and Enugu, Nigeria.

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See Also: Dump Digging; Landfills, Modern; Midnight Dumping; Open Burning; Toxic Wastes.

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Oregon

Oregon, located in the Pacific northwest, attracted human settlement as early as 13,200 B.C.E., and its natural features (including the giant Columbia River on its northern border, the Klamath River in the south, and the Snake River to the east, as well as the Cascade Mountains and dense evergreen forests) have attracted settlers seeking fish, timber, and cool, moist climates. Most of the population resides in the Willamette Valley in the northwest, including those in the largest city, Portland.

Garbage was not a problem in Oregon before the 19th century. Before then, trash accumulation was generally small and much seems to have perished over time. Generally, only the coastal middens survive into the 21st century. Oregon's concern about its beaches' accumulation of storm wrack, debris, jetsam, and trash led to a campaign to reduce the total quantity of trash and to recycle metal, glass, and plastic materials. In the 21st century, Oregon would be awash with trash if a culture of "reduce, reuse, and recycle" had not begun in the 1960s.

Early History of Waste Disposal

While Oregon's population density was low and people followed a seasonal circuit of resource acquisition, most of their trash decayed rapidly. This generally left only stone, shell, and charcoal materials to mark the places they used. George Vancouver and other visitors brought durable goods with them, including tools, containers, decorations, clothing, and weapons made of durable metal, glass, and ceramics. These new classes of artifacts were gifted or traded to the indigenous population.

When Meriwether Lewis and William Clark visited Oregon in 1805 and 1806, they brought metal items in great diversity. They noted that some of the estimated population of 39,000 Native Americans they met had guns, pistols, powder flasks, lead balls, brass teapots, knives, and brass and copper sheets. Since metal, when dropped or discarded, joins stone and shell in durability, a new class of trash began to accumulate. Lewis and Clark contributed gifts and trade goods, such as beads, bells, thimbles, axes, and looking glasses, which eventually added to the debris accumulating in the landscape.

Oregon Trail and Early Settlers

The westward migration of emigrants from the United States to the Oregon Territory began in 1843 over the Oregon Trail. The arduous journey to find new agricultural land left not only wagon wheel ruts but also household goods strewn along its length. So much was discarded between the Rocky Mountains and the Snake River that people

collected, transported the abandoned goods east to Salt Lake City and sold them to the next party going west. Tens of thousands settled in the lands ceded by the indigenous peoples.

By the mid-19th century, overland settlers had left wagon parts, household goods, and graves to mark their passage across the dry Great Basin to the east side of the Cascade Mountains. Settlers and traders who came by ship or raft left wrecks on the shores and along the rivers. By 1859, when Oregon became a U.S. state, the settlers had founded villages and towns. Native Americans were restricted to the lands they had reserved for their use in a series of treaties with the United States.

Settlers stayed in one place, making or importing goods to make life more comfortable; their discards accumulated in homesteads and camps. The Native Americans had accumulated more material culture and were envisioned as becoming farmers melting into the emigrant population. Population density increased eightfold by 1890, and garbage became a serious problem. In response to concern for public and environmental health, the state Assembly passed the first of Oregon's antipollution laws forbidding the dumping of carcasses in any waterway in 1889. The people of Oregon passed an initiative creating the state Sanitary Authority in 1938 to assure pure water and the prevention of further pollution because the Willamette River had become so polluted with raw sewage and garbage that fish could no longer live in its waters. Fish, especially salmon, have been a major economic resource in Oregon since humans first came upon salmon streams. Destruction of fisheries was intolerable.

Modern Waste Disposal

After World War II, an explosion of new products improved U.S. life. Soda pop, beer, and frozen foods were sold in aluminum packaging. Plastic made from petroleum products became a new, inexpensive, lightweight packaging material.

A completely new category of trash, plastics and aluminum products became frequent and did not decay or rust. Like stone, ceramics, and glass, the plastic and aluminum discards became a permanent feature of the landscape. Another wave of emigration and the Baby Boom further increased Oregon's population (which increased from 1,089,684 in 1940 to 1,768,687 in 1960, 2,633,105 in 1980, and 3,831,074 in 2010), resulting in more garbage. By 1965, solid waste disposal was prohibited in the waters of the state. Instead, garbage was collected into landfills, and the Department of Environmental Quality was charged with cleaning up the state's land, water, and air.

Landfills expanded as population grew and as further kinds of more-durable material became common. By 1967, Oregon was in a transition from abatement to prevention of pollution. Oregon's 1971 Bottle Bill was the first in the nation: soft drink and beer containers are charged a $0.05 deposit, refundable on return. Roughly 80 percent of these deposit containers are returned. A 2007 amendment expanded the deposit to include water and flavored water containers.

Reduction and Recycling

As landfills filled and required commitment of more land to hold ever-increasing quantities of garbage, Oregon's legislature passed the Opportunity to Recycle Act (1983). This act established a hierarchy of measures to reduce materials going into landfills. First, reduce the amount of garbage generated; for instance, reduce the amount of packaging for the goods and products made or sold in the state. Second, reuse items for their intended use; for example, automobiles that do not run can be donated to charities that repair and resell them. Third, recycle materials of items that cannot be reused, such as newspapers, office paper, cardboard boxes, no-deposit glass and aluminum containers, and scrap metal.

Compost organic waste, pruned plant materials, wood construction materials, and scraps. Recover energy from materials that cannot be recycled or composted; for example, used motor oil is filtered and burned for some heating purposes. Oregon has a goal of recovering 50 percent of the waste generated in the state. That goal had not quite been met as of 2007.

Waste Cleanup

Along with these legislated steps, a private organization, Stop Oregon Litter and Vandalism (SOLV), engaged the public's imagination and conscience. SOLV held the first organized beach cleanup in the

world in 1984. SOLV's leadership has continued and has expanded to all waterways and community cleanups. The public has remained engaged and involved, cleaning up beaches, lakes, waterways, roadsides, and communities on a regular basis, especially on Earth Day in April of each year. As part of this antilittering effort, groups "adopt" both streets and roadways, agreeing to clean up their segments at least twice a year.

These programs have reduced the amount of roadside trash throughout the state. Persons sentenced to community service for minor crimes are often utilized for trash cleanup of major highways.

Future

The rich and perhaps wasteful culture of the 20th century is not being fully represented in the future archaeological record. Removal of drink containers, whether by redemption or recycling, significantly biases the record of alcohol and sugar consumption in Oregon, a state that is also famed for production of wine and microbrews. To the historic archaeologist of the future, this may be a serious flaw in the data. For instance, start-up wineries may get their bottles from a foreign source but find that the bottles are slightly defective and do not allow labels to be applied by machine. This would be a variation from the mass-produced wine bottles of the major wineries of Oregon. Removal of recyclable material from trash removes significant categories of metal, glass, and plastic artifacts from the representation of life in 20th-century Oregon.

Garbage collection into landfills leaves only items, not context. Household, commercial, and industrial waste is indiscriminately mixed by heavy machinery in "transfer stations." Transfer station materials are aggregated and further mixed at landfills. It would seem, however, to be worthwhile to deprive archaeologists of the far future of these minor cultural differences than to be buried in contemporary waste.

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See Also: Archaeology of Modern Landfills; Economics of Waste Collection and Disposal, U.S.; Fast Food Packaging; Recycling.

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Organic Waste

Organic waste is waste of plant or animal origin. Solid waste, food scraps, yard waste, and paper waste are generally considered organic waste. Organic waste occupies a major fraction of municipal solid waste—about two-thirds of the household waste for developed countries and even higher for developing countries. The agro-industrial sector is another major source of organic waste, including animal manure, fish excreta from aquaculture, and solid waste from food processing. Human waste, such as night soil and sludge from wastewater treatment facilities, is also considered to be an organic waste. The proper management of organic waste is essential for protecting public health and reducing the impact of human activities to the surrounding environment.

Hazards

There are number of factors that make the management of organic waste difficult. Organic waste tends to attract pests and cause odor problems. Due to its high water content, organic waste is not suitable for storage or long transportation. The most notable characteristic of organic waste is that it undergoes a relatively active biodegradation process. This biodegradation results in pollution of the surrounding environment. When a large amount of organic waste is introduced into water, oxygen is depleted and fish may die. Organic waste can also be a source of air pollution. If the decomposition of organic waste takes place under anaerobic conditions, such as occurs within landfills, the decomposition

process produces polluting by-products. The most prevalent of these is methane, a greenhouse gas 25 times more potent than carbon dioxide. Due to its origin, organic waste, especially human and animal waste, can contain pathogens, parasites, and other forms of pollutants. The direct disposal of organic waste to land and waterways has been a common practice throughout human history. This leads to the spread of commutable disease, which takes the life of a child every 20 seconds in the early 21st century. Some scholars are concerned that the repeated application of organic waste on land will lead to an accumulation of heavy metals in the soil and further contaminate agricultural products. Organic waste also contains high level of nutrients, such as phosphorous and nitrogen. The improper disposal of organic waste can cause the eutrophication of lakes and further impair water quality. The careful management and disposal of organic waste is necessary for protecting the health of the public and of ecosystems.

Definition

There is no set definition for organic waste, but a subset of organic wastes is defined by regulation. The European Union (EU) established the Landfill Directive in 1999 in order to reduce the content of biodegradables at landfills and to reduce landfill methane gas emissions, a major human-induced methane emissions source. The Landfill Directive defines biodegradable waste as "waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and green waste, and paper and paperboard." *Biowaste* is also a term used in regulations for solid waste management in Europe, which indicates the combination of food and yard waste.

Treatment

Source separated organics or *organic fraction of municipal solid waste* are operationally defined terms commonly used for municipal waste management. Alternative to direct disposal, organic waste can be treated by incineration, composting, anaerobic digestion, or by mechanical biological treatment both aerobically and anaerobically. Through these treatments, organic waste is stabilized. Such treatment also results in the reduction of volume and disinfection of the waste, making its final disposal easier and safer. Some treatment processes are more suitable for certain fractions of organic waste. For example, some paper waste cannot be handled by the composting process but does not impose any difficulties for incineration. Thus, the fractions of waste included in source separated organics or the organic fraction of municipal solid waste is highly dependent on which technologies and management schemes are adopted in a given location.

Human excreta—urine and feces—can be treated on-site, with latrine toilets, cesspools, or septic systems. "Night soil" is often used as a euphemism for human feces or other solid by-products from such on-site treatments. When combined with graywater from clothes washing machines, dishes, and bathing, it then becomes known as "domestic wastewater." Sewer systems are installed in almost all major cities in the 21st century. Centralized facilities treat

Food, green waste, paper, and other organic waste must be managed properly to protect public health and the environment. Organic waste can attract pests, create odors, cause fish kills when dumped into water, and produce methane during decomposition.

wastewater prior to discharge. *Sewage sludge* is the name for solid residues generated from wastewater treatment facilities that are either further treated on-site for stabilization or directly disposed of. In the United States, the term *biosolids* is used to denote treated sewage sludge. Often, the treatment and handling of sewage sludge is responsible for as much as half of the operational costs associated with treating wastewater.

Reuse

With careful management, organic waste can be utilized as a resource, rather than as a waste. Source separation of organics from solid waste is the first step in encouraging beneficial use of organic wastes. As of 2010, source separation of organic waste is still in its infancy in North America but is widely adopted in the rest of the world. Mechanical sorting of organic waste is also available. Since the 1970s, siting of landfills has become increasingly difficult in many places, as landfills are considered to be one of the locally unwanted land uses. Organic waste diversion can be used as a means to extend the life of a landfill as well to achieve a number of environmental and social benefits.

Feeding food scraps to animals, especially to pigs, was started probably as early as humans domesticated them, and it is still a common practice in various locations in the 21st century. For example, in Egypt, the *zabaleen* population has been a major provider of waste management services for years. In 2009, when the swine flu outbreak occurred, their swine operations were shut down and cities like Cairo experienced a crisis in organic waste management.

Land application is another practice commonly used to dispose of organic waste. This provides an opportunity for nutrient recycling, to improve soil properties, and to bind carbon into soils. Composting agricultural residues, manures, food scraps, yard waste, and night soil has been performed throughout history and was the major method for enhancing agricultural productivity until synthetic fertilizers replaced its position after World War II. Still, treated or untreated wastewater can be used for farm irrigation, maintaining a stable supply of water and nutrients. Compost is also used as a soil amendment and can be used as a soil cover for landfills. Ecological sanitation (ecosan) is another concept used to integrate material recovery from organic waste as a part of management processes while ensuring the protection of public health. Though it is an overarching concept, ecological sanitation tends to orient itself toward low-technology and low-cost options for developing countries, such as modified pit latrines. The application of biosolids is a common practice, but because of the origin of the waste, this practice is somewhat controversial in the early 21st century. Nutrient recovery from organic waste is important because modern agriculture is highly dependent on fertilizer usage. Phosphate, a major source of conventional fertilizer, is a limited resource, like fossil fuels, but unlike fossil fuels there is no substitution for phosphate.

Energy Recovery

Energy recovery can be another benefit from the utilization of organic waste. For the most part, the carbon contained in organic waste is taken from the atmosphere through photosynthesis. Thus, organic waste is considered a form of biomass and a renewable energy resource. A major portion—if not all—of organic waste is combustible, and can be incinerated. In order to overcome its high water content, organic waste is sometimes co-combusted with other fuels.

The collection of biogas is another means of energy recovery. Biogas is a by-product of anaerobic decomposition of organic waste containing mostly methane and carbon dioxide, with small fractions of other gases. At the landfill, biogas is collected through the installation of gas wells and collection pipes. The combustion of biogas is also encouraged for destroying nonmethane organic pollutants present in biogas. Anaerobic digestion is another measure to harvest biogas from organic waste. Anaerobic digestion is a controlled and enhanced anaerobic decomposition process that can potentially achieve higher methane yields. Anaerobic digestion is widely used at wastewater treatment plants to treat sewage sludge. The digestate could also be land-applied directly, or further composted with other organic waste.

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See Also: Anaerobic Digestion; Biodegradable; Composting; Human Waste; Incinerators; Methane; Pollution, Air; Pollution, Land; Pollution, Water; Public Health; Sewage.

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Osaka, Japan

Osaka City is located in western Japan. Surrounding it is the Greater Osaka area, the second-largest metropolitan area in Japan with 2.6 million people. Historically, Osaka is known as "the Kitchen of the Nation." Much like Chicago in the United States, Osaka has served as a port for commerce, especially during the early-to-middle ages, at which time the nearby cities, such as Kyoto and Nara, were the capital of Japan. After the central government moved from Kyoto to Tokyo, Osaka maintained its role as the center of the Kansai industrial area, including the waste management industry. Osaka played a leading role in advancing waste management in Japan and became a hotbed for research and the development of incinerators. Over 99.9 percent of combustible general waste generated has been incinerated since 1980. Osaka has also been used as a pilot city in implementing innovative technologies, such as pneumatic waste collection systems.

Waste Management Practices

Osaka City is the capital of the Osaka Prefecture and is divided into 24 wards. Just like the other prefectures in Japan, Osaka Prefecture's Waste Management Plan is in accordance with the basic policies of the central government. By these policies, local municipalities have the authority to implement their own waste management practices. It should be noted that the ward system in Osaka City consists of geographical divides, rather than the system of special wards (like that used in Tokyo). By doing so, Osaka implements municipal solid waste management planning at a city scale.

About 30 percent of the residents in the Osaka Prefecture reside in Osaka City; however, this part of the population contributes only 45 percent of the total solid waste generated in the area, which is primarily because of the high concentration of businesses. Approximately 1.39 metric tons of general waste and 5.3 million tons of industrial waste are generated every year. This number is almost half of the peak of 2.17 million tons per year that was reached in 1991. About 430,000 metric tons of municipal solid waste are recycled, while the rest is incinerated. As of 2010, there are two final disposal sites in Osaka accepting 770,000 metric tons of incinerator ash and other by-products annually. The Hokko disposal site is managed by the City of Osaka and takes 82 percent of ashes while the rest goes to the Osaka Regional Offshore Environmental Improvement Center. The Osaka Regional Offshore Environmental Improvement Center is a 1,235-acre landfill and is jointly utilized by the 206 municipalities from Osaka, Nara, Shiga, and Wakayama Prefectures. Osaka City has a target of 25 percent reduction for waste incinerated by 2015, which has been encouraged through the "reuse, reduce, recycle" program in accordance with the basic policies of the central government. Through the encouragement of this grassroots effort, 4,000 zero waste activity leaders have been appointed to lead public education and outreach, many of whom are retired senior citizens.

Historical Perspective

During the premodern era, waste management was done mostly by human labor, and dumping into the ocean or waterways was the most common practice

of waste disposal. In order to protect navigating boats, the dumping of trash into rivers and canals was banned in 1649. However, it was 250 years before the idea of sanitation and public health started becoming the driving force behind waste management. Modern sanitary practice was adopted in Osaka soon after the establishment of the National Waste Disposal Law in 1900, at which point local municipalities became responsible for managing their respective waste. One of the first batch incinerators in Japan was built in 1903, and the very first draft furnace incinerator followed in 1916. Since then, Osaka has been the center for research and development of incineration technology.

Osaka has also served as a pilot city to experiment with waste collection systems. Collection methods evolved from manhandled carts and horse wagons to 21st-century special collection trucks. The Great Depression and the burden of warfare depleted both human and financial resources from the city, leaving Osaka in desperate need of improvements in waste collection and resource recovery practices. As World War II started, the resources were even more scarce, leading to the encouragement of source reduction and separation of waste. This was the first time that Osaka City implemented separate collection of recyclables. The three lines of wastes—kitchen waste, recyclables, and refuse—were collected. Kitchen waste was sent to hog farms or was later composted for fertilizer. The combustible portion of the refuse was sent to the public bath and incinerated as a fuel. Bombings devastated Osaka City. The population of Osaka fell from 3.2 million to 1.1 million, and waste management was practically halted. It was ironic that during the war the record-high recycling rate of 37 percent was achieved. Separate collection of recyclables was not started again until more than 50 years after this first attempt.

The incineration of solid waste was resumed in 1946 in response to rapid population and economic growth. The prewar incinerators were renovated, but because of low efficiency and proneness to cause odor and air pollution problems, Osaka City decided to move forward and import the newest incineration technology at that time. This technology was received primarily from European countries. In 1959, the Sumiyoshi plant installed the first fully automated incinerator, and two years later, the Nishiyodo plant completed assembly of the first incinerator with electricity generation capabilities. Implementation of these more sophisticated technologies showed a model for the rest of the municipalities. Subsequently, eight more incinerators were built, and Osaka achieved its goal of combusting all the combustible waste from the city by 1980. The largest upgrade in incinerator technology took place in light of concerns regarding dioxin pollution that swept across the island of Japan in the late 1990s. The Maishima plant is perhaps the best-known plant in Osaka. It utilizes a step combustion grate incinerator, which was completed in 2001. The plant is known not only for having the latest equipment in exhaust gas technologies but also for its very artistic appearance. The exterior of the Maishima plant was designed by the Viennese artist Master Friedensreich Hundertwasser, and it symbolizes the harmony of technology, ecology, and art.

Even with all the efforts to achieve volume reduction of waste through incineration, securing final disposal sites was not an easy task. As urbanization rapidly took place in Osaka, siting a new landfill became increasingly difficult, and waste began to finds its way into Osaka Bay. During the later 1960s and early 1970s, some smaller landfills were sited in the shoreline area. However, soon after, Osaka ran out of space on land and sought to reclaim land from the sea to use as final disposal for its waste. The Hokko Landfill site was established in 1973 and continues as the major landfill for the city since.

As the second-largest industrial area in Japan, the Greater Osaka area became a core Japanese manufacturing sector and contributed a large sum of industrial waste. The problem of safe disposal of industrial waste became a pressing issue, as was finding a final disposal site for municipal solid waste. The Osaka Phoenix Project was started in 1981 to address this issue and to incorporate solid waste management on a regional scale as a part of the planning for the overall port system. The Osaka Regional Offshore Environmental Improvement Center, a landfill located in 1982, has been providing the final disposal site for about 200 municipalities.

The Osaka Phoenix Project played an important role in Japanese waste management when the Hanshin-Awaji earthquake hit Kobe, another major

port city in Japan located adjacent to the Greater Osaka area. The landfills established by regional partnerships offered a disposal site for concrete and other noncombustible waste generated by the earthquake. This case showed the importance of including solid waste management in the emergency response plan. Still, the proximity principle—treatment of solid waste must take place where it was generated—was the core philosophy of Japanese solid waste management for preventing long transportation of waste and responsible management; however, this case showed the importance of having regional partnerships.

Osaka also has a legacy of innovative collection systems. A pneumatic waste collection system was established in 1961. This system carried waste through a vacuum-type underground pipe system from each household to incineration plants or waste transfer stations. This was designed to provide effective waste collection for a high-rise apartment, for the Morinomiya Second Residential Complex (approximately 2,000 households), and for Nanko Port Town (approximately 10,000 households). The introduction of low-emission vehicles for waste collection has since been encouraged, and as of 2007, there were 269 vehicles running on natural gas.

Human Waste

The city of Osaka has also used innovative approaches in human waste management. It is true that the manual collection of night soil and land application was also a common practice until the mid-20th century. However, Osaka City is equipped with the oldest sewer system in Japan, built over 400 years ago when Hideyoshi Toyotomi constructed Osaka Castle. This ancient sewer line continued to be used even after the modernization of the sewer system during the 1890s. About 1.2 miles of these sewer lines were still used as of 2010. The first wastewater treatment plant was built in 1940, and by 1977, more than 99.9 percent of the population was served by flush toilets connected to public sewers.

By 2010, approximately 740 million gallons of wastewater were treated every day in Osaka at the 12 wastewater treatment plants throughout the city. All the sewage sludge from these sites is planned to be sent to the Maishima Sludge Center, which is a central sludge treatment facility. The pipelines carrying the sludge have already connected nine facilities, and the construction of the final portion was begun in 2010. At the Maishima Sludge Center, sludge is processed through anaerobic digestion. The dewatered sludge is treated through incinerators and a melting furnace. The melted sludge is used as a construction material for purposes such as concrete aggregate. Because of the centralized treatment of sludge, the sludge utilization rate has improved from 14 percent to 57 percent and allowed Osaka City to install more sophisticated technology for pollution control and energy recovery.

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See Also: Incinerators; Incinerators in Japan; Japan; Pollution, Air; Tokyo, Japan.

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Overconsumption

The term *overconsumption* refers to a way of living in which the lifestyle patterns of human beings lead to an accelerated expenditure of natural resources. Overconsumption is connected to a series of values that promote lifestyles that are inherently

unsustainable. In addition, the trend of population increase plays a significant role in the exacerbation of consumption impacts on the environment.

Evidence

The evidence for the presence of overconsumption is found in numerous lifestyle patterns. In terms of overall consumption, the United States, China, Japan, Russia, India, and many European nations share much of the blame for current conditions. According to author Jared Diamond, the U.S. consumption of natural resources, like oil and metal, combined with its production of wastes, like greenhouse gases and plastics, is about 32 times higher than in the developing world. A major concern with overconsumption is that consumption patterns indicate an increase in all areas, including resource use. In 1972, according to the team of Mathis Wackernagel, which studied ecological footprints, the planet was at 85 percent of the limits of sustainability. In 2008, sustainability was at 125 percent, meaning that humans were living beyond the sustainability of the planet's ecosystems. Some refer to this pattern as "ecological overshoot." The result is the decline of fisheries and forests, the loss of potable drinking water, the decline of fertile soil, and more pollution and waste. If these patterns continue, ecologists argue that the lifestyles associated with overconsumption will result in the need of two or more equivalents of Earth just to meet these increasing strains and demands.

In terms of specific resource usage, the United States leads the world in electricity, oil, and natural gas consumption and is second in coal consumption. Worldwide, many nations have followed the lifestyle patterns of the United States. This, in turn, has led to further depletion of natural resources, the increase of atmospheric carbon dioxide levels, and an increase in products that end up as garbage. While many nations share in the environmental effects of overconsumption, there is a striking disparity in terms of the overall patterns of consumption. According to Global Issues, in 2005, the wealthiest 20 percent of the world accounted for 76.6 percent of total private consumption, while the world's middle classes (60 percent of people) consumed 21.9 percent, and the poorest (20 percent of people) consumed only 1.5 percent. Furthermore, the richest 20 percent consume 45 percent of all meat and fish, 58 percent of total energy, 84 percent of all paper, and own 87 percent of the world's vehicles.

Effects

The effects of overconsumption are numerous, widespread, and long lasting. Natural resources will dwindle, and even those not directly used in the production of the many forms of consumption will decline. As human lifestyle patterns continue in an exponential pattern, the carrying capacity of ecosystems will be overwhelmed, leading to a decline of those ecosystems. Entire nations will experience the desertification of their lands, the draining of their aquifers, and the polluting of breathable air. Overconsumption is connected to demography. As 19th-century demographer Thomas Malthus suggested, the unnatural increase of population, if left unchecked, will result in a stripping of natural resources. Population is thus a multiplier of the many impacting patterns of overconsumption. Given population increases, one major concern is that if other nations follow the United States' model of consumption, the environmental impact will be monumental. Coupled with the issue of population and consumption is the production of garbage. According to Paul Hawken, each American wastes 1 million pounds of materials per year. Heather Rogers adds that 80 percent of the products produced in the United States are used once, then discarded. These patterns of unsustainable living cannot be supported by the Earth's limited resources.

According to the United Nations, consumption not only undermines the Earth's resources but it also stands to create greater inequalities and poverty in the world. In addition, many argue that it will lead to warfare between nations striving to hold onto or gain resources. One of the most precious of these resources is water. Water and other nonrenewable natural resources may become the greatest sources of future political conflict worldwide. Additionally, the never-sated patterns of consumption result in the need for cheap labor. Worldwide, the consumption patterns of wealthy nations are met through the employment of cheap workers in sweatshops and maquiladoras. Overconsumption also results in a number of issues that impact individuals. Many individuals suffer from obesity, seri-

ous health issues, and diseases of modernization, which are directly tied to contemporary lifestyles. Further, there are psychological tolls: many people suffer from depression and psychological disorders as a result of consumption patterns; others discover that they grow increasingly unhappy as their wealth and possessions increase.

Theories in Economics

While overconsumption can be tied to communist and socialist systems (including those of the former Soviet Union and China), as globalization has expanded and as more nations have moved toward the embracing of capitalism (including China), the effects of overconsumption have increased. Overconsumption can be tied to what David Harvey calls the "capital surplus disposal problem of capitalism." That is, under a capitalist system, an overarching goal is increasing profits by any means necessary. Even in conditions of creative destruction in which products are created only through the destruction of other things (including the environment), little concern is placed on the impacts of increasing profits. As capitalism expands, many politicians, legislatures, and judiciaries have expanded the legal rights of corporations, even in the face of environmental and social harms.

According to marketing theorist Victor Lebow, the system of capitalism promotes the idea of consumption as the natural way of living; and it is a way of living, he adds, that promotes the extensive using up, wearing out, replacing, and discarding of objects. Capitalism promotes a value structure that stresses individualism, immediate gratification, and the idea that the Earth is a limitless resource. Another key feature of capitalism is what Charles Kettering of General Motors referred to as the "organized creation of dissatisfaction," which involves the creation of desires within the consumer to buy new things, even replacing things that work. Vance Packard noted this practice, using the term *planned obsolescence*. The initial purchasing of a product is a notable impact on the environment, but when consumers are convinced that they need a replacement for an old item, the impacts on the environment are multiplied. Additionally, capitalist consumerism promotes a close affiliation between the consumer and the product. This affiliation has expanded beyond the levels analyzed by 19th-century economist Karl Marx in the notion of commodity fetishism.

Since the 1800s, U.S. consumption patterns were altered when goods and services were no longer marketed as functional or utilitarian; instead, companies began to associate goods and services with various forms of lifestyle. In this way, the product becomes inseparable from the person, and it becomes more and more difficult for consumers to not consume products. Further, as Thorstein Veblen notes, often the products purchased are acquired just for the purposes of conspicuous consumption. Thus, at its core, a capitalist system promotes forms of living that are unsustainable and are geared toward overconsumption.

Choice

Overconsumption is also related to consumer choices and behaviors. One of the staggering realizations of overconsumption is that people have made the choice to spend billions of dollars on luxury goods, expensive and unneeded forms of technology, and forms of curious novelty instead of choosing to spend this money on fulfilling the basic needs of food, security, medical care, housing, and education of less fortunate people. Christopher Lasch identified contemporary consumer living as a form of narcissism in which people are only concerned with their well-being, with little regard to the effects of their consumption on others and on nature. Article 25 of the 1948 Universal Declaration of Human Rights states that "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services." This standard of living, health, and well-being is, however, impossible given that overconsumption is fundamentally rooted in an unequal distribution of resources (both natural and human made).

Alternatives

The model of overconsumption is resultant from the dominance of one main form of cultural lifestyle. There are examples of other cultures that promote forms of living in dramatic contrast with the cultures of overconsumption. As opposed to accumulation, northwest coast Native Americans often follow the model of the potlatch, in which the distribution

of goods equates with prestige. Anthropologist Marshall Sahlins wrote of the !Kung of South Africa as the original model of affluence. Their model of affluence, in contrast with consumer models, is one in which one produces much and desires little. The Center for a New American Dream offers a model of living that parallels many of the life values of the !Kung. One of their philosophies for consumers is to have more fun with less stuff. In Japan, the Seikatsu (lifestyle) Club Consumers' Co-operative Union is one response to overconsumption. The group, with over 300,000 members, monitors its consumption patterns, has direct involvement in purchasing of items, actively recycles, and has been successful in leveraging local companies to change production processes.

An important goal for ending overconsumption is to focus on greater education and emphasis on people's individual impacts. Paul Ehrlich and John Holdren offered that individual environmental impact could be calculated by multiplying the variables of population, affluence (or consumption), and technology, represented algebraically as $I = P \times A \times T$. Were people more conscious of the connections and effects of production, distribution, consumption, disposal, and reuse, they might be more willing to alter their behavior and perhaps curb consumption. Consumers may be convinced to stop overconsuming and consume in a way that is more equitable. Or, as E. F. Schumacher offered, consumers may choose a way of living that maximizes well-being and minimizes consumption. Some consumers, including freegans, freecyclers, and members of cooperatives, have tried to educate other consumers about new models of living. Some corporations have heeded many of these strategies. Patagonia, a clothing manufacture, features a detailed Web report on the nature of its production processes, including carbon footprint for each product, water use, and other indicators. Ray Anderson of Interface, Inc., in Atlanta, Georgia, took a radical approach that involved the reuse of old carpets to make new ones.

Some environmentalists do not believe that individuals will make a difference in curbing consumption. Many advocate for global policies of reduction, reuse, and rethinking. Paul Hawken has called for a model of natural capitalism in which radical resource productivity, biomimicry, a service and flow economy, and investment in natural capital become the norm. Others have called for One Planet Living, which includes concepts such as zero carbon; zero waste; sustainable transport; the use of local and sustainable materials, food, and water; focus on natural habitats and wildlife as well as culture and heritage; equity and fair trade; and principles of health and happiness. Other global models include the degrowth movement (a view that calls for the downsizing of production and consumption), zero growth (the view that a continuous growth economy is unsustainable), and true cost economics (a view that focuses on all of the costs associated with production, including those related to the environment).

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See Also: Consumerism; Culture, Values, and Garbage; Underconsumption; Zero Waste.

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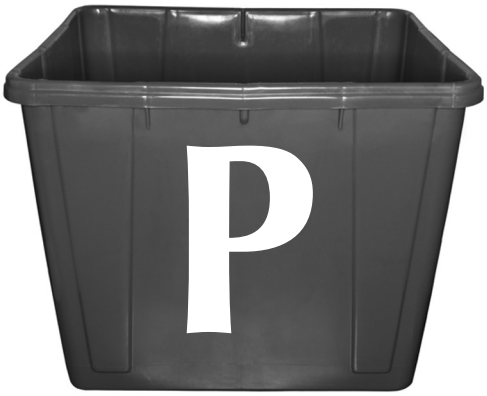

Pacific Garbage Patch

Pacific Garbage Patch is the name given to one of several large collections of plastic oceanic debris, the first of which was discovered floating within the north Pacific. Its complexity presents unique problems to the regulatory governance of environmental pollution and introduces nonhuman agencies into the conceptualization of waste flows. Consequently, oceanic garbage patches like the one in the north Pacific demonstrate the material and global impact of industrial economies by way of the material afterlife of plastics.

Prediction and Discovery

Located between Hawaii and Alaska and estimated to be roughly the size of the state of Texas, the patch is one of several sites within the world's waterscapes where marine litter has gathered since the early 1900s. A gyre is a vortex that slowly accumulates waste material because of the rotation of ocean currents and wind movements. Oceanic garbage patches are unusual among pollution events because marine scientists predicted that they might exist before they were officially documented. In the conventional narrative of pollution events, a group of people take note of a negative development affecting human or nonhuman life and seek out a precipitating cause and responsible party. The impact of plastic on the ocean was already a growing concern when a paper at the 1989 National Oceanic and Atmospheric Administration conference proposed that high densities of waste plastic might converge in the ocean's gyres. But it was not until a catamaran piloted by Captain Charles Moore took a detour through the north Pacific gyre in 1997 that the extent of the patch became apparent. Moore and his crew were returning from a race from Los Angeles to Hawaii and decided to explore the vast stretch of sea, which was typically avoided because of its lack of fish and winds. They were stunned by the amount of plastic waste they found floating at or near the surface, which Moore estimated as approximately 3 million tons.

Marine litter from ocean dumping is a known problem, but most organic wastes are consumed or disappear into the food chain. Plastics, on the other hand, tend to endure and decay only gradually through exposure to the sun. Over time, photodegradation breaks plastic objects into their basic constituents—polymers—creating a chemical soup of tiny plastic pellets, which blend in with the marine ecosystem.

When a pollution event is discovered, there is an effort to assess the damage, find the party responsible, and clean it up. Typically, this is conducted under the supervision of the territorial government's regulatory mechanisms. But nonhuman forces of circulation carry plastic garbage from shipping lanes and coastlines into transboundary waters, where no country has ultimate jurisdiction. As a consequence of the nonhuman traffic in plastic, it is not entirely clear who is responsible. Many societies have practiced ocean disposal for centuries, and some have speculated that one source of plastic might even be landfills along the coast, losing stray plastic debris in the wind. Not surprisingly, many writers on the subject of the garbage patches defer responsibility to consumers and society's everyday dependency on plastic use. In some ways, this crisis in accountability mirrors difficulties with climate change governance, particularly the difficulty of distributing responsibility and inviting individuals and households to change consumption and disposal habits in order to prevent global catastrophe. Even if a particular party were held accountable or took responsibility for the oceanic debris, it is not clear what could be done about it.

Moore has become the leading public persona raising awareness of the garbage patch through the media and exploring its effects through regular research expeditions. Early on, perhaps the most famous published result, found in the *Marine Pollution Bulletin* in 2001, was that the gyre supports six pounds of plastic for every pound of zooplankton. Moore began the Algalita Marine Research Foundation (AMRF) to support further investigation of the patches and continues to collaborate with other researchers, environmental groups, and nongovernmental organizations.

Because the normal narrative of pollution events does not apply, most of the research is not attempting to establish who is ultimately responsible but rather to determine what impact the patch might be having. It has been argued, for example, that floating fragments of plastic accumulate toxic chemicals from the water and, when ingested, transfer these substances through the food chain, eventually back to humans on land. If this is true, the economic consumption of plastic materials as storage vessels could ultimately lead to humans serving as storage vessels for the remains of plastics through their bodily consumption of marine life.

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See Also: Fish; Ocean Disposal; Politics of Waste; Pollution, Water.

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Packaging and Product Containers

Consider the number of items sold without packaging or a container. Do not be surprised that it is difficult to identify particular individual goods—much less product categories—that do not use packaging. Even large-ticket items such as cars and trucks include stickers and protective coverings like floor mats when sent to dealers. Many other items, such as liquid soap, beverages, and most food, simply cannot be transported or sold without a package or container. Besides its protective function, packaging and product containers serve other important purposes. They provide crucial product information to consumers and can be a critical input in the decision to buy a product. Typical consumers, however, discard packaging and product containers without much thought—more interested in what has been contained rather that the container itself. Packaging and product containers enable a consumer-driven economy, but because they are usually discarded as waste, they can be detrimental to the environment.

Functions

Before their disposal, packaging and product containers fulfill a number of functions in the marketing and distribution process. Most essentially, packag-

ing houses and protects the product. Some products may be fragile and require packaging that can absorb shock and protect the product from damage. Other products may spoil if exposed to environmental factors like light and moisture or excessively low or high temperatures. Some products, such as chemicals, paint, medicines, or sharp objects, can be potentially dangerous, and packaging must minimize risk both to individuals handling the product through the shipping and retail process as well as to the end user. For safety reasons, many products must be tamper-evident or tamper-resistant. Furthermore, products can travel thousands to tens of thousands of miles through the entire supply chain from the manufacturer to wholesale and retail operations before they are purchased by the end user. Proper packaging can ease the transportation and storage process.

For end users, packaging can enhance the use and convenience of products, such as pull-top cans, individually packaged snack foods, resealable food containers, squeezable condiment bottles, and premeasured quantities of detergent. Some beer companies offer their beverage in cans that turn colors when the beer is cold enough to drink or employ other packaging gimmicks to distinguish their product. Though enhancing consumers' experience with a product is paramount, convenience to the intermediaries in the supply chain is also important. Shipping cartons that are efficiently and easily loaded and stacked into box cars or other transportation sources reduce an array of costs, including those for fuel, labor, and vehicle acquisition and maintenance. If a product's packaging or container makes it too difficult to stock, either because it is an odd shape or because it takes up too much space, retailers may refuse to carry it or transportation costs may be exorbitant.

Packaging and containers must also provide information about the product, including ingredients, warranties, potential uses and benefits, and possibly price. Local, state, and national regulations govern the details that must be included on product labels. In the United States, to ensure that consumers receive fair and accurate information, the Fair Packaging and Label Act of 1966 (FPLA) requires companies, with some exceptions, to label consumer products with ingredients, quantity, and manufacturer information. Amendments passed in 1992 call for the inclusion of metric, as well as the U.S. system, of measurements. The Nutrition Labeling and Education Act of 1990 standardized definitions of claims such as "low fat" and "light" on packaged food, and the Federal Food and Drug Administration issued regulations in 1993 requiring restaurants to adhere to the same requirements for any nutritional or health claims appearing on signs or menus. Many states have adopted recommendations outlined in the Uniform Packaging and Labeling Regulation published by the National Institute of Standards and Technology, a division of the U.S. Commerce Department. Other laws and regulations apply to particular products or industries. The European Union (EU) has also adopted a number of regulations affecting product labeling, including standards for food items that require identification of the product, ingredients, potential allergens, a sell-by date, and the optimal storage conditions.

Retailers or wholesalers may also have requirements for packaging and product containers, such as the inclusion of the universal product code (UPC), which allow retailers to quickly scan items, assisting in the point-of-sale process and aiding inventory control. Some big box retailers require vendors to include Radio Frequency Identification (RFID) tags on packaging and containers. These tags allow for quick identification of products and improve the efficiency of the supply-chain process while assisting in inventory tracking. RFID tags can also be used as a security measure by tracking the location of potentially stolen items. In the future, they may trigger anti-shoplifting alarms.

Packaging and product containers promote the product, brand, and company. Because a large proportion of buying decisions are made in the store when a consumer is choosing between two or more varieties of a product, often in only a few seconds, manufacturers are devoting ever more resources to innovative and appealing packaging. Steven DuPuis and John Silva that assert packaging that appeals to consumers' senses or emotions is most successful. Some manufacturers include scratch-and-sniff scents to allure consumers through their sense of smell. Packaging that convinces consumers that the product is reliable or the best product in the category is also effective. When brand equity exists, capitalizing on the strength of the brand through the package

can entice consumers into purchasing a product. The shape of the Coca-Cola bottle itself is so powerfully identified with the brand that it is trademarked.

Packaging, then, provides myriad benefits to manufacturers and retailers, who enjoy ease of handling, transportation, and storage, and influences consumer sales. Consumers benefit through the constant innovation in packaging that makes products safer and easier to use.

Layering

Products might include multiple levels of packaging, the primary container actually holding the product, a secondary container that aids in protection or handling and in providing a promotional message, and perhaps additional levels. Most cereals, for example, have plastic liners as the primary packaging and paperboard boxes printed with marketing material and required labeling information as its secondary packaging. A pair of tennis shoes might contain an extraordinary amount of packaging compared to the volume of the product: material is placed inside the shoe so that it maintains its shape; each shoe is placed in a separate bag or wrapped in paper to minimize scuffing; and the pair of shoes is then packaged in a box. Used in transporting goods from manufacturer to distributor to retailer to end consumer, cardboard boxes, palettes, and boxcars represent an additional level of packaging. As direct-to-consumer sales via the Internet increase, more and more boxes, shrink-wrap, and other shipping material enter the waste stream. Shipping containers often include identifying features on their exterior, from the name and logo of the manufacturer or retailer to information about the products inside.

Typically, the various layers of packaging are made from paper or paperboard, plastic, glass, steel, aluminum, wood, or, less frequently, other materials such as jute or bamboo. When selecting the appropriate raw material for a product's package, manufacturers examine the features of the material in light of their design specifications, the needed qualities of the package or container, and the cost burden.

Brief History

Packaging was not always as ubiquitous as it is in the 21st century. Although natural materials such as leaves, bark, and textiles have always been used to wrap, contain, and transport items, commercial packaging did not exist until the 19th century. The first packages, strictly utilitarian, were designed to preserve food. Before the advent of food packaging, grocers received items in bulk, and customers requested the items and quantity they desired. Food packaging allowed customers to serve themselves. As the Industrial Revolution developed and manufacturing technologies advanced, packaging material and production became easier, faster, more reliable, and more standardized. The post–World War II boom in consumer products further drove demand for packaging and containers. As companies developed new products and competed for market share, packaging evolved to house those products and appeal to consumers.

Redesigning a package might mean using less plastic, eliminating secondary packaging, or making the package smaller. Some containers cannot be recycled or redesigned because of regulatory requirements, or because of consumer demand.

Environmental Impact

Environmental concerns were negligible to nonexistent in the post–World War II consumer boom, and disposing of unwanted packaging was as simple and

guilt-free as throwing it in the trash bin. Knowledge of the hazards of packaging and product containers when they become waste began to be discussed in the 1970s; the problem and its complexity is well known in the 21st century. In 2008, containers and packaging comprised over 30 percent of the total volume of municipal solid waste. Of that, less than 44 percent was recycled. Every 30–40 days, Americans discard their own weight in packaging. California alone generates 15 million tons of packaging waste each year. Other industrialized countries have similar consumption and waste patterns. Discarded packaging contributes to the need for landfills and their accompanying health risks to humans, animals, and the environment.

Before packaging even reaches the end user, it can also negatively impact the environment. Packaging and containers lead to the depletion of natural resources that are necessary for their production. Glue and ink used in packaging can be toxic, and pollution results from the manufacturing and transportation process. Some packaging can even be directly harmful to human health, depending on the materials used in its creation. For example, bisphenol A (BPA), which is used in the manufacturing of plastics such as bottles or food containers as well as other nonfood plastic items, has been linked to prostate and breast cancer as well as other reproductive system disruptions.

These concerns lead to a final function of packaging: the ability to dispose of the packaging in an environmentally sound, cost-effective manner. A number of alternatives, many of which require the cooperation of manufacturers, retailers, consumers, and the government, can be utilized alone or in conjunction to help solve the vexing problem of packaging and containers in the waste stream. Recycling is a popular option and is not likely to disappear, but recycling requires products made from recyclable materials. Furthermore, it cannot work if recycling collection facilities are not present or if end users do not make the effort to recycle their packaging. Furthermore, mistakes or misunderstandings in the sorting process can contaminate the collected material. While recycling is an important component of managing waste from packaging and product containers, it must be supplemented with other strategies.

Disposal Alternatives

In conjunction with recycled and recyclable containers, companies are utilizing new approaches to packaging and container design. Applying systems thinking to the design process enables designers to see the life cycle of the package, its place in the system, and its effects on other parts of the system. Numerous frameworks provide guidance to designers wanting to take a systems perspective and use lifecycle analysis. The cradle-to-cradle approach emphasizes a closed loop and rejects the idea of waste, calling for material discarded to become raw material for another product or process. The natural step framework offers four principles to guide product and packaging design, as well as other company operations. Biomimicry seeks design solutions in the inspirational form of the natural world. Finally, the Sustainable Packaging Coalition provides a checklist of best principles. These approaches help design more-efficient manufacturing processes and reduce source material in both the product and its packaging. Redesigning a package might reduce the amount of plastic needed in the manufacturing of a container, eliminate secondary packaging, or make it smaller, all which reduce the amount of material required. When packages are smaller, more can be transported in a single shipment, leading to more efficient transportation. New materials also allow manufacturers to offer more environmentally friendly packaging. Compostable and biodegradable plastics, made from renewable resources, replace traditional plastic, which does not break down. Packages made from pulp can be infused with seeds and planted instead of thrown out as waste. New discoveries constantly increase the range of options available to manufacturers that want to use environmentally friendly material in their packaging.

Some packages and containers cannot be recycled or redesigned because of regulatory requirements or consumer demand. Many companies making products in these packages would still like to give consumers an alternative to putting the waste in landfills. TerraCycle, an innovative company founded in 2001, has answered that need. Working with companies like Nabisco, Frito Lay, and Capri Sun, they collect used packaging such as juice pouches

and make new consumer products with minimal changes to the discarded packaging, thereby diverting nonrecyclable packaging and containers away from the waste stream.

Reusing packaging and containers is perhaps the ideal answer to the problem of packaging waste, but there are barriers to its success. Programs for reusing packaging are meaningless if consumers do not participate. Customers must bring the empty container with them to the retailer, but often even the most well-meaning consumers forget. Reminders to return the used packages can help with compliance, as can incentives for using or submitting used packages or containers. However, commercial users of reusable storage containers have realized a number of advantages, from decreased costs to increased storage space. These programs should be clear and convenient to users to achieve gains.

Regulation

When voluntary efforts fail to create change, governments step in to regulate activities. A number of nations have enacted such guidelines to make manufacturers more responsible for the waste they produce, including packages and containers, or to promote recycling. In the United States, regulations primarily revolve around hazardous or toxic products, though some individual states have adopted container deposit programs, resulting in higher recycling rates. However, any environmental claims about the product or packaging that appear on the label or in promotional material and advertising must follow the Federal Trade Commission (FTC) Green Marketing Guidelines. In Asia, both Japan and Taiwan have adopted laws that govern packaging and recycling. Australia and individual provinces in Canada have created programs to reduce waste and promote recycling. Perhaps the most extensive regulations are delineated in the European Union's Packaging Directive, conditions for which were made possible by Germany's 1990 Green Dot program, which was designed to minimize waste by shifting the burden of disposal to the manufacturers.

Conclusion

Only 200 years ago, the vast array of 21st-century products and their unique and innovative packages and containers would have been unimaginable. With 21st-century packaging and containers, consumers gain safety, convenience, and peace of mind. Manufacturers get reliability, standardization, increased transportation and storage efficiency, and a final canvas for promotional messages. The disadvantage, however, in the form of environmental damage, must not be ignored. Manufacturers, consumers, governments, and nonprofit organizations all contribute to the myriad solutions available, including innovation, recycling, reusing, and reducing, but more must be done to solve the vast and vexing issue of packaging waste.

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See Also: Consumerism; Environmental Defense Fund; Landfills, Modern; Overconsumption; Post-Consumer Waste; Producer Responsibility; Recyclable Products; Shopping; Zero Waste.

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Paint

Wastes in paint are regarded as "difficult waste." Paint can create messes: it can spill either in a regular refuse collection or in a recycling box; it can go all over the dustbin, the rubbish truck, or the pavement.

Paint is a difficult waste and therefore people tend to store it. Unlike other residues, consumers keep unused paint in patios, sheds, or garages, expecting to find a future use or waiting for a safe method of disposal that never comes. It is a case of deferred or postponed disposal. It sometimes appears that people do not know what to do with wasted paint.

Difficult waste is that which, in certain circumstances, could be harmful to human health or the environment; for this reason, it might not go in regular collection services, or contractors could charge a premium because they, in turn, will be charged at the point of disposal. But hazards can only happen in certain circumstances and, indeed, the only significant risk property of paint is the flammability associated with solvent-based paints, which can include many gloss paints, undercoats, and primers. Conversely, water-based paint, more commonly used in the 21st century, is virtually harmless, but it can still create messes due to its liquid and viscose character.

Disposal

According to the Environmental Protection Agency (EPA), every year American homeowners throw out 64 million gallons or 242 million liters of unused paint, which is enough to paint 16 solid highway stripes from the Earth to the moon. Indeed, more paint is wasted in do-it-yourself (DIY) works than in professional ones, since painters and decorators know better than the general public about how much material is needed. Additionally, professionals change their mind less often and tend to stick to the color originally chosen. Retailers of paint also account for some of the waste, because minor faults such as a dent in a can can make the material unsellable. Additionally, when the choice of customized colors is available, rejected results are also disposed of.

Uses and Types

Most of the paint sold is decorative. A much smaller volume is used for other applications, such as the painting of cars, yachts, and boats, and for hobbies and games. It is important to understand the components of paint when addressing the health, safety, and environmental impacts of the product and its waste. Paint, generally, contains pigments, extenders, binders, thinners, solvents, and additives. A significant proportion of high-performance coatings can be used in maintenance work on public buildings, such as hospitals, schools, and road bridges. Industry and commerce deal with many different types of paints and coatings, some of which include gloss, enamel, spray paint, and emulsion; the use and disposal of all these latter substances can have a significant impact upon the environment.

Lead

Lead is a material of particular interest within the components of paint. It is used as a pigment, particularly in "chrome yellow" and "white lead." It is also added to paint to speed drying, increase durability, and resist moisture, which can damage the underlying metal or wood. This is important because lead is generally considered a dangerous substance, particularly for children younger than 6 years old; for this reason, people are particularly wary about disposing of lead paint and have heard alarming media stories about it. Certain countries such as the United States, the United Kingdom (UK), and Australia have totally banned lead-containing paint and also toys and furniture coated with such paint because of the risk of the poisoning in children who may ingest chips or peelings. Because of this potential hazard, in 2007, millions of toys made in China were recalled by different countries. However, in other countries, lead continues to be added to paint intended for domestic use, and it is also generally used in certain industries, by the military, and for street and pavement marks. The walls of older buildings, even in places that have banned lead paint, can also contain lead if they were painted before the 1970s regulations. Effective April 2010, U.S. law also requires that all renovators who work in homes built pre-1978 and disturb more than six square-feet of lead paint must be certified and follow specific work practices to prevent lead contamination. Lead has low reactivity and solubility; as such, lead poisoning usually only occurs when the paint is dispersed (as when sanding or torching paint).

This example of lead gives a different and particular character to the wastes in paint, since dispersed residues can be more harmful than the paint in all its integrity, both when floating in the air or in the form of chipped pieces of toys or furniture. Lead, as residue, can be found in the blood and bones of humans who have inhaled dispersed paint. Lead poisoning is one of the oldest-known occupational hazards; it has been significantly common for painters, plumbers, and decorators (for this reason, it is also known as painter's colic). Very recently, a group of scientists affirmed that they were 85 percent sure that they have found the remains of the notorious Italian painter Caravaggio in Tuscany; one of the reasons to suggest that they belong to the artist is that the bones found contain high levels of lead, enough to drive the painter mad and contribute to his death. It has also been suggested that other infamous artists, such as Francisco de Goya and Vincent Van Gogh, might have suffered from the ill effects of the lead in their paint, stored as residue in their blood and bones. Paint, as waste or residue, also persists inside the body and can cause irritable temper and bad moods.

Community Repaint

Because of the "difficult waste" character of paint and its potential health hazards, the general advice is to use the paradigm of reduce, reuse, and recycle when disposing it. To prevent any extra stock, buy exactly what is needed for each project, reuse old paint for new projects, and recycle through donations to neighbors, family, friends, charity shops, or community repaint projects. Small amounts of leftover water-based coatings can be soaked in some absorbent material, such as cat litter, and then disposed in a dustbin.

Community repaint projects can be found in different countries due to the rising awareness of the difficult character of unwanted paint. According to the Community RePaint Website, in 2009, the national network of these initiatives in the UK saved 313,235 liters of paint, with a market value of over $1.25 million. Over 200,000 liters of paint were redistributed among charities and people in need (in comparison, the same Website estimates a total of 55 million liters of unused or discarded paint generated every year, of the total of 366 million liters of paint sold in the country). The main operational activity of this and other similar networks in different countries is to collect unwanted paint and redistribute it so that waste is converted into a useful material.

As happens with the domestic disposal of wasted paint, only some materials are accepted by the Community Repaint scheme in the UK and other areas. The acceptable materials are paints suitable for domestic application, such as emulsion paint (including vinyl matt and vinyl silk emulsions), gloss, eggshell, satin paint, undercoat, primer, floor paint, masonry paint, exterior paint, varnishes and wood stains, or tile paint. Unacceptable materials include paint thinners, paintbrush cleaners, paint strippers, wood preservatives and treatments, any pesticide product, car paint, specialist and industrial paints, aerosol and spray paints, cellulose-based paint, paint not in its original container, paint over 10 years old, and any paint containing lead. All the latter cases continue to be very difficult in terms of their disposal; for example, spray paint cans are volatile because of the aerosol pressure they contain and can explode when submitted to heat or extreme pressure in a garbage collection vehicle. As a result—and even though empty cans can be disposed of in the regular home garbage—if there is even a small amount of paint in the can, it cannot go in the domestic waste.

In terms of trends and challenges in the management of paint waste, different organizations continue to be concerned about the liquid components in the household waste stream, where they see a potential for contamination, spoilage, and volatile organic compound (VOC) emissions (the main source of human-made VOCs are solvents present in paint and protective coatings). It is important to address these issues globally, since the growing economies are demanding more and more paint as a result of their booming architecture and construction activities. In Asia, for instance, the rise of the middle class has generated more demand for architectural coating consumption as housing production and ownership is expanding. Additionally, in less-developed countries, road construction is surging, which requires more traffic paint, as the growing infrastructure of bridges, water treatment

plants, and power plants is driving usage of industrial maintenance paints.

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See Also: Floor and Wall Coverings; Hazardous Materials Transportation Act; Household Hazardous Waste; National Clean Up and Paint Up Bureau.

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Pakistan

Sharing borders with India in the east, Iran and Afghanistan in the west, and China in the north, Pakistan has an area of 499,545 square miles, making it a little less than twice the size of California. Its population, however, exceeds 170 million—the sixth highest in the world. The high population is accompanied by an unstable economy, with the gross domestic product barely reaching 6 percent since the 1970s and frequently sinking below 2 percent. Hence, while some studies have been conducted and proposals have been made for reforming the waste management system, their recommendations are not fully implemented, usually because of a lack of resources and conflicting priorities. Consequently, Pakistan's problems regarding the generation and disposal of waste have limited prospects for improvement on the regulatory level. Private initiatives and traditional practices, especially in rural regions, do reveal an alternative, regionally effective way of collecting, reusing, and disposing waste. Many of the country's urban poor, for instance, make a livelihood out of trash picking, inadvertently implementing an extremely thorough—albeit flawed—system for sorting waste.

Consumption

The country's literacy rate is one of the lowest in the world, contributing to low levels of awareness and concern regarding waste disposal. Likewise, the 3Rs of "reduce, reuse, and recycle" remain unknown and are usually implemented for monetary gains by those who make a living at it. The disregard for appropriate waste disposal is especially problematic in urban areas. Despite being an agrarian society with the majority of the population employed in agriculture, there is a steady trend of rural-urban migration, with more than one-third of the population living in urban areas in the beginning of the 21st century.

Consumption patterns and availability of goods and services vary starkly between rural and urban areas. Grains, dairy, housing, and health are luxuries in urban areas, whereas fruit, poultry, durable food items, electricity, and entertainment are scarce in rural areas. On the other hand, education is a luxury for all, since the good schools and institutes are private and costly. In urban areas, a consumer culture is rapidly establishing itself, but given the low purchasing capacity, the market is full of poor-quality items with a limited life span, which ultimately increases the amount of waste produced.

The country's consumption of ozone-depleting chlorofluocarbons is the 14th-highest in the world. In addition, Pakistan has high levels of oil consumption, which has always been greater than the available resources, and continues to rise as oil remains the primary fuel for transport and for generation of electricity. Although originally suspected to have several oil reserves, no new discoveries have been made since the 1980s, and a considerable amount of oil is imported. The natural gas reserves, on the other hand, are richer, with the main source being Sui in the southwestern province of Balochistan. Consequently, there was a drive to shift many vehicles from petroleum to compressed natural gas (CNG). While half of the energy consumption is already provided by natural gas, the resources of coal (which is mostly low grade) and natural gas have not been exploited to their full capacity. An Alternative Energy Board was established in 2003 with the aim of alleviating the electricity shortage by generating power through other means, particularly waste-to-energy (WTE)

technologies. Far-reaching results, however, had not yet appeared as of 2010.

The majority of the population is young. Combined with the rising percentage of urban dwellers, this large proportion of young consumers has led to an increasing demand for liquid dairy products (LDP). The first decade of the 21st century witnessed an increase of 19 percent, making Pakistan the world's fourth-largest LDP consumer. While the consumption of milk is high, especially in comparison to other Asian countries, the intake of fruits and vegetables along with fish and meat remains very low. The consumption of fruit and fresh vegetables, which are highly dependent on seasonal availability, is also limited by the lack of organized transport and sale throughout the country. The fact that many of these foods are not regularly available at affordable prices leads to deficiency disorders. Although consuming more meat and eggs than India and Sri Lanka, Pakistan's meat intake has also declined since the start of the 21st century because of rising prices. With wheat being the staple food, covering 72 percent of the energy requirement, the country's consumption of wheat, at 120 kilograms per person per year, is one of the highest in the world. Hence, even though wheat is grown by 80 percent of farmers, additional wheat has to be imported. While in the 1980s the per capita energy intake was equivalent to daily requirements, no surveys have been conducted since then.

Waste Disposal

The amount of waste generated per person in 2001 was 0.6–0.8 kg per day, which was one of the highest in south Asia. In 2006, 54,888 tons of solid waste were produced daily, of which no more than 60 percent was collected. In the capital city of Islamabad, around 388 tons of waste is generated per day and a slightly lesser amount is produced in Multan, which differs glaringly from the 6,000–9,000 tons estimated for Karachi. Additionally, it is estimated that Pakistan generates 250,000 tons of hospital waste annually, of which the province of Punjab, with its 250 hospitals, produces 15 tons per day.

Municipal garbage can contain 8–21 percent food waste and 10–16 percent garden waste, such as leaves, grass, and fodder. Whereas approximately 30–48 percent of the garbage can be fine material, recyclable items are 13–23 percent of the total waste. Since the percentage of organic or biodegradable waste is relatively high, it is still less than that of most developing Asian countries. Nonetheless, the high levels of moisture are sufficient to rule out incineration as a suitable method of waste disposal. Though composting would be the ideal solution for this kind of waste, it is only practiced at an individual scale in rural areas and in a few private plants that usually convert compost into fertilizer or animal feed.

Open Dumping

Open dumping, one of the most environmentally hazardous options, is still the main solution for waste disposal. Due to the dearth of awareness, there is limited local protest against this method. While open dumping is the solution for 80 percent of the waste, composting and landfills account for less than 10 percent of it. A new landfill site was proposed at Kuri, located at some distance from Rawalpindi and Islamabad, but it raised considerable concern because of the potential threats to water and air quality. Instead, a WTE plant has been suggested, but not realized. Incineration is limited and usually practiced at an individual level, as in the burning of garden waste. Nonetheless, such burned waste can also include items that damage the environment, like black polythene bags.

Recycling

Plans to adopt Turkey's method for waste disposal and management, which is based on centralized separation and distribution for treatment, are yet to be realized. The concept of separating or recycling waste on an individual level remains absent, and few incentives or facilities for recycling and reusing waste are officially provided. With the change toward a more consumerist lifestyle, plastics—usually nonbiodegradable—form a significant portion of the garbage. Regional, national, and international nongovernmental organizations—like the Karachi–based Shehri, the Pakistan Environment Welfare and Recycling Program (PEWARP), and the World Wildlife Fund (WWF)—launch campaigns for better solid waste management. However, their attempts at generating greater awareness about the hazards of improper waste disposal are largely limited to edu-

cational institutes and rarely reach a wide audience. Similarly, the literature they produce on the issue of waste disposal remains inaccessible for the majority of the population. In rural regions, on the other hand, traditional practices of reusing leftover materials or refuse are common. Cow dung, for instance, is patted into thin, round cakes, dried on bricks, and ultimately used as fuel. Since packaged products are also scarce in villages, a major element making up the waste in urban areas is absent.

The relatively small, but growing recycling industry focuses on paper, cardboard, and—to a much lesser degree—plastics. Hence, in urban areas, the only kind of separation that occurs in the domestic sphere is the removal of material like paper, metals, and glass, which are collected by neighborhood trash collectors called *kabari* (derived from *kabar*, the Urdu word for "trash"), who pay for recyclable garbage. Often, they also run secondhand stores for electrical appliances, furniture, and even car parts. In addition, street sweepers collect and dispose of some waste.

Scavenging

A large population is also a prominent source of labor and, given the low level of development, the waste management system is labor intensive. Nonetheless, most of the workers, such as street sweepers or truck drivers, receive minimal wages. Because of the inadequate waste collection and disposal system and high levels of poverty, trash pickers play a prominent part in the informal waste management system. Since the 1990s, many of these are illegal immigrants from Afghanistan, about 100,000 of whom were trash pickers in Karachi alone at the beginning of the 21st century.

At transfer points, waste scavengers have the opportunity to sort out garbage. Entire families of trash pickers scavenge the waste in landfill sites or dumping grounds, mostly for recyclable materials of metal, plastic, and glass. Although this kind of sorting removes the main recyclable components from the waste, when the trash picking takes place during the process of transporting the waste to the official dumping ground, the remaining garbage is left unattended along the transport route.

Waste collection also varies according to the economic status of the area. Shantytowns, for instance, are usually ignored. A change in waste collection has occurred in scattered urban areas, like in some sections of Lahore and Karachi, where communal bins have been replaced by house-to-house collection services, which have been set up privately and bring the waste to official landfills or open dumping grounds. These private entrepreneurs operate in close collaboration with the city district's waste management authority, usually on the basis of a subcontract. Their efficiency indicates that the country's waste management situation can be ameliorated without taxing the economy.

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See Also: Biodegradable; Consumption Patterns; Developing Countries; Karachi, Pakistan; Open Dump; Street Scavenging and Trash Picking.

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Paper and Landfills

Paper and landfills have an important relationship that is historical, social, and material. Industrial methods of paper manufacture and landfill disposal together displaced the rag and bone men and other urban recyclers of the 19th century. By the

late 20th century, paper became the most common material found in municipal solid waste (MSW), the biggest threat to scarce landfill capacity, and a significant contributor to the carbon dioxide footprint of landfills. In the 20th century, the prominence of paper products has transformed the labor practices associated with modern landfills. The materiality of paper, specifically its tendency to catch on the wind and spread on- or off-site, has resulted in paper becoming a category that encompasses all forms of landfill litter. The "paper pickers" who are commonly employed at landfills as a consequence exemplify the distance between the labor practices of modern landfills and the forms of recycling for which paper was once synonymous.

Brief History

For hundreds of years, paper production involved a form of reuse that stood in marked contrast to the practice of dumping and burying associated with landfills. Beginning in China, paper was made from recycled rags, silk, or animal skins. After the invention of the printing press in 15th-century Europe, paper became more widely available as part of a growing print culture, and the supply of rags dwindled. While books and other durable printed materials remained largely in the possession of elites, paper commodities owed their production, in part, to the castoffs of common urban households. After the Industrial Revolution, the rag and bone men of England collected old rags in a horse-drawn cart to be resold as raw material for papermaking, an early form of urban recycling. In the mid-19th century, paper was successfully derived from the fibers of wood pulp, an innovation that led to the industrialization of papermaking, which ultimately provided paper to mass consumers at a greatly reduced cost and made possible the birth of modern bureaucracies and corporations. As a powerful force in the changing political economy of literacy, paper transformed from a product of urban recycling to a force of rural deforestation.

Over the course of the 20th century, the once-familiar sight of rag and bone men collecting recyclables was gradually replaced with sanitation workers collecting bags of anonymous rubbish for mass disposal. Even when used clothing is recycled in the 21st century—rather than being reused—the clothing typically enters an international rag trade that includes Africa and, particularly, India. In part, the changing pathways of waste disposal and recycling are a consequence of material changes in houses. The spread of modern landfills throughout the United States shortly after World War II coincided with increasing use of oil and gas in central heating. With declining use of fireplaces and wood-burning stoves, it was less common for household rubbish to be burned prior to its collection by sanitary workers, a shift that affected methods of paper disposal most of all.

Composition in Landfills

In the 21st century, paper products, including magazines and newspapers, are the most common material found in MSW, making up approximately one-third of the garbage that households throw away after recycling, according to Environmental Protection Agency (EPA) statistics. As a consequence, paper is one of the most common materials dumped at municipal solid waste landfills. This has consequences for the economics of waste disposal as well as landfill labor practices and forms of management. As a capital asset of a waste company, a landfill is valued based on its existing capacity, which includes the actual limits of its permitted growth as well as the area it could potentially expand into in the future. Municipalities make similar assessments of landfill capacity in order to plan for their future waste management needs. Paper is a bulky material, which, compared to organic wastes, breaks down more slowly over time. The space that paper occupies is politically and economically significant not least because, in addition to taking up space, paper represents trees that have been cut down and whose carbon dioxide stores are being re-released into the atmosphere. For all of these reasons, there have been considerable efforts to improve the recycling of paper products since the 1970s.

Paper Picking

In terms of the practical construction and regulation of landfills, paper creates difficulties of a different nature. Upon entering a landfill site, waste is brought to the active dumping area, called a "cell," where bulldozers and compactors pack it tightly into an artificial slope with the aim of preserving as

much space as possible. During this process, stray rubbish may either bounce down the slope, blow in the wind onto areas that have been capped and may have grass growing on them, or blow onto other parts of the landfill site and beyond its boundaries. According to U.S. regulations, embodied by the Resource Conservation and Recovery Act, all such stray litter is garbage and therefore must be contained on-site in designated areas. For this reason, most landfills employ portable screens placed downwind or fences placed along the periphery of the site. These screens and fences trap stray litter, preventing it from migrating further. Because of its material qualities, paper is susceptible to being carried off by the elements. Perhaps for this reason, as well as its omnipresence, at some landfills *paper* is the name used for the generic category of stray litter of any kind, and "paper pickers" are those laborers whose primary job is to collect stray garbage wherever it has gathered and to bag it so that it can be carried back to the active cell to be dumped. Laborers and other landfill employees may regularly refer to a wide variety of materials as paper—even objects clearly made of rubber or plastic—in order to signal that these items have wandered from an acceptable location.

Paper thus constitutes the material basis for the labor hierarchies of landfills. As the least skilled and lowest-paid member of the landfill's workforce, paper picker is typically the entry position at a landfill, which may offer opportunities to learn new skills and move up the labor hierarchy. But there are advantages that come with being the lowest of the labor force. Like the category of rubbish for which they are named, paper pickers also wander freely through landfill space, exploring the margins of the landscape on foot and developing a different sense of the site than that of machine operators, mechanics, office staff, and managers. The labor of other employees is primarily directed at constructing the landfill or managing the machines and workers who do. Paper pickers are tasked with maintaining the symbolic and material order upon which landfills are based, dividing objects and spaces of "garbage" from "nongarbage." The presence of paper, as in the generic

Paper products, including magazines and newspapers, are the most common material found in municipal solid waste (MSW), making up approximately one-third of the garbage that households throw away after recycling. Paper is bulkier and breaks down more slowly than organic wastes in landfills. The replacement of fireplaces and wood-burning stoves in post–World War II households meant that household rubbish—especially paper products—was thrown away instead of burned, leading to heavier use of modern landfills.

category of stray garbage, violates the landfill's hierarchical balance between zones of purity and pollution, control and chaos.

It is this ordering of space that landfills also accomplish well beyond their site boundaries. But this form of order brought about through mass disposal of paper and other materials stands in stark contrast with the careful work of gleaning rags from the city to produce paper that was once the task of rag and bone men.

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See Also: Industrial Revolution; Landfills, Modern; Paper Products; Recycling.

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Paper Products

Paper is an indispensable product throughout the world. Its primary use is as a medium for writing, essential for bureaucracy, education, communications, information storage, and in the spread of information. In addition, it is used for the packaging for transport and convenience of a wide range of items from food to industrial equipment. Paper also has specific technological uses, such as for filters and in art, home furnishings, and architecture, and it has a range of uses for hygiene purposes. Paper in several forms is consumed on a daily basis by each person in the Western world. Why paper is consumed so widely and the sustainability of this high-consumption pattern are both, therefore, key issues relevant for everyone.

Environmental Impact

Paper is both biodegradable and a renewable resource, which means in consumption and waste terms, its environmental impact is relatively small compared to the many more-toxic and bulky waste products that are found in everyday garbage. However, the chemicals, water, and electricity used in its manufacture are considerable—and these are nonrenewable resources—and certain types of chemicals used in paper production are toxic. In addition, if waste paper is sent to a landfill, it releases carbon dioxide emissions. Further, forest resources are not always as renewable as one may like to think. These environmental impacts can be greatly reduced by recycling (paper being one of the most easily and cheaply recyclable products in everyday use) and by conscientious consumption practices.

History

The word *paper* comes from papyrus, the plant that was first used for making a medium for writing in ancient Egypt in 3100 B.C.E. Papyrus continued to be used as a main writing material in Egypt and some neighboring regions in the wider Middle East for over three millennia, through the Roman period. Despite the use of papyrus as a writing medium since the invention of writing in the Middle East, which heralded the start of recorded history and brought an end to prehistory, papyrus is technically not considered to be paper, although it provided the etymology for the word. With papyrus, the plant stalks are not pulped but are kept intact and are interwoven together and pressed dry. The invention of paper by pulping materials and mixing them with water, the basic method still used today, occurred in China and is generally attributed to Ts'ai Lun, an official in the royal court, in approximately 105 C.E. Prior to this time, the main writing medium in China had been silk, an expensive luxury item. Ts'ai Lun's paper was made from pulping a mixture of rags and other organic material, a procedure involving textile recycling.

Around 700 C.E., the Arabs acquired the knowledge of papermaking from the Chinese. The Arabs used mainly linen from the flax plant to make their paper, already widely grown because of its use in textile production. Paper technology soon spread throughout the Middle East and also to Spain, then

under Arab rule. However, it did not spread to the rest of Europe until several centuries later after the Christians drove the Moors out of Spain; along with everything else, they took over the paper mills and learned the skills involved in making paper out of linen as well as out of rags. The highest-quality paper was still, however, produced in the Middle East, and Europeans began trading to acquire it. Writing on parchment (made from animal skins) continued in Europe throughout the Middle Ages and beyond, when rag and cloth paper and paper made from plants such as flax started being manufactured in Europe. A watershed in paper consumption came with the invention of the printing press by the German Johannes Gutenburg in 1440. This introduced a method of printing with movable type sets, including metal molds and oil based inks, which allowed mass production of printed books for the first time. This innovation transformed social, political, and intellectual communication channels. Previously, books were scarce items that were copied to order and reserved mainly for highly selective subject matter, such as religious books, scientific treatises, and maps.

Several centuries later, alongside advances in printing and the spread of the technology throughout the world, the manufacture of paper became fully industrialized. To meet the growing demand for paper and the need for it to be more cost effective, a new source material had to be found. This was accomplished in the 1840s by the German F. G. Keller and the Canadian Charles Fenerty, who invented the process of mechanical pulping of wood, which gave it an ideal consistency for the manufacture of paper. In the 21st century, many people take it for granted that paper is made from wood; the realization that this has only been so since the mid-1800s comes as a surprise to many. Indeed, so complete is the reliance on wood for paper that nonwood-based pulp accounts for only about 1 percent of 21st-century global paper production.

Production Methods

All types and qualities of paper share the same basic method of manufacture, including newspaper paper, print paper, and carton used for boxes. Paper can be handmade, but in the 21st century, it is generally made on an industrial scale. The wood is shredded finely enough so as to allow full absorption in water. It is then mixed with water to form a pulp. A chemical known as "sulfate," or the Kraft process, is generally used to bring the pulp to the right consistency. The mixture is then refined, cleaned, and agitated before being pumped onto a moving screen. As the pulp travels along the screen, excess water is drained and recycled where possible. A paper sheet made from interwoven cellulose fibers begins to form. As it moves through the papermaking machine, it is pressed between large rollers to extract water and subsequently through heated rollers to remove any remaining water. Sheets of paper may then be shaped, colored, and given additional texture with the addition of a variety of coatings and finishes.

Uses

Paper has become the most ubiquitous product in the age of information. While some products such as books, posters, and works of art are useful for a period of years (even decades or centuries), paper has been the most amenable material in finding uses in a throw-away society, which though vital, are transitory. Such products often complete their journey from shop floor to garbage in a single day; for example, newspapers, print paper, packaging, lavatory paper, tea bags, transport tickets, price tags, shopping bags, flyers, leaflets, wrapping paper, napkins, and tissues. Although the widespread use of the Internet, the advent of online newspapers, and the increasing shift of correspondence from the post box to the e-mail in-box have diminished the use of paper considerably, the sheer volume of information available on the Internet and ease of typing up documents on computers have simultaneously created a huge new demand for paper to feed into printers. The use of paper is also expanding as a replacement for the more environmentally harmful plastic in food packaging and shopping bags.

Sustainability

In the 21st-century consumption society, which is stretching the world's limited resources, it is the responsibility of each consumer to become more aware of how, where, and by whom products are made to ensure that they comply with ethical and environmental standards. In the case of paper, the product is made from two main resources—wood and water—and the manufacture of paper consumes

a considerable quantity of electricity. Steps each country should take to make paper consumption more sustainable include encouraging water used in pulp mills to be reused as much as possible, improving recyclable paper collection schemes from homes and offices, increasing the use of renewable energy in pulp mills, minimizing the use of toxic chemicals, and using wood from sustainable forests.

In 1992, the United Nations Conference on Environment and Development set out guidelines that for a forest to be considered fully sustainable, it had to be managed according to social, economic, and environmental criteria. The Forest Stewardship Council (FSC) is an international body that has the most stringent regulations, which track the wood all the way from the moment of logging to its appearance on the shop floor as paper. The conscientious consumer should look out for the FSC label that certifies that the paper being purchased conforms to the strictest environmental controls. Although the industry has become much cleaner since the 1970s, there is still a considerable percentage of paper that is uncertified. The number of FSC-certified forests is growing rapidly, accounting for over 84 million hectares globally in 2010, which, however, was only equivalent to 10 percent of the world's production forest.

The term *sustainable forestry* is often used to mean simply that the trees are replanted after harvesting. Certain labels may be misleading; for example, many paper products may state that they are manufactured from sustainable forests. However, unless this statement is defined or accompanied by an FSC label, it is hard to tell whether it means anything more than that the trees are replanted after harvesting. This in itself does not guarantee that the forest is well managed, sustaining native wildlife and noncommercial flora. In some parts of the world, forests are still seen only as a resource, meaning that ancient, richly biodiverse forests are still cleared and logged illegally. Such forests are not a renewable resource, but rather are irreplaceable and should be protected, as replanting them will never succeed in restoring their biodiversity. FSC-controlled sources exclude timber that is illegally harvested, from forests where conservation values are not adhered to, from land converted to plantations or other nonforest use, or harvested in violation of people's traditional rights. The FSC also has a Mixed Sources label that states that at least 70 percent of the virgin fiber must come from FSC-certified forests, with the remaining percentage from controlled sources. Recycled waste can also be included up to a maximum of 90 percent. The FSC also has introduced a recycled label. To carry this label, a material must contain a minimum of 85 percent post-consumer waste, up to 15 percent pre-consumer waste, and must be made by an FSC-certified mill.

Recycling

Paper made exclusively from wood is called virgin paper, while paper produced out of used paper that is re-pulped is called recycled paper. Recycling paper can greatly diminish demand for virgin fiber from wood. However, there will always be a demand for virgin paper because, although paper is thought of as a renewable resource, it cannot be recycled indefinitely. It can only be recycled four to six times, as the fibers get shorter and weaker each time. In addition, some virgin pulp must be introduced into the process each time to maintain the strength and quality of the fiber, so no matter how much is recycled, paper will always need some virgin fiber.

The United States produces 90 million tons of paper annually (25 percent of timber cut), and it consumes about 100 million tons, making it the largest market globally for paper products. Despite improved recycling technologies, there is still a high demand for virgin fiber. In the United States, consumption of recycled paper accounts for 35 percent of total paper consumption, while another 25 percent of recycled paper is exported out of the United States.

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See Also: Certified Products (Fair Trade or Organic); Computers and Printers, Business Waste; Computers and Printers, Personal Waste; Paper and Landfills; Recycling.

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Pennsylvania

Pennsylvania, a state that thrived in the colonial period around the port of Philadelphia and subsequently developed industry in Pittsburgh, Scranton, and several other regions, has seen significant generation and disposal of industrial wastes from mining, iron and steel mills, transportation, and other industries for over two centuries. Pennsylvania holds the distinction of importing the most waste of any state in the United States each year since the 1990s. The history of waste and consumption in Pennsylvania revolves around attempts by public officials and citizens to strike a balance between environmental protection and business profits in dealing with the residuals of consumption, in particular, other states' waste. The results of these attempts are mixed. Pennsylvania hosted over 50 mega-landfills by 2010, with pressure from business to add more. Throughout the 1990s and into the first decade of the 21st century, Pennsylvania developed some of the strongest recycling programs in the United States. With growth in industry concentration and expansion of landfills, Pennsylvania and the communities that host large landfills are facing new social, economic, and environmental challenges. Moreover, the relationship between waste generation and disposal in Pennsylvania and that of neighboring states is integrally related to waste policy and outcomes.

Consumption

Consumption is not particularly different in Pennsylvania than in the rest of the United States. The U.S. Bureau of Economic Analysis provides gross state product numbers but does not disaggregate the gross state product to provide citizens' expenditures. While per capita gross domestic product (GDP) was about $39,578 in 2009, ranking Pennsylvania 18th nationally, per capita income was much less. Assuming a savings rate of 2 percent, 13 million Pennsylvanians consumed approximately $24,000 annually in goods and services.

Waste Management

Pennsylvanians produced over one ton of waste per person during the first decade of the 21st century. In 2004–09, Pennsylvania disposed of 22–25 million tons of municipal waste annually. Imported waste, mostly from New York and New Jersey, accounts for 7–10 million tons of this total. Since many Pennsylvanians recoil at the idea of accepting other peoples' waste, landfills tend to underreport the amount of waste coming into the state. In addition, the way waste is transported both from out of state and within the state makes a full accounting difficult. Nevertheless, even if imported waste is underreported, the fact remains that Pennsylvania has been the greatest importer of out-of-state waste since the 1990s.

Environmental Problems

Throughout the 1960s and 1970s, Pennsylvania struggled with a myriad of environmental problems, one of which was the existence of over 1,000 small, unregulated trash dumps. The rise of the environmental movement and the passage in 1966 of the Solid Waste Management Act created momentum to deal with the problem, but political will was absent and business was unwilling to stomach increases in solid waste disposal costs. This was the beginning of conflicts between environmental groups and business in Pennsylvania that continue into the 21st century. Waste disposal firms were not obliged to cooperate in establishing tougher regulations and higher costs. A series of environmental accidents coupled with media coverage, environmental education, and awareness—and the fact that waste is visible, often offends the olfactory senses, and is typically transported over roadways—brought calls for action from citizens across the state living near these dumps. Of particular concern was the impact of landfill effluent contaminating drinking water supplies. Action came in 1968 with the creation of the Department of Environmental Resources (subsequently renamed

the Department of Environmental Protection) and the passage of the Solid Waste Management Act to prevent pollution from the disposal of solid waste.

Environmental accidents increased, and tension between environmental groups and big business intensified. Most notably, the world's attention was directed toward Pennsylvania on March 28, 1979, when there was a partial core meltdown at the Three Mile Island nuclear reactor near the state capital of Harrisburg. The accident tipped the balance toward rigorous environmental regulation throughout the 1980s, culminating in Act 101: The Municipal Waste Planning, Recycling and Waste Reduction Act, which mandates local recycling programs and county waste plans and strengthens the environmental protection standards for new municipal waste facilities.

Consolidation

Masterfully written, the comprehensive Act 101 eliminated the approximately 1,000 dumps, replacing them with large, efficient, and cost-effective landfills. It also created a boom in recycling and raised millions of dollars in tax revenue through disposal fees. Initially, the disappearance of cheap dumps meant higher prices and a perceived shortage of disposal as new, modern landfills were vetted and built. The new landfills had to pass rigorous environmental and economic assessment tests in order to be permitted. Pennsylvania had made the jump nearly overnight from a literal wasteland with the vestiges of coal extraction and a runaway waste industry to home of some of the most technologically advanced landfills in the nation. Recycling flourished with the support of public dollars (a $2-per-ton fee on all municipal waste disposed of at landfills). In 1990, the new recycling law resulted in approximately 300,000 tons of waste diverted from the waste stream. Continued success and support from the populace resulted in the growth of recycling to the diversion of an estimated 5 million tons of waste in 2005—nearly one-third of municipal waste produced in-state that year.

With the successes of Act 101 came unintended impacts. Large landfills, while more advanced than their predecessors, created external costs unanticipated by legislators. Malodors, truck traffic, vectors, noise, and environmental risks decreased property values and stigmatized small, rural communities. While the act provided for some compensation in the form of the Host Community Benefit Fees, the compensation did not stem decreases in property values or business exodus from blighted landfill towns. Furthermore, the size of the modern landfill in Pennsylvania typically meant consolidation and increased market concentration; for example, Waste Management, Inc., controlled over 40 percent of disposal capacity in Pennsylvania in 2010. It also meant more out-of-state waste, resulting in higher prices for Pennsylvanians and a visceral response to the knowledge that they were the dumping place for garbage from other states.

Politics and Policy

With market concentration came political power and, ultimately, regulatory capture, where regulators make the rules and often end up working for waste disposal companies via a revolving door. The solid waste advisory committee, an appointed state body active in determining waste policy, is industry heavy. Lobbying by waste companies is extensive, leading to—at best—selective implementation of industry-friendly regulations. Regulators often ask industry lawyers to provide language for new initiatives—in effect, those being regulated are writing their own rules. Perhaps more damaging to successful waste management policy is the diversion of waste fees and taxes dedicated specifically to recycling and land stewardship to pay for politicians' pet projects and shortfalls in the general fund unrelated to waste management. Without these dedicated funds, prudent resource use suffers.

Pennsylvania's leaders, backed by corporate interests and the Pennsylvania law, have made the waste disposal and transportation business in Pennsylvania a dominant force in determining the price of waste disposal in the entire northeastern corridor of the United States. Pennsylvania has served as a sink for excess waste from New York, New Jersey, and New England. This lowers the relative price of waste disposal for exporting states, increases the price of disposal for Pennsylvanians, and reduces, or in some cases completely eliminates, any incentive at the individual or community level to curb consumption and waste disposal. In addition, it lessens the explicit and implicit value of recycling, leading

to more resource extraction and even less-efficient production practices. Low prices for waste disposal in Pennsylvania mean that other states do not have to worry about finding enough disposal space.

The major tension in waste disposal in Pennsylvania remains the clash between the stated goal of reducing waste—not by renaming it or reclassifying it but by actually reducing the amount of waste produced and landfilled—and the desire of corporate waste firms for more waste to increase profits. The irony is that in Pennsylvania, where substantial gains were made for about 15 years because of very effective waste laws, one fatal flaw in Act 101 allowed easier waste facility permitting for well-capitalized firms, leading to rapid expansion of landfill operations in Pennsylvania, industry concentration, and political power. This flaw has broken the vital connection between consumption and waste disposal. When one is forced to recognize this fundamental connection and to deal honestly with one's own waste, much more thought and planning go into reducing the production of waste and recycling and reusing what is produced.

Without this connection, public measures to curb waste disposal in the northeast region will turn out to be empty gestures because these states can simply ship their waste problems elsewhere. By breaking the connection between consumption and waste, Pennsylvania enables itself and neighboring states to engage in irresponsible, wasteful behavior and—perhaps more damaging in the long run—derails measured dialogue about how to most effectively manage waste.

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See Also: Landfills, Modern; New Jersey; New York; Noise.

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Personal Products

The personal products that can be bought in any supermarket throughout the industrialized world—such as false eyelashes, disposable diapers, hearing aides, or aspirin—are often consumed almost without notice in daily life. In spite, or because, of their ubiquity, these products are central to how modern people experience, create, and modify themselves.

Personal products are those that in their object form or in the way they are used, experienced, and valued relate to the embodied self, or "person." A product is not just any object or item but is created in a (usually industrial) process of manufacture. Personal products are manufactured, retailed, used, discussed, and debated in a myriad of ways. Personal products fall under three distinct categories describing their modes of use: adornment, hygiene, and enhancement.

Real World Context of Personal Products

A relatively small number of companies and conglomerates dominate the global market in manufacturing personal products, including Johnson & Johnson, Unilever, and Procter & Gamble. Johnson & Johnson is a New Jersey–based multinational whose brands include Neutrogena, Listerine, Acuvue, Band-Aid, Tylenol, and Mylanta. Johnson & Johnson also manufactures medical devices such as gastric bands, orthopedic implants, and insulin delivery devices. Unilever is an Anglo-Dutch multinational company in the food, beverage, cleaning agent, and personal care markets. It was originally formed as a result of a merger between an English soap company and a Dutch margarine producer, as palm oil is a key input to both products. Unilever's

brands include Vaseline, Cutex, Dove, and Rexona, as well as Ben & Jerry's, Slimfast, Lipton, and Flora. Procter & Gamble is a multinational U.S.-based company, owning brands such as Gillette, Pampers, Clairol, Duracell, and Oral-B. During the 1950s and 1960s, the company produced and sponsored television serials (called "soap operas"), including *As the World Turns*, *Guiding Light*, and *The Young and the Restless*. Procter & Gamble also sponsors Spanish-language telenovelas on networks such as Univision and Telemundo.

Both large and small manufacturers have broadly and narrowly targeted brands, aimed at mass, local, or niche markets. L'Oreal is the largest cosmetics group in the world, with hundreds of hair color and styling, body and skin care, and fragrance brands. Its Garnier and Maybelline brands are internationally retailed in mass-market outlets, while "luxury" brands are sold at high-end locations and specialty stores. Other L'Oreal-owned brands such as Kiehls and The Body Shop have distinct market-niche images. This apparent diversity masks significant centralization of ownership: L'Oreal is 30-percent owned by Nestlé and also owns part of Sanofi-Aventis.

Personal products are retailed in drugstores, pharmacies, department stores, supermarkets, specialty shops, and increasingly online. Major chains include companies such as Watsons (Hong Kong–based, with retail outlets in Asia, Western Europe, and Turkey, Estonia, and Slovenia), Walgreens (U.S.-based, with over 7,500 stores and upward of $60 billion in annual revenue), and Boots (over 3,000 retail outlets in the United Kingdom, Western Europe, Russia, North Africa, and Thailand, as well as interests in pharmaceutical wholesalers in Germany and China). This is a contrast with arrangements in, for example, France and Germany, where a pharmacist can legally only own up to three or four stores.

Personal Products to Adorn and Decorate

Adornment products can be applied directly to the body, including cosmetics, tattoos, hair-styling products, jewelry, and corsetry. Historians of cosmetics note that people have always adorned their bodies and faces to appear more beautiful. Wealthy ancient Egyptians were entombed with their kohl pots, the Romans used lead paste to whiten their faces, while aristocratic Japanese matrons dyed their teeth black for over 1,000 years. In Western societies, wearing makeup became taboo for men and indecorous for women, at least until the 20th century. With the rise of cinema and the availability of affordable, mass-produced cosmetics, a range of products, including makeup, perfume, false eyelashes, girdles, manicure products, and nail polish, were regarded as essential in the creation of feminine beauty. More recently, these have been joined by Hollywood tape and related products, Spanx, false nails, semisurgical procedures such as Botox or collagen implants, and plastic surgery.

Generations of women have been told by advertisements, films, and parents that the natural female body requires enhancement and adornment to be truly feminine. Second-wave feminists in the West, refusing to conform to normative modes of femininity, often expressed this by rejecting cosmetics and their accoutrements. Beyond the second-wave feminists, Naomi Wolf in *The Beauty Myth* describes how normative beauty traps women even where other barriers to liberation have been lowered.

The role of personal products in creating the ideal feminine body has another layer of complexity for women of color. The intersecting influences on identity of gender, race, and class have been played out on women's bodies through a variety of personal products, including skin coloration and hair-modifying products. The business of skin whitening in the global south and its diasporas has been the subject of significant criticism in academic and popular discourse. For many authors, the preference and valorization of white skin reflects centuries of colonial imposition of white supremacy and privilege, deeply internalized ideologies described by postcolonial theorists such as Franz Fanon. Idealization of fairness is reflected in the tendency—in Hollywood, Bollywood, fashion magazines, and fairy tales—to equate fairness with beauty. A global controversy arose in 2010 after Vaseline developed an iPhone application in which the user's photo could be uploaded, then lightened.

Another set of personal products that has played a significant role in producing racialized bodies are the paraphernalia—combs, picks, relaxants, and so on—associated with African American hair. Historians have written of the symbolic economy of

treated and untreated hair and hairstyles in Africa and African diaspora communities. Comedian Chris Rock, in his 2009 documentary *Good Hair*, interviewed representatives of the $9 billion African American hair care industry, exploring the class and gender implications of "good hair," as well as what it means to "go natural" and embrace African American beauty.

These personal products have been used to adorn or modify the body in line with normative aesthetics. Other decorations, such as tattoos and piercings, have in many contexts been transgressive of socially acceptable norms. Tattoos across cultures have marked a person's inclusion in socially marginalized groups, for example, sailors, gangs such as the Japanese *yakuza*, current or former prison inmates, or as part of a rockabilly or similar subculture. Unlike the transient adornment of makeup, body paint, or henna, tattoos are more permanent and extreme, embodying personal and social histories.

Personal Products to Clean the Body

Hygiene products include toiletries and products often (though culturally and historically specifically) thought of as necessary to basic cleanliness, including soaps, body creams, deodorants, toothpaste, and mouthwash. A whole other set of personal hygiene products helps to gender bodies as either male, such as shaving products, deodorants, and aftershave, or female, such as depilatory products, douches, and perfumes.

Since the 20th century, dirty bodies have been considered a threat to health. The development of new personal products has been one way to disguise and distance base physical functions, killing bacteria while creating a nonbodily image. The use in advertising of baby animals to denote softness to sell toilet paper is one example.

Disposable menstruation products (called "sanitary products") have been notable for the coyness of their marketing. The advertiser Albert Lasker, working for Kotex in the 1920s, introduced a system where women could buy plain-wrapped Kotex by leaving money in a box, without needing to speak with a sales assistant—clearly a spiritual forbear of the later ubiquity of blue liquid in sanitary pad advertising campaigns. Contraceptive products, such as birth control pills, condoms, and diaphragms, have also been the objects of squeamish marketing and distribution as well as moral opposition.

Finally, the products associated with baby care, such as breast pumps, disposable diapers, cloth diapers, powders, and wipes, are a significant and growing subset of hygiene personal products, in many cases creating a product where—just a generation ago—no market existed.

Personal Products to Enhance and Extend Bodily Function

Enhancement products replicate the body's own functions, with varying degrees of fidelity, including pacemakers, orthopedic implants, bionic ears, prescription glasses, contact lenses, dentures, catheters, prosthetic limbs, walking frames, calipers, and braces. The older technologies, such as a walking stick or a pair of false teeth, are discrete from, though intimately related to, the body. Newer products, such as orthopedic implants or gastric lapbands, subtly but importantly shift how people understand the "natural" body as well as provide a new paradigm for thinking about how products interact with the person.

One effect of this is that it can seem that the limits of human bodily functioning—its inevitable aging and deterioration, diversity in ability, and disability—can be overcome by technology. If high technology becomes necessary for "normal" functioning, unequal access to these products—depending on socioeconomic and geopolitical factors—becomes an important issue.

Compared to the previous two groups, technology-based personal products may appear too durable to be considered alongside highly consumable, temporary products. An important characteristic of these products, however, is their shortening life span and increasing disposability. Two factors in particular have meant that products such as dentures and glasses are now more consumable. First, technological advances have enabled more and more products to be made disposable, whether for sanitary reasons or for convenience. Contact lenses, orthopedic implants, and dissolving sutures are now far less permanent. Second, the rate of technological advance has been accompanied by commercial tactics of in-built obsolescence; devices such

Technological advances and commercial tactics such as in-built obsolescence have meant that personal products such as eyeglasses, hearing aids, and braces have become consumables; they are easily disposable and rapidly outdated.

as hearing aids and braces are rapidly outdated and overtaken by new and improved versions.

Perhaps the least visible group of personal products that enhance body function are pharmaceuticals. In redrawing the boundaries between health and illness, these products are redefining normal bodily function.

In the early 21st century, global sales of pharmaceutical products were dominated by drugs used for diseases of lifestyle (such as high blood pressure and cholesterol) and aging (such as arthritis). In 2010, just 10 drugs accounted for nearly 10 percent of global pharmaceutical revenues. Annual sales of pharmaceutical products are around $830 billion, with approximately $300 billion in the U.S. market and just under $70 billion in emerging markets led by China and Brazil.

The global market in pharmaceuticals is dominated by "big pharma," active in drug research and development, manufacturing, and wholesaling. The major firms include Johnson & Johnson, Pfizer, GlaxoSmithKline, Roche, and Sanofi-Aventis, all of which have annual revenues of over $40 billion. The dominance of a relatively low number of firms has been consolidated since the 1990s, shaped by the high cost of investment in developing "blockbuster" drugs, which are highly profitable but require significant development lead time and have only short patent lives. For example, Pfizer's blockbuster antidepressant, Zoloft, came off patent in 2006, resulting in a 75 percent fall in revenues from this drug. It is likely that a similar prospect awaits Pfizer's Lipitor, a cholesterol-lowering medication that has topped the global sales lists in recent years, when it comes off patent in 2011.

Finally, there are devices that extend the body beyond its original capacity. In many parts of the world, cell phones and personal computers are reconfiguring how people experience themselves in relation to other people and to public space.

Disposal of these high-technology personal products is more complex than that of the relatively simple products of the past. Unlike earlier natural or simple synthetic products, 21st-century cosmetics and pharmaceuticals contain powerful bioactive ingredients that, because they leach into the environment in ever-growing volumes, have a largely unknown impact on ecosystems. Similarly, the increasing volume of electronic waste, comprising potentially harmful chemical components and mostly dumped in developing countries, is likely to grow, and—unlike earlier waste—its impact on human health is uncertain.

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See Also: Cleaning Products; Cosmetics; Disposable Diapers; Germ Theory of Disease; Mobile Phones.

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Pesticides

Pesticides are agents that kill organisms that pester humans and include insecticides, herbicides, rodenticides, and fungicides. Pesticides are commonly used in homes and on gardens, golf courses, and agricultural crops. They may be sprayed, dusted, infused into soil or buildings, or genetically engineered into plants.

Brief History

As early as the 1300s, arsenic and heavy metals such as lead and mercury were used to kill rats in plague-ridden Europe. These chemicals continued to be applied into the mid-20th century to kill animal and insect pests. Arsenic is still infused into pressure-treated wood to deter fungi and insects in the 21st century.

In 1873, dichlorodiphenyltrichloroethane (DDT) was synthesized by a German scientist, but its insecticidal properties were not discovered until 1939 by a Swiss entomologist, Paul Muller, who won the Nobel Prize in medicine for his discovery. DDT was used in World War II to delouse soldiers to prevent typhus, and it is estimated that DDT saved hundreds of thousands of soldiers' lives. In the 1930s, DuPont scientists discovered that carbamates, derived from the calabar bean, could be used to kill bugs, and the German chemical cartel I.G. Farben developed organophosphate nerve gases such as sarin to kill people. In 1938, I.G. Farben produced the organophosphate pesticide tetraethyl pyrophosphate (TEPP), which was among the many chemicals tested for toxicity on concentration camp inmates.

After World War II, chemical companies in Europe and the United States that had been granted patent rights to I.G. Farben chemicals had an excess of TEPP, sarin, and other organophosphate nerve gases. Since a neurotoxin has much the same effect on an insect's nervous system as it does on a human's, chemists adjusted the formulas so that these compounds could be sprayed on farms to kill crop-damaging insects. Parathion and malathion, chemically similar to sarin, were developed in the late 1940s by American Cyanamid using I.G. Farben research. Subsequently, hundreds of other neurotoxic pesticides were developed and applied worldwide.

Given its well-known insecticidal benefits during the war, DDT also found a ready market in the postwar United States. Touted as completely safe, DDT was sprayed in homes and on crops across the country. Along with fossil fuel–based fertilizers and other features of industrialized agriculture, such pesticides led to the unprecedented production of high-yielding crops known as the green revolution.

In the mid-1950s, Rachel Carson was among the scientists who saw that the widespread use of pesticides such as DDT posed severe ecological damage. In 1962, Carson argued in her book *Silent Spring* that DDT and some 200 other pesticides were being used indiscriminately and that many persist in the environment, continuing to harm animals and ecosystems. The agricultural and chemical (agchem) industries invested much time and money to denounce Carson as unscientific. Her book was nonetheless a best seller, and her efforts led to the U.S. ban on DDT in 1972.

Banning a pesticide in the United States does not prevent its sale elsewhere. DDT continues to be sold abroad in the 21st century, mostly in developing countries to fight malaria. Many other chemicals that are illegal in the United States are also still sold abroad, including agricultural pesticides that return to the United States on commercially grown imported produce. In the late 1990s, exports of U.S.-banned pesticides averaged over 26 tons per day.

Pesticide Waste

If pesticide waste is defined as any portion of an applied pesticide that does not reach the target organism, then roughly 99 percent of applied pesticides are waste chemicals. When, for example, a spider is sprayed with an insecticide, a thin, spider-sized film of insecticide is all that is needed

to kill it; the rest—nearly the entire cone of spray mist plus all the droplets that escape into the air—are excess. Similarly, when atrazine is sprayed on crops, the herbicide contacts not just the weeds in the field but also the nontarget organisms, including the beneficial insects and soil microorganisms living in the field; the plants, birds, humans, and other mammals inhabiting the area; and the frogs, fish, and other creatures living in or around nearby streams. So-called pesticide drift, waste pesticide that can be carried long distances by wind currents, further impacts nontarget organisms. Moreover, organochlorine pesticides such as DDT, aldrin, and dieldrin can persist in soil and water for decades. They are also bioaccumulative, so when predators such as orcas, eagles, or humans eat animals that have contacted the pesticide, they, too, may be harmed.

In the 21st century, over 1,100 pesticides are used worldwide. According to Environmental Protection Agency (EPA) estimates, in 2001, world pesticide sales exceeded $32 billion for over five billion pounds of applied chemicals. In the United States, farmers and other consumers spent over $11 billion on 1.2 billion pounds of pesticides, about 99 percent of which did not contact target organisms.

Pesticide Resistance

Though pesticides were initially effective in increasing agricultural productivity, the efficacy of a pesticide does not last if it is used indiscriminately. DDT, for example, was first used on U.S. farms in 1945; by 1950, barn flies in U.S. dairies were nearly 100 percent resistant to it, and dairy farmers were advised to stop using DDT because the chemical was appearing in the milk supply. By the early 21st century, roughly 500 insect species, over 130 species of weeds, and 70 species of fungus had developed pesticide resistance.

When an organism develops resistance to a pesticide, the industry replaces it with another—often more toxic—chemical. Overuse of a less-toxic herbicide such as glyphosate and a naturally occurring insecticide such as *Bacillus thuringiensis* (Bt) is illustrative. Monsanto's glyphosate herbicide, Roundup, is considered much safer than 2,4-D or 2,4,5-T, phenoxy compounds chemically similar to Agent Orange, used as a defoliant in Vietnam. However, the widespread use of Roundup has produced so-called super weeds that are immune to glyphosate. By 2007, 12 weeds had developed resistance to Roundup, and farmers resorted to using the more lethal 2,4-D, paraquat, and arsenic to control them.

Monsanto, second only to Syngenta in herbicide sales, has also genetically engineered Bt into cotton and corn. Each engineered plant produces Bt in each of its cells, so when the pest nibbles any part of the plant, it ingests Bt. This insecticide is considered safe enough, at least in its natural form, to be used on organic farms. In organic applications, Bt is applied sparingly and only on infected plants, but when Bt is genetically engineered into crops, every cell of every plant contains the insecticide; the field thus becomes a breeding ground for resistant strains. Bt resistance is detrimental for the farmers who then need to apply stronger pesticides to their genetically engineered plants. It is even more detrimental to organic farmers who do not have that option when the resistant insects invade their crops.

Prevalent Pesticide Categories

Organochlorine pesticides include aldrin, chlordane, DDT, dieldrin, endosulfan, lindane, and many others. These chemicals assault pests by disrupting nerve impulses. Acute effects on mammals include convulsions, nausea, tremors, and muscle uncoordination. These pesticides are bioaccumulative, persist in the environment, and thus can travel long distances. As fetotoxins, they can pass through the placenta into the fetus and are also found in breast milk. Many are neurotoxins, and research shows correlations with cancer, Parkinsonism, epilepsy, and birth defects.

Organophosphates (OPs) include azinphos-methyl, chlorpyrifos, diazinon, glyphosate, malathion, parathion, procymidone, TEPP, and hundreds more. OPs constitute 70 percent of the pesticides applied in the United States. All OPs except glyphosate inhibit cholinesterase, an enzyme essential for proper functioning of the nervous system, and even low exposure to OPs can destroy the myelin sheath around nerve fibers. Exposure is linked with Parkinsonism, diabetes, multiple sclerosis (MS), attention deficit hyperactivity disorder (ADHD), and cancer. Most OPs are endocrine disruptors.

OPs' chemical cousins, the carbamates, are also nerve gases that pose similar threats to humans and the environment. They include aldicarb, carbaryl, carbofuran, carbendazim, flusilazole, and many others. Like the OPs, carbamates have been especially hard on birds, causing extensive die-offs.

Phenoxy pesticides, many of which are contaminated with dioxins, include 2,4-D, 2,4,5-T, mecoprop, and silvex. Phenoxy pesticides are groundwater contaminants, and they are carcinogens, fetotoxins, and immunotoxins that can also cause nerve damage.

Pyrethroids, including allethrin, fluvalinate, and permethrin, were introduced more recently and are considered preferable to other classes of pesticides in part because they are water soluble and therefore do not persist in the environment. Pyrethroids are used in flea collars, insect-repellant clothing, and ant sprays. These pesticides interfere with sodium and potassium conduction in nerves and can thus cause symptoms comparable to organochlorine poisoning. In 2008, there were 26,000 reports of pyrethroid poisonings of people in the United States.

Triazine pesticides include atrazine, cyanazine, propazine, and terbutryn. These are carcinogens, neurotoxins, and groundwater contaminants. Atrazine, a widely used herbicide in the United States and the second most used agricultural chemical in Australia, is an endocrine disruptor and likely carcinogen. Evidence suggests that atrazine has contributed to worldwide amphibian die-offs.

Reducing Pesticide Waste

There are ways to reduce pesticide waste. Farmers could use less by adopting integrated pest management (IPM) techniques, such as using beneficial insects and other organisms to reduce pest populations, erecting insect barriers to deter spread of pests, and using toxic chemicals only as a last resort.

Around the house, people could enhance garden soil fertility to reduce pest populations organically and, inside the house, remove food scraps and other pest attractants. When pesticides are necessary, safer chemicals such as boron and orange oil could replace organophosphates and pyrethrins.

Finally, regulatory agencies such as the EPA could be strengthened. In the early 21st century, unless the EPA sees proof that a pesticide is clearly dangerous, it is approved. This process contrasts with the European approach, the precautionary principle, which shifts the burden of proof. Under the precautionary principle, companies must prove their chemical is safe before it can be sold. Also, the EPA weighs environmental and human health risks against benefits that accrue primarily to the agricultural and chemical industries, and agchem companies play a large role in determining which pesticides are registered. The agency relies on the companies' own tests of their products; the EPA prescribes the tests and toxicity standards for types of applications, then the companies perform the tests. Moreover, the government's revolving door cycles industry employees into positions where they regulate their own companies' chemicals. For example, Monsanto's former chief lobbyist, Linda Fisher, was EPA deputy administrator from May 2001 until June 2003, and agchem industry employees often sit on EPA scientific advisory panels.

Conclusion

In the 21st century, tons of pesticide, nearly all of it toxic waste, are carried in the bodies of countless humans and other animals, and eventually all of this waste ends up in the soils, rivers, and oceans around the globe. Future pesticide waste could be reduced by eliminating conflict of interest in regulatory agencies and adopting the precautionary principle worldwide. Exposure to pesticide waste could be further avoided by greater use of integrated pest management and organic practices in farms and gardens.

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See Also: Farms; Federal Insecticide, Fungicide and Rodenticide Act; Household Hazardous Waste.

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Pets

The 2010 National Pet Owners Survey reported that 77 million dogs and 93 million cats lived in U.S. households. These figures do not include the unknown numbers of feral populations residing in rural and urban areas. Concerns over the "carbon paw prints" of these animals in sustainability discourses focus on the food they eat and the tons of feces they excrete. Ecologists confirm that cat predation can have a devastating effect on urban songbird populations, while dog wastes can pollute groundwater with pathogens and cause eutrophication in urban streams. What goes in and comes out of companion species is loaded with ecological and political issues—not to mention parasites. New Zealand authors Brenda and Robert Vale found that the greenhouse gases emitted by producing a large dog's annual diet equal two SUVs driven 6,000 miles a year, while Will Brinton, an expert on composting with the Woods End Laboratories in Maine, estimates that pet cats and dogs in the United States excrete 10 million tons of waste per year. Where does it all go? Bagged in plastic, it enters landfills with limited opportunities to biodegrade. Left on the ground, runoff takes it into the local watershed. Flushed down the toilet, it is pumped to sewage treatment plants that may not eliminate its parasitic hitchhikers, many of which are zoonotic (capable of infecting multiple species like humans, small mammals, and birds). Sustainable designers dream of using methane digesters to transform these 10 million tons of feces into a renewable energy resource—a way to sequester carbon and pathogenic microorganisms at the same time.

Pet Products

This budding composting business represents yet another growth market in a robust pet economy. In the United States, a $45 billion per year industry revolves around companion animals—a niche market that has stimulated myriad specialty goods and services, including pet clothes, animal psychics, robotic litter boxes, and yoga for dogs (nicknamed "doga" by practitioners). Americans spend $18 billion each year on pet food alone. In 2007, an outbreak of kidney failure in dogs and cats was traced to canned foods manufactured with contaminated wheat gluten by a Chinese company. The gluten had been cut with melamine to boost its nitrogen levels and simulate higher protein content in testing. A similar scandal in 2008 involved adulterated baby formula. In both cases, consumers were outraged by the lack of regulation in international supply chains for food, highlighting how pets are considered family members as worthy as infants of protection.

Feces in Landfills

Pet feces make up around 4 percent of a city's solid waste, slightly less than the notorious bulk of disposable diapers. Once bagged in plastic, animal wastes have difficulty biodegrading. Research has shown that this desiccation has a silver lining in that pathogens do not generally leach into groundwater. The growing popularity of biodegradable poop bags may change this situation. To mitigate the risk of water pollution from feces in landfills, the Environmental Protection Agency (EPA) favors flushing pet excreta for treatment in sewage plants. Meanwhile, landfills continue to accumulate around two million tons of nonbiodegradable cat litter every year.

Kitty Litter and Cat Feces

In 1948, Ed Lowe opened up a new market in pet merchandise by manufacturing a clay-based product called Kitty Litter to replace the sand used in cat bathrooms. The name stuck as a generic one for all brands of litter box fill. Clay-based litter contains silica, a carcinogen harmful to pets and owners alike. The problems with kitty litter's final resting place in lungs and landfills only add to its troubling origins in clay and bentonite strip mines. In 2001, the Oil-Dri Corporation proposed new strip mining operations in Hungry Valley, Nevada, to save on shipping 140 thousand tons of litter from factories in Georgia, Illinois, and Mississippi to the western

United States. Their mine would be located only 100 yards from the Reno-Sparks Indian Colony, prompting Paiute, Shoshone, and Washoe to fight the project with the help of environmental groups. Their concerns include respiratory illnesses caused by dust blowing in from the mine, potential groundwater contamination from arsenic used in processing, increased traffic, noise, light pollution, and irreversible violence against the land. New brands of biodegradable litter made of corn, pine, and even recycled newspapers sidestep the political and ecological issues connected to clay-based litter, but the problem of parasites in cat feces remains.

Felines are the primary host to the brain parasite *Toxoplasma gondii*, which can reproduce only in cats but can infect a variety of species. A cousin to malaria, the pathogen infects humans through cat feces and undercooked meat. It can be lethal to people with compromised immune systems. The parasite can cause fetal brain damage, encephalitis, and miscarriages, so pregnant women are warned not to change litter boxes or garden in potentially contaminated soil. Because the parasite alters the behavior of infected rodents to make them more likely to be eaten by cats, some behavioral ecologists have mused that it similarly must affect human behavior and personality, even at the aggregate level of national cultures. Surprisingly, epidemiologists estimate that 40 percent of the world's population, or 2.5 billion people, are hosts to *T. gondii*. Its ecological territories are growing, with new host populations off the coast of California. The parasite is turning up in dead sea otters and other aquatic mammals.

Californians who flush cat feces or have trained cats to use toilets unleash *T. gondii*'s egg-like oocysts into sewage treatment plants. Some of the robust oocysts survive chlorination to be released into the ocean. Feral cats living and defecating near streams provide another route. Once oocysts reach the sea, they are ingested by mussels, oysters, and anchovies, which are, in turn, eaten by sea lions. Municipal waste management plans to make methane with pet feces would have the secondary benefit of limiting the load of *T. gondii* oocysts reaching the sea.

Dog Feces

Likewise, sequestering pet feces would protect urban watersheds and public health by preventing pathogenic, nitrogen-heavy runoff from reaching streams and groundwater. Dog wastes join lawn fertilizers as significant nonpoint source pollution. Given its high nitrogen content, dog feces entering waterways can cause algal blooms that rob streams of dissolved oxygen, thereby killing fish, insects, and crustaceans. Canine wastes pose a public health risk through contamination of drinking water sources and direct contact. According to the Environmental Protection Agency, a gram of dog feces contains over 23 million coliform bacteria. The microbes act as an indicator species for testing fecal contamination of water, with the assumption that more harmful bacteria and viruses carried by dogs (like giardia, salmonella, and intestinal parasites) may be present. Additionally, rats eat dog feces, so scooping poop helps deter rodent populations. But the risk of direct contact with feces-borne parasites remains for children playing in lawns and parks where dogs defecate.

Disposal Alternatives

The problem of pet feces might become part of a solution to renewable energy production by transforming it into methane via anaerobic bacterial digestion. Composting systems that generate methane can function at a variety of scales. The Park Spark Project in Cambridge, Massachusetts, is a design proposal for an underground feces-composting unit in dog parks that would produce methane to power a gas lamp. At the municipal scale, San Francisco, California, with its goal of zero waste by 2020, has a pilot project to transform the city's pet feces into methane. Energy-producing composting systems are not new to dairy farms, nor to Germany, the United Kingdom, and other European Union nations, where biogas plants have been in use since the 1990s. Pet owners can implement a more humble solution with do-it-yourself feces composters in the backyard, being careful not to use the resulting compost on food gardens and to locate the bin where it will not be swept away by rain.

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See Also: Human Waste; Landfills, Modern; Methane; Microorganisms; Pollution, Water.

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Philippines

The Philippines consists of over 7,000 islands in southeast Asia, surrounded by the South China Sea, the Philippine Sea, and the Sulu Sea. The total land area is 186,411 square miles and the population in 2011 was 101,833,938, the 12th-largest in the world. The country was a Spanish colony from the 16th century, was ceded to the United States in 1898, became self-governing in 1935, and independent in 1946. The United States maintained military bases in the Philippines until 1992. The islands are volcanic and the terrain is mountainous, with some coastal lowlands. Almost half (49 percent) of the population lives in urban areas; major cities include the capital, Manila (11.4 million est. population in 2009 in the metropolitan area), Davao (1.5 million), Cebu City (845,000), and Zamboanga (827,000).

Per capita gross domestic product (GDP) in 2010 was $3,500 (ranking 161st in the world) but with a relatively high growth rate of 7.3 percent (21st in the world) and an industrial production growth rate of 12.1 percent (13th in the world). The primary GDP sectors are services (54.8 percent), industry (31.3 percent), and agriculture (13.9 percent). In 2006, 32.9 percent of the population lived below the poverty line and the Gini index was 45.8, 36th highest in the world. Over 20 percent (22.6 percent) of the population live on less than $1.25 per day (an improvement from 1991, when 30.7 percent of the population met this standard) and about 15 percent of the population are undernourished (also an improvement from 21 percent in 1990–92). Major exports include semiconductors and electronic products, transportation equipment, clothing, copper products, petroleum products, coconut oil, and fruits. Remittances from migrant workers constituted over 10 percent of GDP in both 2008 and 2009. Transparency International gave the Philippines a Corruption Index score of 2.4 in 2010, on a scale from 0 (highly corrupt) to 10 (very clean).

Growth of the Middle Class

One phenomena observed in the Philippines, as in many Asian countries, is the emergence and growth of a middle class (defined in the Philippines by daily expenditures in the range of $2 to $20 in 2005 U.S. dollars). The middle class in the Philippines increased from 44 percent of the population in 1988 to 54 percent in 2006, meaning that about 21 million people were added to the middle class during those years. Members of the middle class are more likely than the poor to live in cities and to work at salaried jobs, rather than be self-employed. Individuals and families who define themselves as middle class have a higher demand for durable consumer goods and increased expectations regarding matters like education and healthcare (and government-sponsored improvements in these sectors often benefit the middle class more than the poor).

In 2006, 44.9 percent of households in the Philippines with per capita income below $1.25 owned a radio, 26.1 percent owned a television, 0.3 percent had air conditioning, 3.3 percent owned a refrigerator, 1.9 percent owned a motorcycle or scooter, and 0.2 percent owned a car. For households with per capita incomes in the $10–$20 range, 72.3 percent owned a radio, 96.1 percent owned a television, 45.3 percent had air-conditioning, 88.9 percent owned a refrigerator, 18.8 percent owned a scooter, and 39.9 percent owned an automobile. The percentage of the population in a given income class owning specific consumer goods is higher in the Philippines than in China or India, although the latter countries, because of their larger populations, may represent larger absolute numbers of households owning goods such as an automobile or air conditioner.

Energy

The Philippines has proven reserves of 0.138 thousand barrels per day of petroleum and 3.48 billion cubic feet of natural gas. In addition, the Philippines is a claimant, along with China, Taiwan,

Residents peer out of a garbage-filled slum in Manila, the Philippines. World attention has focused on pollution in metropolitan Manila, the 11th-largest city in the world and also among the most densely populated. Lack of government planning has resulted in serious infrastructure and pollution problems, including inadequate water distribution and sewage systems. Traffic congestion is often severe and industry is heavy, contributing to heavy air pollution. Solid waste is commonly left in open-air dumps where poor Filipinos scavenge.

Vietnam, Malaysia and Brunei, to parts of the Spratly Islands, an area in the South China Sea that is believed to contain significant oil and natural gas reserves. Total oil production in 2008 was 24,720 barrels of petroleum per day, ranking 74th in the world. Crude oil production in 2008 was 24,550 barrels per day, ranking 63rd in the world. However, this production is far overshadowed by consumption, which in 2008 was 295,000 barrels per day, ranking 40th in the world, leaving the country a net oil importer (270.28 thousand barrels per day in 2008, ranking 26th in the world).

The Philippines has a petroleum refinery capacity of 282,000 barrels per day (as of 2009), ranking 50th in the world. Substantial natural gas production and consumption is a recent phenomenon in the Philippines: in 2000 natural gas production was 0.353 billion cubic feet; while in 2003, this increased to 102.414 billion cubic feet; and in 2009, to 111.242 billion cubic feet. As natural gas in the Philippines is produced for domestic use only, natural gas consumption follows the same pattern as production. The Philippines produced 3.978 million short tons of coal in 2008 (ranking 36th in the world) and consumed 13.1 million short tons (ranking 34th in the world), making the country a net coal exporter (of 9.122 million short tons in 2008).

Over 60 percent of electricity in the Philippines is generated by burning fossil fuels (oil, coal, and natural gas), with a smaller percentage provided by hydropower and other renewable sources. Installed electrical capacity in 2008 was 15.68 gigawatts, net generation of electricity was 59.161 billion kilowatt hours, and net consumption was 49.71 billion kilowatt hours. Total energy production in 2007 was 0.514 quadrillion Btu (ranking 68th in the world) and consumption was 1.300 quadrillion Btu (ranking 46th in the world). Carbon dioxide emission from consumption of fossil fuels in 2008 was 74.24 million metric tons, ranking 45th in the world. The country has good potential for renewable energy: the Global Energy Network Institute estimates that the Philippines has a power generation potential of over

250,000 megawatts from renewable resources, primarily geothermal. As of 2005, the Philippines was producing 10,723 gigawatts of electricity from geothermal sources (second behind the United States), 9,843 from hydropower, 61 gigawatts from wind power, and 1 gigawatt from solar voltaics.

Environmental Issues

Rapid economic development, coupled with lack of environmental regulation, has contributed to many environmental issues in the Philippines, including soil erosion, deforestation, coral reef degradation, air and water pollution in major cities, and pollution of fish breeding grounds in coastal mangrove swamps. As an island nation, the country is also at risk from rising ocean levels due to melting of the polar ice caps quickened by global warming. Access to clean water is a nationwide problem: almost one-third of illnesses reported in a five-year period were waterborne, over half of groundwater is believed to be polluted, and many areas experience water shortages during the dry season. About 2.2 million metric tons of organic pollutants are produced annually, with almost half (48 percent) stemming from domestic sources, 37 percent from agriculture, and 15 percent from industry. Toxic waste left behind by the U.S. military is also problematic; for instance, unusually high levels of birth defects, miscarriages, and cancers have been identified among people living on deserted bases. While the U.S. bases were occupied, they engaged in many environmentally unfriendly practices such as dumping untreated sewage into coastal waters; longer-lasting sources of pollution include the harm from dumping fuel and chemicals, leakage from petroleum stored in underground tanks lacking leak-detection equipment, and inadequate disposal of hazardous solid waste, including asbestos, paint, and batteries.

Much world attention has focused on pollution in Metropolitan Manila, which is the 11th-largest city in the world and also among the most densely populated. The city developed largely in response to market forces rather than government planning, resulting in serious infrastructure and pollution problems, including inadequate water distribution and sewage systems (only about 11 percent of the population has access to piped sewers and much sewage is discharged without treatment into Manila Bay). Traffic congestion is often severe and motor vehicles are primary contributors, along with industry (over half of Philippine manufacturing is located in the Manila metropolitan area), to a serious air pollution problem. Disposal of solid waste is also a problem, with much of it being deposited in large open-air dumps such as the Payatas dump site, which occupies 50 acres in Quezon City, part of Metropolitan Manila.

Many poor Filipinos make their living scavenging from these dumps, exposing themselves to smoke and hazardous materials. These open dumps also represent immediate threats to health of surrounding homes (for instance, in 2000, a mountain of garbage collapsed and killed hundreds of people living in the immediate vicinity) and represent an ongoing source of pollution.

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See Also: Consumerism; Consumption Patterns; Developing Countries; Dump Digging; Manila, Philippines; Street Scavenging and Trash Picking.

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Poland

Poland, located in central Europe, had a population of over 38 million people during the 2007 census and the sixth-largest economy in Europe. During the 20th century, Poland was a center of iron, steel, coal, and textile production. The economy has grown considerably since the demise of communism in the early 1990s, with the development of high-technology firms, automobile manufacture, and several other industries.

The issues of Poland's consumption and waste are of great importance from an environmental and social point of view. Human activities are often related to the exploitation of natural resources. Polish citizens use natural resources predominantly for the production of consumer goods, creating a waste problem in the process.

Waste Production

Waste constitutes a growing problem in Poland. Statistical data indicate that Poland generates in excess of 12 million tons of municipal waste per year in the early 21st century. (Municipal waste should be understood as solid and liquid wastes generated in households and other functional buildings.) Assessment data show that the average amount of gathered municipal wastes per capita in Poland ranged between 300 and 500 pounds per year. The amount of waste generated by an average Pole is comparable with respect to the average European. Many Polish districts practice selective collection of municipal waste. A considerable portion of municipal waste is constituted of paper and cardboard, then glass, followed by biodegradable wastes, large-dimension wastes, and plastic. The smallest portions of waste are hazardous wastes, textiles, and metals.

Landfills

Unfortunately, most municipal waste in Poland is thrown away. Waste management is still one of the most serious issues when considering environmental protection in Poland. Developing the infrastructure of Polish cities is caused by more and more intense human living and economic activity. Regrettably, most generated wastes are not used economically but are simply dumped. One of the most frequently used methods of managing wastes in Poland is waste disposal. Dumps and landfills are not only the oldest but also still the most popular method of waste management. Wastes that are usually not recyled are plastic packaging, glass packaging, paper, cardboard, glass, metals, organic wastes, and destroyed building materials. Unfortunately, despite the fact that most of these wastes are able to be processed to obtain usable material, Polish municipal services continue to transport such wastes out of town.

The standard procedure that is carried out in a dump is based on several stages. First, wastes are ground down in order to form the tiniest parts. Then, compressing (also called "waste compaction") is carried out by a huge compactor so as to extend the dump's lifespan. After those two stages, daily covering with soil occurs. The estimated amount of municipal waste generated each year is about 10–12 million tons. A considerable amount of this (more than 90 percent) lands in a dump. The main advantage of that method of neutralizing wastes is its simplicity and relatively low cost. The greatest danger is "wild dumps" that are in contrast to arranged dumps.

Huge environmental hazards exist when people throw waste into woods or in a wild dump because in such places the public does not generally care about the site's ecological aspects. Additionally, even an arranged landfill site during the period of exploitation causes dust emissions and the leaching of poisonous chemical substances into soil and underground waters. In Poland, the benefits gained from recycling municipal wastes has not yet convinced production enterprises to recylce.

Plastics

The management of plastic municipal solid waste is of great importance from the environmental and economic points of view. It is worth mentioning that plastic wastes are nonbiodegradable, nonrenewable, and multiresistant, such that the natural environment is not capable of dealing with such

products. Due to the fact that plastic has a wide scope of unique properties, such as being light weight, durable, flexible, versatile, and strong, the material is widely used in industry. The origins of plastic wastes are not only in packaging but also in electronics, paints and varnishes, automobiles, furnishing, agriculture, housekeeping products, buildings, and other groups of nonclassified sources. The management of plastic wastes is an urgent task because the consumption of plastics is over 1 million tons per year in Poland.

Up-to-date technological progress allows a myriad of ways of recycling and recovery of plastic. The recycling strategies include mechanical recycling, which is also called "physical recycling," in which several processes can be listed. Mechanical recycling belongs to the group of material recycling. Processes include rebonding, particle bonding, compression molding, adhesive pressing, and powdering.

The next category of plastic waste treatment is a chemical recycling known as depolymerization. That method allows one to obtain a product with almost identical features as the prototype that went through the chemolysis. The next solution that can be used when coping with post-consumer waste plastic is feedstock recycling. This process enables one to achieve liquid and gaseous hydrocarbons. Moreover, that process comprises only a few steps, which are reduction of iron ore, pyrolysis, hydrogenation, and synthesis of gas. Predominantly, that process appears to be attractive for the petrochemical industry because it can benefit from recovering value from scraps.

As of 2010, the petrochemical industry in Poland had not shown interest in this practice because the excise tax on recovered fuel was too high. The last known method of utilizing plastic wastes is energy recovery. Energy recovery is the most environmentally friendly and cost-effective solution of utilizing solid municipal wastes. The recovery of energy from post-consumer plastic causes no emission of carbon dioxide, significantly cuts down the amount of wastes collected on landfills, and the energy taken back from plastic wastes can be used not only for household but also for industrial needs. Devoting special attention to the issue of recycling of plastic is caused by the fact that the decomposition of a plastic bottle can take as long as 500 years and at that time, toxic chemicals penetrate the ground.

Glass and Recycling Bins

Glass is a nonorganic material that can be reused and recycled. Glass recovery is of great importance because this material is predominantly manufactured from sand and energy. Before melting, the glass wastes are sorted, collated, and then washed in order to achieve a high quality of recyclate. Color-coded containers serve to help Polish residents separate wastes depending on their type. In Poland, glass is collected for recylcing by color. For example, a white container is only for colorless glass, while colored glass is deposited in a green container. A blue dustbin is provided for people to dispose of paper waste, and a yellow container serves to collect plastics and metals.

In Poland, as part of conscious action in favor of environmental protection, the dual system of sorting household wastes was initiated. Generally, it can be said that the system is based on employment of two containers. One container is for dry wastes and another for clean, wet wastes. In the first group belong the wrappings made of metal, plastic, paper, faience, textiles, and used hygienic products. The second group includes all biodegradable wastes, such as food remains.

Hazardous Wastes

Regarding environmental protection, in Poland initiatives are aimed at the elimination of toxic effects of heavy metals. Throughout Poland, recycling waste plants exist where individuals can leave hazardous wastes. Moreover, such wastes are taken for free from inhabitants.

Particularly dangerous for the environment are worn-out electronic and electric appliances. These materials are treated with particular care in Poland. The indication of employment in environmental protection takes many forms; for example, there are authorized gathering points for the collection of used batteries, old medicines, and mobile collection of wastes. Hazardous wastes are treated with particular care because of the fact that these types of wastes containing heavy metals exert harmful influences on the air, land, and water. At the moment

of permeating the water, the contamination of all living organisms' is nearly unavoidable.

Environmental Burdens Caused by Wastes

Polish society's socioeconomic activities have a serious consequence on the natural environment, with economic development able to trigger harmful changes to the natural environment. The degradation of the environment is greatest in industrial areas and where the population density is high. In urban areas, exploitation of natural resources can be intense. Generated wastes determine the condition of soil, water, and air. The development of Polish cities is inextricably linked with industrial plants, the development of mass transport, the growing number of cars, and increasing numbers of buildings. All these factors are responsible for emitting sulfur compounds, nitrogen compounds, and carbon oxides into the atmosphere. Gaseous pollution caused by sulfur and nitrogen are especially harmful because their reaction with water leads to acid rain. The social dimension of air pollution in this sense should be understood as a factor causing deterioration of stone monuments, buildings, and soil acidity. The gaseous pollutions triggered by wastes are greatly influencing human health, causing physical, mental, and respiratory tract diseases.

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See Also: Paper Products; Pollution, Air; Pollution, Land; Pollution, Water.

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Politics of Waste

Though politics and waste are inextricably linked, they are uneasy bedfellows. As the size and complexity of the waste stream have grown, the relationship between politics and waste has become deeply complicated. Exactly what constitutes waste, how it is controlled, what oversight it requires from which sources, and what costs it imposes on whom have been debated across U.S. history.

Early History

According to archaeological evidence, colonial Americans often cast their discards around their homesteads. This was not a problem in rural areas where neighbors were distant and foraging livestock consumed much of the waste, but the habit caused trouble in towns and cities. As early as the 17th century, towns required residents to sweep in front of their homes and to deposit their rubbish in specific locations. Enforcement was sporadic, except when the threat of epidemics inspired more concerted street-cleaning efforts. Even casual observers understood that diseases like yellow fever were deadlier in dirtier neighborhoods than in cleaner quarters.

First Organizations

Serious answers to waste problems did not become common across the country until the late 19th and early 20th centuries, when Progressive Era activists argued that there was a direct link between street cleanliness, public health, and what was understood to be the appropriate moral rectitude required of new immigrants. Organizations like Chicago's Municipal Order League and New York City's Women's Health Protective Association joined with physicians and civic leaders who were urging reform. Together, they pushed local and state politicians to create and enforce mandatory housing codes, zoning measures, food quality regulations, and street cleaning and garbage disposal infrastructure.

From these efforts grew municipally controlled systems that were more or less effective and organizationally transparent. The American Society of Municipal Engineers and the International Association of Public Works Officials (which merged to form the American Public Works Association in 1937) helped cities organize formerly casual labors and structures of waste management around clear measures, like how many man-hours were required to sweep how many miles of streets and collect how many tons of garbage, with what tools, at what cost. These efforts reflected a political trend toward greater rationalization and bureaucratization of government at all levels, but it was far from perfect. Municipal wastes were still dumped, with few controls, on land or in waterways, while incinerators (called "destructors" in that era) were primitive and noxious by 21st-century standards.

Consumption and Production Increases

Tighter management of municipal solid waste (MSW) coincided with a shift in cultural trends that would have profound effects on daily life and on the nature, volume, and political profile of garbage. Ashes, a significant component of household trash for centuries, were a good indicator of this change: they accounted for nearly half the municipal waste stream as late as the 1920s but less than 10 percent by the 1960s. At the same time, there was a steep rise in consumer consumption. The factories, mills, mines, and agricultural conglomerations that proliferated in the first half of the 20th century made commodities faster and more cheaply than ever before in human history.

As the 20th century progressed, the nation's industrial might was a significant factor in its increasing strength within the global economy. World War II inspired industrial innovations that were retooled in the postwar era both to create and to meet increasing domestic consumption demands, but their success came at a cost. Novel manufacturing processes, increasing use of plastics, falling prices of consumer goods, and rising incomes of U.S. families were among the many factors that combined to introduce new extremes of pollution to air, land, and water.

Environmental Awareness and Litter

Public alarm grew. Concerned citizens of the late 19th century who forced change in urban policies and MSW regulations were largely from the privileged classes; by contrast, in the mid-20th century, a movement toward greater environmental awareness and regulation started at the grassroots. Like their forebears, these protestors looked at municipal solid waste and other forms of domestic garbage as areas of primary concern. Corporate interests, which watched these efforts closely, crafted their own responses; the story of the disposable beverage container is a good example.

When disposable cans and bottles started replacing traditional refillable glass containers, they also started showing up as litter on city streets, along roadways, and even in rural areas. Several states were concerned about this new garbage problem. Vermont was one of the first to pass legislation banning disposable containers, but it was stymied by a clever new initiative.

In her 2006 book *Gone Tomorrow: The Hidden Life of Trash*, Heather Rogers describes how Keep America Beautiful (KAB), a nonprofit organization that acted and sounded like an environmental group, was actually created by the packaging and container industries in 1953 to prevent regulations that would restrict package manufacturing, distribution, marketing, and use. The problem of litter, suggested KAB, lay not with industry but with individuals, as the famous KAB tagline implied: "People start pollution; people can stop it" (first intoned by one of its early spokesmen, a relatively unknown actor named Ronald Reagan). Instead of passing laws to limit containers or packaging, it made more sense, according to KAB logic, to pass antilitter ordinances. Since then, KAB has successfully used advertising, public relations campaigns, and lobbying to undermine a variety of controls on packaging, including container deposit laws (better known as "bottle bills"). Though KAB claims to support community recycling, for decades it has opposed one of the few local-level recycling initiatives that actually reduces the waste stream. Bottle bills existed in only 10 states as of 2010.

Regulation

A few years later, municipal garbage was the subject of other legislative attention. The Solid Waste Disposal Act of 1965 tried to shrink the country's waste stream by supporting research to help towns

and cities create less environmentally damaging disposal systems (despite its good intentions, it did little to change MSW protocols).

In 1969, *Time* magazine's first-ever "Environment" section included a story about Cleveland's Cuyahoga River, so thoroughly polluted with industrial effluents that it caught fire. The blaze became a symbol of how shockingly devastated the U.S. environment had become, though, in fact, the fire was neither as large nor as devastating as the accompanying photo in *Time* implied. The picture was from a previous, much-larger conflagration. The bigger story, which *Time* did not tell, was that river fires were relatively common on the Cuyahoga and on many other waterways in the nation's heavily industrialized zones.

The Clean Air Act, first passed in 1963, was strengthened in 1970, the same year as the first Earth Day. It was also the year that the Environmental Protection Agency (EPA) was established to create and enforce national environmental policy. The agency was eventually given broad powers over water and air quality, pesticide and radiation hazards, and solid waste disposal.

In 1972, the Clean Water Act was made law, and in 1976, Congress addressed the failure of the Solid Waste Disposal Act with the more comprehensive Resource Conservation and Recovery Act (RCRA). Not only did RCRA focus regulatory attention on municipal solid waste management systems, it also required "cradle-to-grave" oversight of hazardous wastes, meaning that such substances had to be monitored and regulated from their creation through their disposal.

Some of these measures had tangible and lasting effects. Slowly but steadily, waterways that had been devastated by pollution became clean enough for swimming. Air quality improved in cities around the country, and places like wetlands and marshes, long considered appropriate locations for landfills, were recognized as vital ecologies in need of protection.

Even as these laws proved effective, industry and corporate interests continued to organize against them with claims that government-mandated pollution prevention and abatement rules were too costly and that standards for various waste-control measures were too burdensome.

Focus on MSW

An enduring consequence of such industry pushback is the uneven nature of regulatory oversight. Some categories of waste that occur in massively damaging quantities inspire scant public attention and only light governmental controls, while smaller, less-severe instances of waste-generating pollution receive significant interest. MSW is an excellent example.

When the EPA tallies all recognized waste categories within the United States, it estimates a national total of as much as 10 billion annual tons. As of 2008, according to *BioCycle* magazine's biannual "State of Garbage in America" survey, the country's total MSW output was 389.5 million tons, or approximately 2.5 percent of the nation's overall waste stream. However, MSW attracts a disproportionately intense regulatory focus compared with many larger, less-visible, and more-harmful wastes.

One reason that waste politics concentrates on MSW is that it is a regular part of everyday life for most Americans and it is comparatively easy to measure and regulate. MSW is a conglomeration of many disparate waste forms, but it has relatively clear origins when considered as a single waste category. A city or a town asked to identify its municipal waste can point to residents' household discards. One town might inventory these a little differently than the next town because local governments do not all collect and characterize their municipal castoffs the same way, and the EPA divides MSW into many subcategories. But even with such caveats, it is generated by more or less obvious sources and is contained, at least temporarily, within recognizable boundaries.

Partly because of this, MSW management is molded by a myriad of laws from every level of government, making clear the immediate and continual (if not always acknowledged) connection between citizens, their castoffs, their elected representatives, and the policies those representatives devise. Even the smallest details of garbage collection are mediated by political controls. Municipal trash is picked up by a person or by a crew of people in a collection truck. It may be an automated front-loader, a side-loader, a rear-loading compactor, or a container truck; it may be built to hold 32 cubic yards, 25, 16, or 9. Whatever its model or capacity, it must

adhere to a long and detailed list of state and federal laws. These include a host of variables, such as dimensions and weight. The tires must be regulation sizes, strengths, and tread depths. Mechanical requirements like lights, turn signals, reflectors, and brake functions must adhere to truck safety rules. Increasingly stringent emissions standards dictate fuel choices and—like all vehicles—the trucks must obey requirements for registration, insurance, and inspections and must adhere to interstate fuel and transportation agreements.

When driving to disposal sites, collection trucks can only travel on roads capable of bearing their weight. They might also have to detour around towns or counties that do not allow trash to be transported through them, though these limits are often voided by federal regulations that guarantee the free flow of commerce.

Some smaller towns, especially in rural areas, get around this and other MSW problems by not providing garbage collection. Expenses incurred by contracts with a private carter or by paying a sanitation workforce with town funds are eliminated, but the strategy creates infrastructural and environmental stresses that can prove costly over time. Because citizens must transport their own refuse, a few collection trucks are replaced by many individual homeowners driving individual vehicles to the collection facility, which puts more traffic on roads and more exhaust into the air. It also means less oversight for whatever recycling laws might be in place. And if the disposal facility is privately owned, the town may find it difficult to control fee increases when the contract is up for renewal.

The Department of Transportation, in concert with the Federal Motor Carrier Safety Administration, requires workers who drive and operate collection trucks to hold a commercial driver's license. If they are employed by a municipality, then that local government, following federal, state, and local labor laws, and often in negotiation with a union, determines hours, wages, benefits, retirement policies, and perhaps pensions. The local government also determines which equipment is necessary (e.g., does the town need only collection trucks, or should it also have mechanical brooms?) and the structures of maintenance such equipment requires. In addition, the municipality works out procurement procedures for supplies like fuel and auxiliary tools, codifies rules for when and how private vendors are hired, elaborates precise parameters of municipal collection responsibilities (e.g., does the agency only service private residences or does it also collect commercial waste?), and decides where within its organizational structure the waste management system fits. In some cities, garbage collection is part of a public works department; in others, it is a separate entity within city government, like a department of sanitation or a department of street cleaning.

If the collection truck goes to a landfill with access to the "open face" or "active bank," the trash is dumped there, then compacted and covered with clean fill. If the truck empties at a waste-to-energy (WTE) facility, the rubbish is burned to generate power. If the truck tips at a transfer station,

Some smaller towns, especially in rural areas, do not provide public garbage collection; however, the resulting infrastructural and environmental stresses can prove costly over time, including lack of regulatory oversight and less efficiency in transporting waste.

the trash is loaded onto barges, rail cars, or tractor-trailers for travel to another destination.

A transfer station is the point where MSW moves from the municipality into a larger geography, which forces local governments to forge relationships with other, more-distant players in the world of waste. Transfer stations exist in part because of Article I, Section 8, Clause 3 of the U.S. Constitution, known as the "Commerce Clause," which gives Congress the right to ". . . regulate Commerce … among the several States. . . ." Much to the regret of some states and to the relief of others, waste counts as commerce, so states exporting it cannot be refused by states that do not want it, though host states can write landfill permits with strict limits on the amount of out-of-state garbage they will accept.

While the federal interpretation of the Commerce Clause prohibits states from refusing trash, the Resource Control and Recovery Act gives the EPA the power to impose stringent environmental and safety controls on all waste facilities and especially on landfills, which are full of unwelcome by-products. Leachate, a kind of "garbage juice" laced with heavy metals and other toxins and found wherever there are masses of trash, can cause serious groundwater pollution. The EPA requires it to be captured and treated to potable standards. *Volatile organic compounds*, a catch-all phrase for gases emitted by a variety of sources, and methane, a significant greenhouse gas created by decomposing organics, both require piping and retrieval systems. States must adhere to all federal regulations but are also free to impose more rigorous controls.

Environmental Justice

Not surprisingly, landfills, transfer stations, WTE plants, and, to a lesser extent, materials recycling facilities (MRFs) are intensely politicized zones. A public concerned about environmental issues and savvy about using Internet-based media to amplify voices of protest is quick to organize against them. No one wants them as a neighbor, and opposition is often motivated by the Not in My Backyard (NIMBY) syndrome. In the 1970s, a new awareness of connections between waste, race, and class changed the shape of the debate.

In the early 1980s, the state of North Carolina decided to build a hazardous waste landfill in Warren County, where most residents were not white and one-fifth of the population lived below the poverty line. When a local church group started researching where other waste facilities in the region had been built, they discovered that a disproportionate number were located either in communities of minorities or in impoverished rural areas. A 1983 study by the Government Accounting Office confirmed this, showing that three out of every four hazardous waste facilities in the southeastern United States were in African American communities.

Activists and organizers with experience in civil rights struggles came together to fight the Warren County landfill. They lost that battle, but their campaign quickly grew beyond its regional focus to embrace issues of environmental racism and equity across the country. It became the environmental justice movement, transforming the national conversation about environmental concerns. Among the many measures of its success is its role in government. The EPA administors grants and awards dedicated to environmental justice research and works closely with the National Environmental Justice Advisory Panel.

Other Waste Disposal Policies

Environmental justice is but one example of new movements, initiatives, and proposals that aim to reshape waste policies and politics. Extended producer responsibility (EPR), common in Europe, is gaining support in the United States. It requires that manufacturers bear the costs throughout the life cycle of the goods and products they create. Among its many ramifications are those of discard. Instead of imposing disposal costs on individuals or on municipalities, EPR puts them back on the producer. Bottle bills debated in many states are common examples of EPR, but can also apply to cars, appliances, electronics, and even to products like paint, motor oil, and medications.

Other initiatives outside the purview of formal government bureaucracies are making political waves by urging more radical approaches to waste issues. Zero waste counters the "cradle-to-grave" idea of waste management and instead advocates retooling the relationships between extraction,

manufacture, distribution, and consumption so that these processes form a closed and self-perpetuating loop. In this model, waste is not a by-product or a leftover; in fact, waste does not exist. What was once called "waste" is instead understood as a potential resource or residual that loops back into the system as an energy source. Some skeptics point out that zero waste requires infrastructural, economic, and cultural supports that are not yet easy to find on a grand scale, while others argue that until it addresses large structural sources of waste, zero waste is more rhetoric than real change. But the cause has earned endorsements from municipal governments across the country and adherents around the world.

Another waste management innovation called "pay as you throw" has proven successful in several states. Householders pay for MSW collection based on the weight (or, in some cases, the volume) of what they discard. This method, also called a "unit-pricing model," measures waste the way utilities measure electricity or water. Those who generate less waste pay less money. In many cities with pay-as-you-throw programs, waste reduction is further encouraged by making recycling pickup a free service. Despite some initial resistance, municipalities that have embraced pay as you throw have found it an effective way to shrink the waste stream and generate revenue.

Recycling and Repurposing

Other proposals focus on recycling. The collection and processing systems are already in place, so some waste experts would like to see programs expand to include categories that are not yet considered profitable recycling commodities. These ideas can become chicken-and-egg arguments. Naysayers point out that there are no markets for many recycled materials, while proponents argue that changes in recycling parameters will encourage the creation of appropriate markets.

Some activists take this even further and suggest that, along with recycling facilities, reuse and repurposing centers should also be built. Advocates for this strategy say that by diverting wastes to such centers, there will be less need for long-haul transport, thus saving road wear-and-tear and lowering truck emissions. It will also create jobs, foster small business development, and help bolster local tax bases. Such facilities, dubbed resource recovery parks, already exist in Florida, California, and Hawaii.

Lobbying

Any substantive changes to MSW collections, definitions, measures, or end-use plans will find reactions among solid waste professionals. Private solid waste managers belong to a wealthy and politically powerful industry. A study released in early 2011 by First Research, a market analysis firm, gauges waste industry annual revenue at $75 billion. The study found that three-quarters of this revenue comes from waste collection, treatment, and disposal.

An industry that depends on collection and disposal for the bulk of its income will be wary of changes in the systems that generate its profits. Fluctuations in industry income are already pegged to the economy. When the economy is strong, Americans consume more; when they consume more, they waste more; when they waste more, waste professionals make more money. A weaker economy shrinks the waste stream, which in turn diminshes industry profits. Industry lobbyists have a strong hand in crafting legislation relevant to their field, but this kind of work is not done in public venues. Because the waste industry often uses environmental language when discussing problems of solid waste pollution, it is not always easy to discern the true intent of political decisions and legal precedents that claim environmental benefit but were shaped by waste-industry insiders.

Larger Questions

Much political rhetoric since the 1990s has protested unwelcome government intrusion in private life; ironically, recycling and solid waste disposal ordinances, which oblige householders to alter their behaviors within their own homes, are ready illustrations. When curbside recycling was made mandatory in New York City in 1989, many New Yorkers complained bitterly. According to press accounts, some even demanded that they be paid for the tedious work of rinsing pet food cans and bundling newspapers. On the other side of the country, more than two decades later, residents of

San Francisco were delighted to follow their city's ambitious recycling laws. By the autumn of 2010, San Francisco boasted that it had kept 77 percent of its municipal waste out of landfills.

Such municipal success, however, still misses a bigger picture. Some analysts even interpret it as harmful. Curbside recycling purports to benefit the environment by diverting discards from the trash and sending them instead to materials recycling facilities. Citizens are taught that when they recycle, they are shrinking the nation's waste stream and thus helping to "save the planet." It is a deeply ingrained belief, but consider the numbers. If municipal waste accounts for less than 3 percent of the nation's total waste output, even 100-percent MSW diversion will have only minimal impact. Annie Leonard, in her 2010 book *The Story of Stuff,* compares it to a faucet left running until it floods a home. No one would attempt to mop up the mess without first turning off the faucet. Similarly, because municipal recycling addresses only a small part of the problem and only at the end stage, even the most ambitious campaign will never have an impact on the plethora of wastes generated by largely unseen processes of extraction, manufacture, and distribution.

Consider the case of plastics. In the 21st century, it is difficult to find a commodity or a product component that does not include some form of plastic. Two common varieties are polyethylene terephthalate (PET) and high-density polyethylene (HDPE), often used for beverage containers and other single-use packages and known more commonly as #1 and #2 plastics. Because they are relatively easy to break down, PET and HDPE have become standard in municipal recycling programs throughout the United States. Unlike glass and many metals, which can be remade without losing structural integrity, #1 and #2 plastics can only be downcycled; every time they go through a recycling process, their quality and usefulness diminish.

Curbside programs cannot address many other forms of plastic that are difficult to recycle or reuse. They cannot do anything about the multiplicity of wastes generated by plastics-manufacturing processes, nor can they separate plastics from common additives like bisphenol A and phthalates, compounds used to impart traits like pliability, durability, or flame resistance. These have come under scrutiny as research suggests that these and similar substances are endocrine disrupters.

Plastics provide a sobering example of the discrepancy between the goals and the actual efficacy of locally based waste-reduction initiatives. By identifying the individual, household, and municipality as primary sources of waste while ignoring larger-scale industrial and commercial sources, municipal recycling efforts miss most of a very big picture. Such a gap, exacerbated since the 1990s by increased political support for community recycling, has serious implications for measuring and responding to the true impact of waste.

Part of the problem is that "waste" is not a single concept but a label applied to a wide range of by-products, leftovers, discards, effluents, and scraps, all of which vary in composition, source, and impact. Different forms of waste require different protocols for handling, transport, storage, disposal, and long-term oversight. Policies about nuclear military waste, for instance, differ from policies about nuclear-reactor waste. Biosolids (more commonly known as sewage sludge) have treatment requirements unlike those used for animal wastes in agricultural contexts. Hazardous household wastes, similar to but not the same as hazardous wastes, may not use the same channels as municipal household wastes. Medical waste, mining waste, electronic waste, and construction and demolition debris require their own rules, as do the many kinds of industrial wastes.

Conclusion

The unique nature of much 21st-century waste is forcing a reconsideration of the entire framework used to craft political guidelines for waste-generating processes and for finding solutions to waste-related problems. It is increasingly difficult to pinpoint particular origins of various wastes, which are themselves new forms of pollutants and toxins. Nor is it possible to trace their paths, analyze their effects, and propose clear or single-source solutions. This ambiguity of source, composition, and destination creates new challenges in controlling or ameliorating the effects of waste. Greenhouse gases, the wastes most directly implicated in climate change, are one example of this. The approximately 315 billion tons of plastics that have formed vast

gyres in all the world's oceans are another. Plastics are also implicated in the toxic chemical concentrations called "body burdens" present in life forms all over the planet.

Municipal waste management can address none of these concerns on a global scale. As long as politicians and policy makers assign responsibility for waste management to cities, towns, families, and individuals, and do not give similar attention to the actual sources of so many waste forms, real solutions to the problems of waste are still distant.

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See Also: Clean Air Act; Consumerism; Economics of Waste Collection and Disposal, U.S.; Environmental Justice; Environmental Protection Agency (EPA); Externalities; Landfills, Modern; Packaging and Product Containers; Pre-Consumer Waste; Recycling; Resource Conservation and Recovery Act; Solid Waste Data Analysis; Toxic Wastes.

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Pollution, Air

A problem in urbanized societies for centuries, air pollution has important implications for local, regional, and global atmospheres. Ranging from smoke, smog, and the infamous, deadly "London fog" to emissions linked to global climate change, the consequences of air pollution have intensified since the Industrial Revolution. Attempts at regulating pollution have ranged from local fuel-treatment ordinances such as the St. Louis smoke control ordinance of 1940 to global efforts to cap carbon emissions such as the Kyoto Protocol.

Environmental deterioration is one of the greatest problems humanity faces in the 21st century. Air pollution is an important part of this apprehension, especially in highly industrialized countries, such as China and the United States, and in fast-developing urban centers, which can be found, for instance, in many cities in southeast Asia. Air pollution is an issue everyone has the right to know about and is a subject everyone, in some form, has to deal with. It is an issue that can and should be controlled not only by governments but also by society at large. Problems of air pollution can only be solved if each individual feels obliged to be concerned. The term *air pollution* describes any kind of hazardous air contamination caused by human activities. In fact, air pollution can be roughly divided into indoor air pollution and outdoor air pollution, and there are different types of pollutants responsible for generating contaminated air.

Outdoor Air Pollution

Outdoor air pollution in urban environments is fast becoming a grave threat to urban residents as levels of toxicity increase beyond safe limits. This is especially true in countries where urban centers are rapidly growing and becoming extremely dense, such as India. While developed countries such as the United States, Canada, Australia, and most European countries have government-controlled air quality monitoring apparatuses, the major problem with developing countries is a lack of any urban air quality data collection infrastructure. When real-time pollutant levels in the air remain unknown, it becomes much harder to manage air pollution or to promote public understanding of the subject and its severity.

Whether one lives in a high-income, middle-income, or low-income country, air is regularly contaminated with varying levels of several pollutants. The fundamental pollutants include sulfur oxides (a group of chemical compounds containing sulfur and oxygen), carbon monoxide (a colorless, odorless, and tasteless gas extremely toxic in high levels), nitrogen oxides (a group of chemical compounds containing nitrogen and oxygen), lead (a heavy metal with various industrial uses), ground-level ozone (visualized as smog in high concentrations), and particulate matter (particle pollution). These pollutants were identified as the six most common air pollutants by the Environmental Protection Agency (EPA) and are also referred to as criteria pollutants. According to the EPA, particulate matter and ground-level ozone pollution are currently the most widespread health threats around the world.

Particulate matter is a mixture of microscopic solids and liquid drops suspended in the air and is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, soil or dust particles, and allergens (such as fragments of pollen or mold spores). The larger the particles are, the more hazardous for public health they become.

Whenever outdoor air becomes smoggy, it contains high levels of ground-level ozone. Ozone is a colorless gas composed of three atoms of oxygen (O_3). Ground-level ozone, or "bad" ozone, is ozone found in the Earth's lower atmosphere. It is formed when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources react chemically in the presence of sunlight, creating a combination of smoke and fog referred to as "smog." About 10–30 miles above the Earth's surface, conversely, ozone forms a protective layer that shields the planet from the sun's harmful ultraviolet (UV) rays. This is called the "good" ozone, and it is gradually being destroyed by human-made chemicals. Humans are hence much more exposed to adverse effects that may be caused by UV exposure. The fact that ozone is also a greenhouse gas links ozone-related air pollution with the issue of climate change and global warming. In addition, exposure to ozone may cause a vast array of acute respiratory illnesses; therefore, ground-level ozone is a chief public health hazard. Motor vehicles are a major contributor to smog, hence it is very important to increase public awareness of public and social steps that can be taken to help reduce ground ozone levels (such as the use of carpools or public transportation).

In countries where air pollution is being monitored, a maximum level of these pollutants has been set according to science-based guidelines. In the United States, for example, there is an air quality index constantly updated and publicly accessible through the EPA Website (www.Airnow.gov). Whenever the maximum level is exceeded, the toxins' level is labeled "hazardous," the public is warned, and safety measures are employed. In countries lacking a monitoring mechanism, however, pollution levels can reach unsafe thresholds.

Volatile Organic Compounds

Another important group of outdoor and indoor air pollutants is referred to as "volatile organic compounds" (VOCs). These include various chemical compounds that are emitted as gases from a range of solids and liquids, such as household products, furniture, wall coverings, office equipment, sprays, disinfectants, air fresheners, and more. Some studies have shown these chemicals may be responsible for leukemia and lymphomas. One of the common VOCs is methane, a widespread greenhouse gas, which—along with ozone and other greenhouse gases—is responsible for global warming and climate change. Global warming is caused by greenhouse gasses that accumulate in the upper atmosphere, creating a condition where heat is trapped in the atmosphere, causing the Earth to become warmer and warmer over time. This effect, also referred to as the greenhouse effect, is the origin of a drastic change in climate conditions.

Indoor Air Pollution

Indoor air quality is significant because many people spend significant amounts of time in offices and closed rooms. VOCs can be found in much higher concentrations in indoor air. Ozone is also found in indoor air, though in lower concentrations than outdoors. Other common indoor air pollutants include radon, molds, asbestos fibers, carbon monoxide, and carbon dioxide. Radon is an invisible radioactive gas that can be found in many houses and is

considered responsible for many lung cancer deaths in the United States and Europe every year. Airborne molds contain an array of biological chemicals and are considered allergens. Asbestos is a mineral fiber that has been used in a variety of building construction materials for insulation and as a fire retardant. Asbestos used to be widely employed and can still be found in many common building materials. When asbestos-containing material is slashed or demolished, microscopic fibers are dispersed into the air. Even though significant release of asbestos fiber does not occur unless the building materials are disintegrated, in 1975, the U.S. federal government set standards for acceptable levels of asbestos fibers in indoor air. The risks from inhaling asbestos fibers include respiratory disease and lung cancer. Removal of asbestos-containing materials is not always a favorable option because the fibers can spread into the air during the removal process.

Carbon monoxide (CO) is one of the most acutely toxic indoor air contaminants. It is a colorless, odorless gas that derives from an incomplete burning of fossil fuels. Common sources of carbon monoxide are tobacco smoke and automobile exhaust. Indoor levels of CO can be controlled via smoke-free policies. Carbon dioxide (CO_2) is an indoor pollutant emitted by humans and plants (at nighttime). It is associated with human and plant metabolic activity. At high levels, carbon dioxide may cause drowsiness and headaches. In developing countries, particulate matter is a major indoor pollutant in addition to being a key source of outdoor pollution. Indoor particle pollution is caused by the burning of biomass (such as wood, charcoal, dung, or crop residue) for heating and cooking. The exposure to such high levels of particulate matter caused between 1.5 million and two million deaths in 2000.

Some indoor and outdoor air pollutants act as major triggers of asthma, a serious, sometimes life-threatening respiratory disease affecting the quality of life for millions of people worldwide. In addition, leading researchers claim that air pollution is as accountable for cardiovascular diseases as smoking, high blood pressure, and high cholesterol levels. Air pollution has an especially negative health effect on children, who are more sensitive to the contaminants and carry them in their bodies for longer periods of time. Children living in densely populated urban areas and highly exposed to air pollutants have a higher risk of developing respiratory infections and diseases such as asthma and pneumonia.

Awareness

In order for the issue of air pollution to receive adequate public awareness and governmental attention and significance, activism on a small scale is insufficient. Consideration must be directed toward the way the issue is introduced and discussed in the media. In the early 21st century, a great amount of scholarly attention is being given to the problem described in the theory of framing, which relates to the way an issue is presented and conferred in the media and in the public sphere. Framing theorists assert that great media visibility equals great levels of importance assigned to an issue, and vice versa. Should an issue receive little media coverage, its perceived meaning and magnitude by the public would be very low. Knowledge, it is claimed, is negotiated through social discourses, so that a hefty amount of media attention results in greater public knowledge on this subject matter. Furthermore, studies have shown that understandings of polluted air are embedded in daily life through the body and senses.

The different ways of sensing air pollution are organized spatially, temporally, and socially. In other words, people are much more concerned about what is physically apparent, whereas what people cannot sense appears nonexistent. In addition, people assign the utmost amount of attention to risks and damages they can actually see with their eyes. These findings can explain why ozone-related issues, for example, received low expressed levels of concern in the 1960s until smog started to appear, leading to an increased communal alertness and many subsequent civil acts.

Low- and middle-income countries generally have lower public and governmental consciousness regarding air pollution. To correct this, legal regulations (such as clean air acts) need to be utilized. Santiago, Chile, for example, was one of the first cities outside the Organisation for Economic Co-operation and Development (OECD) to implement a tradable permit program to control air pollution. In such programs, often referred to as "tradable emissions," economic incentives are provided for

the achievement of reductions in the emission of pollutants.

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See Also: Carbon Dioxide; Clean Air Act; Emissions; Environmental Protection Agency (EPA); Methane.

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Pollution, Land

In a general sense, land pollution constitutes the degradation and contamination of the Earth's surface. The thin layer of topsoil that covers the Earth's landforms constitutes an important source of life, providing nutrients and support for the food and fiber needs of the world's living creatures. Land pollution encompasses an overall degradation of this life-supporting layer of soil. This degradation threatens the health and well-being of humanity around the globe and results in a number of environmental problems. The rates of land pollution are growing in the 21st-century consumerist society. Common industrial activities contributing to land pollution, such as mining and industrial agriculture, will likely continue to increase as the world's growing population creates greater demand for resources.

Land pollution is not isolated or contained. It carries over into other areas of the Earth's biosphere—the thin layer of soil, water, and air encompassing the Earth's surface and supporting life. The generation and disposal of waste through industrial production and human consumption that contribute to land pollution also contribute to water and air pollution. However, land degradation and contamination are not naturally occurring phenomena. Rather, these processes are the results of human behaviors and social structures. As such, land pollution is tied to social and economic development. It also unequally impacts communities and citizens throughout the globe, leading to higher rates of associated health and environmental problems for some people. Given this, efforts to ameliorate land pollution will need to be global in scope as well as systemic and sustainable. Examining the causes and effects of land pollution is complex, requiring an understanding of the relationship between nature and society. It is also an important task if a sustainable future is to be ensured for the Earth and its inhabitants.

Garbage

Land pollution is largely caused by industrial production and human consumption. The most consumptive societies in the world include those nations with the highest levels of affluence and urbanization. Highly industrialized nations use lots of energy and natural resources to produce goods and services for global and domestic markets and have high domestic consumption levels. These activities generate a vast array of pollutants, many of which are deposited on land. Thus, the greatest contributors to land pollution are highly industrialized or rapidly industrializing nations. In the case of garbage, which contributes to land pollution in a number of ways, Lester Brown of the Worldwatch Institute reports that each person in the United States produces about five pounds of trash each day, nearly double the amount produced in 1960. In fact, one of the few human-made objects viewable from space is the Fresh Kills Landfill just outside New York City. According to the United Nations Environment Programme, many less-industrialized societies, such as India or Bolivia,

are estimated to produce much less trash—roughly one-half pound per capita per day. Developed nations also consume the vast majority of the energy produced in the world, and this consumption results in the production of a variety of hazardous wastes and by-products that pollute the land, including nuclear waste, coal ash, and air emissions that lead to the acidification of soils from acid rain.

Agriculture

The industrial production of agriculture, through the use of machinery and chemicals such as pesticides and fertilizers, greatly contributes to land pollution. Land quality and health is an important component of environmental sustainability, and land pollution threatens this sustainability through soil erosion and contamination. Soil erosion from highly mechanized agriculture and deforestation results in an alarming loss of topsoil, undermining the foundation of agricultural productivity. Research by David Pimentel at Cornell University College of Agriculture and Life Sciences reports that topsoil is being depleted around the world at rates 40 times greater than are necessary to replenish soils. In fact, approximately 10 million hectares of cropland are lost annually. In a related vein, the World Resources Institute indicates that roughly 40 percent of the world's cropland has been degraded because of poor agricultural practices. Another form of industrial agriculture production that significantly pollutes the land includes contained animal feeding operations. Astronomical amounts of manure are generated from these operations and must be contained, managed, and spread onto adjacent land. Where containment facilities fail or leak, feces contaminate surrounding land and waterways, often leading to eutrophication. Additionally, the sludge (the solid by-product from excrement processing) spread onto adjacent land can contaminate soils as copper and other heavy minerals present in animal feeds reach toxic levels.

Industrial Activity

Chemical contamination of soils can harm human health through toxic exposure and tainting of ground and surface waters. This contamination comes from a multitude of industrial activity; examples include the production of hazardous wastes associated with nuclear energy and the salinization of soils through intensive irrigation of cropland. In 2010, the Environmental Protection Agency (EPA) reported over 1,200 hazardous waste sites on its National Priorities List, some of which include long-lasting radioactive waste. In addition to this, a vast array of chemicals are used in other industrial processes such as dry cleaning or construction—including detergents, plastics, insulation, solvents, polyvinyl chloride, and so on—and are deposited in soils, contributing to harmful land pollution.

Landfills

Human consumption also pollutes the land as either product packaging deposited in landfills or human and animal excrement that must also be managed. The accumulation of solid waste pollution in landfills renders these landscapes useless for other purposes while destroying the aesthetic of many rural areas, which depend on natural resource amenities for economic development. As trash from landfills escapes into the broader environment, wildlife can become threatened or ensnared in the refuse, such as the entanglement of birds in canned soda six-pack rings. Landfills also release toxic leachate (the liquid sludge emitted from landfills as garbage decomposes) into surrounding soils, ground, and surface waters. These toxic run-offs and emissions contribute to health problems for surrounding communities and wildlife.

Mining

Additionally, energy production and consumption drives environmentally damaging mining activities and the production of nuclear waste, both of which are major contributors to land pollution. One example includes the toxic ash by-product of coal energy production. Strategies for disposing of this ash, which has toxic elements such as lead and arsenic, often entail long-term storage and containment. The failure of these containment efforts in eastern Tennessee in 2008 resulted in the release of 5.4 million cubic yards of wet coal ash when the bank of an ash pond broke in what the *New York Times* reported as the largest environmental catastrophe of its kind in U.S. history. Related to this is the practice of mountaintop removal and strip mining, where the tops of mountain ranges are razed in order to mine coal.

Shifts in Medium

Although land pollution is not as fluid and pervasive as water and air pollution, it is nonetheless connected to the Earth's biosphere and, as such, often has broader impacts. Land pollution can frequently lead to both water and air pollution. Not only do landfills emit toxic leachate that contaminates ground and surface waters but also as garbage decomposes, methane (a powerful greenhouse gas) is emitted. A vast array of other industrial activities that pollute the land also release greenhouse gases, including the application of fertilizer, which releases nitrous oxide, and the burning of coal. On the other hand, water and air pollution can lead to land pollution. Sulfuric and nitrous oxides emitted into the atmosphere contribute to acid rain, which pollutes the land through the acidification of soils. Water pollution can also affect the land. In 2010, British Petroleum's massive oil spill in the Gulf of Mexico not only harmed marine life and polluted the gulf but also oil that washed ashore damaged the land and soils of surrounding shores and threatened wildlife.

Social Relations and Causes

Environmental sociologists examine the social causes and consequences of land and other types of pollution, systematically employing theories of social justice and inequality, technological industrialization, political economic development, and metabolic rift. Environmental justice scholars have shown through their research that land pollution sites, such as brownfields or Superfund sites, are often located near minority communities, disproportionately and adversely affecting these populations. Environmentally related health problems are also higher among these communities. As a result, these scholars point to pollution sites as a form of environmental racism.

In another vein, sociologist Charles Perrow notes what he calls "normal accidents" as highly complex technologies become more pervasive and integrated into society. His analysis of the near-catastrophic Three Mile Island nuclear meltdown shows how reliance on these technologies to manage risky industrial activities can be expected to lead to failure and, sooner or later, catastrophic outcomes. The 2010 British Petroleum Gulf of Mexico oil spill provides a relevant example. Other environmental sociologists have examined what they refer to as the "treadmill of production" in capitalist development, where firms are forced to increasingly produce, and thereby consume, more and more resources in an effort to maintain profits. Global environmental sociologists have shown how the offshoring of environmental costs onto peripheral nations results in ecologically unequal exchange in global trade. An example of this includes the shipping of electronic waste to China and other developing countries from recycling facilities in the United States. While information technology companies in the United States, such as Dell, can produce and sell computers at a profit, the refuse created when these devices become obsolete releases toxic chemicals and is shipped out of the country. Thus, the land pollution associated with information technologies does not disappear but is outsourced to other countries with fewer environmental regulations. Last, metabolic rift theorists explain how capitalist development has resulted in a so-called metabolic rift in the nutrient cycle between humans and nature. This results in the depletion of nutrients from the soil in the countryside and the accumulation of pollution in urban centers. These theorizations of the environment have yielded a rich body of research within sociology and contribute to the understanding of society–nature relations.

Conclusion

An examination of land pollution demonstrates how social relations are embedded within the natural environment and how natural environments are continuously transformed by social relations. Industrial production and human consumption generates many environmental externalities, including land pollution, and the associated impacts can have long-lasting effects. The sustainable use and conservation of land is imperative in the 21st century, where population size and human consumption levels are unprecedented in human history. The protection and conservation of the thin layer of topsoil that covers the Earth's landforms is essential for the support of life. Some sustainable efforts to protect the Earth's lands are underway through the efforts of enterprising individuals and organizations. For instance, the zero waste movement aims to eliminate waste through

reducing consumption, reusing existing materials, and recycling what is left over. City governments, civic organizations, private corporations and environmentally conscious households are capable of adopting environmentally sustainable behaviors that reduce land and other forms of pollution. In the process of achieving this sustainability, the complex relationships between society and nature must be fully analyzed and understood to encourage the best possible outcomes and visions for the future.

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See Also: Acid Rain; Farms; Industrial Waste; Mineral Waste; Population Growth; Zero Waste.

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Pollution, Water

Catastrophic oil spills have brought the issue of water pollution to the center of public attention. While disasters like that of British Petroleum's deepwater rig in the Gulf of Mexico in 2010 and *Exxon Valdez* in Prince William Sound in 1989 serve as stark reminders of some of the more lethal consequences of underregulated resource extraction on the high seas, the spectacular media attention they garner often obscures the far more everyday water toxicities that communities throughout the world increasingly encounter. At a time when most scientists are predicting impending water shortages for much of the world's population, water pollution (the introduction into water sources of foreign substances detrimental to human or aquatic life) is occurring at unprecedented speeds and scales.

Sources

Worldwide, inadequate sanitation remains the largest source of water pollution. The World Health Organization (WHO) estimated, for example, that by 2010, approximately 1.5 billion people were infected with parasites originating in fecal matter and 30,000 people died every day because of a lack of proper sewers. Further, less than 6 percent of all wastewater in Latin America is treated.

In the United States, wastewater contaminated with growing numbers of pharmaceuticals and hormones flushed daily into municipal water systems are causing profound ecotoxicological effects, such as the feminization or sterilization of fish. Industrial agriculture is the second-leading cause of water pollution. Not only does large-scale agriculture rely heavily on the use of often-unregulated pesticides but also high levels of phosphorous found in animal fertilizer regularly make their way back to the oceans. As part of a process known as "eutrophication," fertilizers fuel the growth of algae blooms (or "red tides") that ultimately choke all surrounding marine life (as has happened periodically all along the eastern seaboard of the United States). Transformers, capacitors, and chemical plants continue to release polychlorinated biphenyls (PCBs) into local waterways, contributing to the development of cyanotic heart conditions (also known as "blue baby syndrome") among newborns. Mining operations in much of the world, from Bolivia to the Pine Ridge Reservation, not only bury hundreds of miles of streams each year but also depend heavily on the use of neurotoxics, which often leave surrounding waterways unfit for agricultural use and cause predator fish to be so contaminated with mercury and arsenic that their effects reverberate all the way

Slums built on swampland near a garbage dump in Jakarta, Indonesia. Poor sanitation is the leading cause of water pollution worldwide. The World Health Organization estimates that in 2010, 30,000 people died every day because of a lack of proper sewers.

up the food chain. These operations regularly produce up to 1,000 tons of waste per kilogram of pure metal extracted.

Who Is Affected?

It was once thought that most pollution in the developing world was principally biological (as measured by the presence of bacterial pathogens and microbes from sewage discharge or runoff from livestock farms) and most pollution in the developed world was largely chemical (as measured by the presence of heavy metals, pesticides, and nutrients). But the rapid industrialization of China, India, and Brazil; the continued commitment on the part of multinational corporations to cost-benefit analyses in which environmental damages are treated as "external" production costs, and the retraction of the state from key aspects of water service provision have all meant that countries all over the world are now experiencing similar sorts of fallout from unsafe drinking water, untreated sewage, industrial agriculture, and large-scale mining. But while contamination is affecting communities in ways that blur the geographies of biological and chemical pollution, the damages are not borne equally by all. As with the global disease burden more generally, communities that are politically, racially, economically, or otherwise marginalized tend to be the victims of what environmental justice advocates have called, since at least the early 1980s, "environmental racism." As is frequently pointed out, low-income, African American, American Indian, and Latino communities in the United States often live in proximity to substantially more toxic waste sites and chemical plants per capita than their more privileged counterparts and thus suffer the consequences of water contaminated with statistically higher levels of known carcinogens (as happened, for example, to the predominantly African American community of Mossville, Louisiana, during the 1990s and early 2000s).

In addition, on a more global scale, U.S. and European corporations have frequently been accused of taking advantage of lax environmental laws in much of the developing world to sell bottled water with pesticide residues in excess of 400 times the acceptable rates of the United States (as happened in India in the early 2000s) or to avoid cleaning up oil spills in countries like Nigeria (where every year Exxon leaves behind as much oil as BP left in the Gulf of Mexico in 2010). It is possible to dispute the characterization of these acts as forms of "environmental racism," and corporations point out that they are simply operating according to the laws of those countries. However, many of the poorest communities throughout the world continue to bear the heaviest costs of water pollution.

Regulation

To address some of these dangers and disproportions, since 1972, when the U.S. Congress first passed the Federal Water Pollution Control Act (known subsequently as the Clean Water Act, or CWA), the United States has joined a host of other nations in seeking to regulate what scientists call point source pollution, or wastewater released directly into lakes and rivers by factories, mining operations, or landfills. While

this regulatory framework has led to considerable successes in the improvement of water quality, scientists point out that the Environmental Protection Agency (EPA) currently monitors less than one-third of the toxics flowing through water systems, leaving untracked numerous contaminants of emerging environmental concern (CoEEC) that have only recently come to light because of advancements in trace chemical analysis. Furthermore, the EPA has struggled to make headway with what both states and environmental scientists acknowledge as an even more pressing problem: nonpoint source or diffuse pollution, which is caused primarily by stormwater runoff that carries pesticides and household chemicals far from their points of origin into surface and groundwater reserves. The United States is not alone in this uphill regulatory struggle against diverse forms of water pollution. Though most nations have laws that aim to protect the integrity of water supplies (including the United Kingdom's 1972 London Dumping Convention and Iran's 1971 RAMSAR Convention on Wetlands), and in many cases these laws represent important advancements in approaches to water pollution, they are rarely fully enforced. Critics also frequently point out that they include loopholes and exceptions for corporate interests while at the same time providing minimal legal recourse for affected communities.

Cultural Challenges

Despite these considerable legal obstacles, innovative technical solutions are being explored, including both high-tech fixes like the use of ozone and ultraviolet light, and low-tech solutions like the use of mushrooms in the dispersion of oil. However, curbing and preventing water contamination is not a matter of legal or scientific know-how alone. As political ecologists have long pointed out, there remain formidable cultural, religious, economic, and political differences in the ways in which water pollution is conceptualized and framed. At stake are scientific concerns about what, precisely, counts as a CoEEC or who, exactly, should be responsible for monitoring what the EPA calls "the maximum daily pollutant load allowable." However, in many parts of the world, even more basic questions exist about the very meanings of the terms *pollution* and *purity*. As one example, the Ganges River in India (along with its "sister" river, the Yamuna) has become one of the most contaminated rivers on the planet. It is overflowing with partially cremated corpses, ritual offerings set afloat by Hindu pilgrims, and wastewater released by unregulated industries. However, there remains an ongoing policy stalemate because environmentalists, government officials, and Hindu priests differ substantially in their understandings of just what constitutes "waste" or "dirtiness." For priests, dead bodies are not responsible for the pollution of the holy river (whose job it has been since time immemorial to purify them), while for government officials, the offerings of religious pilgrims present serious assaults on the integrity of the river. While religion—whether Hinduism, Islam, or Christianity—has often been seen as a barrier to environmental legislation, growing numbers of theologians and congregants are beginning to scour their traditions for alternative approaches to the protection of water. Secular and religious differences persist in the ways in which pollution is characterized and play integral roles in determining how the problem is addressed.

Such disagreements between authorities (whether religious and secular, or, in other parts of the world, indigenous and nonindigenous) are also often played upon by powerful private-sector actors, who—intentionally or not—frequently draw upon environmental fears to open novel markets and stimulate new consumer demands. A case in point is that of bottled water. Since the 1980s, bottled water companies have successfully mobilized growing consumer fears about deteriorating water quality by engaging in powerful media campaigns that tout the "purity" of their products. While large-scale studies have demonstrated that this "purified water" is often no less free of chemicals than tap water, the consumption of bottled water has increased from 1.5 billion liters in 1977 to 12.6 billion in 2010. Not dissimilarly, despite a growing body of evidence that suggests that public-private partnerships in municipal water delivery are leading to deteriorating quality and infrastructure, and in the face of growing anti-privatization protests in the global south, cities in the global north continue to privatize their water supplies, hoping that companies will be able to deliver clean water where local governments have failed. The private sector is not alone in capitalizing

upon the insecurities generated by dubious water supplies. Governments, particularly in the post-9/11 security atmosphere, have implicitly drawn upon these fears to push for more and more resources with which to protect municipal water sources from bioterrorist attacks. Thus, deep-seated anxieties about water pollution—both current and projected—are often not only structured by differing religious and secular perspectives but are also marketed for profit and mobilized for political gain, making the fear of contamination as formidable a challenge as the contamination itself.

Conclusion

Water pollution remains one of the most urgent challenges of the 21st century, with many regions of the world reporting it as their primary environmental problem. But, like many such problems, it admits to differing scientific conceptualizations and patterns of measurement, disparately affects the rich and the poor, is surrounded by cultural and religious norms that are often at variance with one another, and is inadvertently creating new trends in consumer behavior. Swift solutions to what may prove to be the fundamental issue of the 21st century will need to take account of this increasingly vast array of legal, cultural, religious, and economic considerations.

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See Also: Clean Water Act; Environmental Justice; Industrial Waste; Ocean Disposal; Pesticides; Public Water Systems; Safe Drinking Water Act; Sewage Treatment.

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Population Growth

Population growth is defined as the balance between the number of people that enter a population (through births and immigration) and the number of people that leave the same population (through deaths and emigration) during the same period of time. If the number of entering people is greater than the number of leaving people, the population growth is positive, and the population size becomes greater over time. If the number of people leaving the population is greater than the number of entering people, the population growth is negative, and the population size tends to become smaller over time. Population growth will be zero if the number of incoming people equals the number of exiting people, and the population size tends to stay stable over time.

Beyond this oversimplified definition, population growth is an issue that mobilizes public opinion and discussion anywhere in the world where the expression is mentioned. It is probably due to its place as one of the most pervasive demographic issues, being something reasonably easy to define and to understand. It is also because population growth has been discussed since ancient times by many scholars, philosophers, clergymen, and ordinary people who have dedicated their time and energy to discuss and to try to understand what are, or would be, the consequences of population growth for the economy, community, environment, and natural resources.

Thomas Malthus

One of the most influential and popular scholars of population growth was the Reverend Thomas Robert Malthus. He published "An Essay on the Principle of Population" between 1798 and 1826,

where he stated his basic principles that population grows at a geometric rate and food production increases at an arithmetic rate.

This would mean that sooner or later population would have to face famine, disease, and widespread mortality. He based his theory on the population increase that was already becoming evident in the 18th century and argued that the number of people would increase faster than the food supply. Population would eventually reach a resource limit, and any further increase (overpopulation) would result in a population crash, caused by famine, disease, or war.

Malthus, as a political economist, was concerned about what he saw as the decline of living conditions in 19th-century England. For him, this decline was due to three main elements: the increase of population, the inability of resources (mainly food supply) to grow at the same rate as the population, and the irresponsibility of the lower classes who were having more children that they could feed. For these reasons, if not able to constrain the population growth, human beings would be condemned to famine, disease, and war because eventually there would not be enough food for everyone. His writings were produced to oppose the utopian way of many 18th-century philosophers who, like William Godwin and Marie Jean Antoine Nicolas de Caritat (the Marquis de Condorcet), believed that the almost limitless improvement in capabilities of modern society would be able to overcome the problems and limitations related to population growth. The Malthusian population theory faced a number of critiques, but it was an important contribution for the discussion of population trends and remains an influential guideline for population policies around the world.

Population Explosion and Neo-Malthusianism

The Malthusian theory was the theoretical and conceptual basis for the idea of the population explosion, extremely popular among government officials, scholars, and demographers during the 1960s and 1970s. According to this idea, the world would collapse because the third world (developing countries) were presenting more significant fertility rates than developed countries. The interpretation was that the number of births by women in the developing countries was greater than the number of births by women in developed countries. As a consequence, the number of inhabitants of developing countries would be so much greater than the number of inhabitants of developed countries that it would lead to massive migration and, consequently, to war for scarce resources and opportunities.

Time and research proved that these relationships were not so simple, and that the long-awaited population bomb would not explode. The world's population is expected to stop growing before the end of the 21st century and will not exceed 10 billion people. However, the Malthusian theory still haunts the minds of scholars and public officials all over the planet, but now in a new fashion called "neo-Malthusianism." It states that the increasing number of inhabitants of developing countries—especially the ones with fastest economic growth rates like China and India—as well as their increasing needs for resources will bring the planet to a collapse. It is possible to hear the echoes of the neo-Malthusianism in global conferences to discuss issues such as global climate change.

Population Growth and the Environment

Human activities can be considered one of the primary drivers for almost all types of environmental degradation and change, especially in the 21st century. Population size affects the scale and the form of human activities and, consequently, their environmental impacts. Global environmental changes are occurring in ways fundamentally different than at any other time in human history. Experts and scientists are showing that virtually all of the ecosystems on the planet have been significantly transformed through human activities and that around 60 percent of the Earth's ecosystems have been degraded or used unsustainably. These changes have been especially significant since the 1950s and are expected to continue into the projected future.

For the first time in human history, society is using many of the planet's resources faster than they can regenerate. The impacts are becoming more and more obvious with the vulnerability of freshwater resources, the mounting number of plant and animal species becoming endangered or extinct, the acidification of the oceans, deforestation, and global climate change. Further, environmental conditions have failed to improve in most sectors. Specific environmental sectors include the following:

- *Public health:* Unclean water along with poor sanitation kills over 12 million people each year, mostly in developing countries. Air pollution kills nearly 3 million more yearly.
- *Food supply:* In 64 of the 105 developing countries studied by the United Nations Food and Agriculture Organization (FAO), population is growing faster than food supplies. Population pressures have degraded some 2 billion hectares of arable land—an area the size of Canada and the United States combined.
- *Coastal zones:* Half of all coastal ecosystems are being pressured by high population densities and urban development. Pollution is rising in the world's seas. Ocean fisheries are overexploited, and fish catches are decreasing in many places.
- *Forests:* Nearly half of the world's original forest cover has been lost, and each year another 16 million hectares are cut or burned. Forests provide over $400 billion to the world economy annually and are vital to maintaining healthy ecosystems. However, 21st-century demand for forest products may exceed the limit of sustainable consumption by as much as 25 percent.
- *Biodiversity:* Earth's biodiversity is crucial to the continued vitality of agriculture and medicine—and perhaps even to life on the planet itself. However, human activities are pushing many thousands of plant and animal species into extinction. Two of every three species is estimated to be in decline.
- *Global climate change:* The surface of the planet is warming due to natural and anthropogenic forces, mainly greenhouse gas emissions derived from fossil fuel burning. If global temperatures rise as projected, sea levels will rise by several meters, causing widespread flooding. Global warming also could cause droughts and disrupt agriculture in some places of the world.

Although changes in these large-scale processes are complex, difficult to understand and assess, and attribute cause or responsibility, the core problems seem to be related to the growing scale of human activities. In this sense, it is clear that there are links between population and environmental change, and these links are dependent on the socioeconomic development pathway of society. In other words, the human population is growing, consuming natural resources at unprecedented rates, and the planet is demonstrating the first effects.

Measuring and Modeling Global Impacts

During the 19th and 20th centuries, the consumption of natural resources increased in a way that had never been observed before, primarily in developed countries during the process of industrialization and economic development. After World War II, these production and consumption patterns spread rapidly to the rest the world. This period has been marked by the generation of unprecedented technological development that led to a greater capacity of humans to influence and impact the environment. The impact of population on the environment depends, however, on a series of features and varies considerably according to the selected aspect of the environment and the impact that is being analyzed.

For conceptualizing and measuring the impacts of population growth over natural resources and on the environment, Paul R. Ehrlich and John Holdren developed a classic accounting equation that has been widely used since the 1970s. It states that human impact on the environment (I) equals the product of population (P), affluence (A), and technology (T), represented algebraically as $I = P \times A \times T$ and known as the IPAT equation. Human impact on the environment (I) can be described as how species, ecosystems, and natural resources are affected or impacted by humans (for example, air pollution or water consumption). Population size (P) is the total number of people. It is important to note that population always acts in combination with the other IPAT factors. Affluence (A) relates to per capita consumption of the environment. It is normally correlated with income—how much each person consumes in terms of resources such as water, energy, passenger miles, resources used for housing, and so on.

The waste generated through resource consumption is part of this equation. Finally, technology (T) represents how a resource is used and how much waste and pollution is created by the production

and consumption of the resource. Sometimes, it improves environmental impact (such as through inefficient coal-burning power plants).

The IPAT equation states that population growth causes a multiplicative effect on the environment. In other words, if the size of the population doubles over a certain period of time (holding other conditions the same), the impact of this population on the environment will double over the same period of time. However, the equation—and all models derived from it—considers that technological advances and improvements of a system can lead to lesser impact.

Meeting the Challenge

This belief in the power of technology to reduce the impact of the human population and its activities on the environment provides the conceptual basis for most of the contemporary public and corporate policies regarding environmental impacts. Thus, it stimulates significant investments in research, development, and technological innovation. For instance, it is possible to cite the alternative cleaner technologies, administrative and institutional changes in the organization of production, and the generation of significant changes in people's lifestyles and decision-making processes.

However, technology will not be enough. It is increasingly acknowledged that there is the need of a global commitment in terms of resource conservation to be able to meet the challenge of sustainable development. Practicing sustainable development requires a number of social, political, and cultural measures to change human behavior toward cleaner agriculture, less industrial pollution, and more effective natural resource management, among many other required changes.

With the stabilization of the world's population, worries about a "population bomb" due to uncontrolled population growth have decreased, although the population will still be growing until the second half of the 21st century. It is also crucial to consider that this population level has never been experienced before by the planet and consumption per capita keeps rising with unsustainable economic development. Compared to earlier debates about population growth, the big picture seems to be much more complex and demands much more political engagement than has been seen in the past.

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See Also: Consumerism; Developing Countries; Industrial Revolution; Overconsumption.

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Post-Consumer Waste

Post-consumer waste can be strictly defined as the part of the waste stream that individuals and households dispose of, rather than recycling or reusing in some manner. There is an expectation—often both unexamined and inaccurate—that post-consumer waste not only has no remaining utility but also that it is destined for destruction of some sort. Such indifference to the material qualities and fate of this waste

is part and parcel of the process by which some items and not others are deemed fit for disposal in the first place. The common means of disposal of post-consumer waste include the use of professional waste collection services (from where it may be incinerated, landfilled, or recycled), domestic incineration, littering, dumping (both legal and illegal), and various phenomena of semi-temporary storage.

What Is Post-Consumer Waste?

The common forms of post-consumer waste characteristic of consumer societies include those items designed to be disposed of, such as packaging, disposable diapers, and razors; food trimmings and other excess materials; used-up items, such as tea bags; uninvited detritus, such as junk mail; objects beyond repair; and worn-out clothes. Such a list can be extended to include post-cleaning slurries, pet waste, food past its best-by date, and objects for which productive recycling is beyond the means, imagination, or capacities of those doing the disposing.

The crucial point is that what counts as waste is historically and culturally variable precisely because waste making is a profoundly social, changeable, and contestable process. Few, if any, materials or discrete objects have been trans-historically or universally regarded as valueless waste. This is true even for material such as human excrement, which has been used as fertilizer in Eastern cultures where vegetables traditionally form a large proportion of the human diet. The 21st century is a period in which not only are more things in greater variety produced than ever before but also in which the range and proportion of things that become designated as post-consumer waste is unprecedented. In addition, there is a wide range of post-consumer goods that have taken on ambiguous definitions, which draw them closer to the category of waste, rather than that of useful but unwanted goods.

All cultures rid themselves of "stuff," though within wide cultural parameters and with much variation. Gift giving, funeral rites, and the distribution of harvest surpluses have been well documented by anthropologists. Nonetheless, all cultures feature an irreducible core of matter that is simply discarded or destroyed. This category is elastic as, for example, what counts as "inedible" or "impure" as well as attitudes toward the definition of "worn out," "irreparable," and "reusable." Despite such variability, processes whereby disposal has been avoided are marked, including giving away, mending, recycling, reusing, and selling of surpluses. Post-consumer waste is a more fecund category as it considers both that which is unwanted in its original form but is reused in some way and the irreducible remainder that is disposed of. It is the culturally variable balance of these two components that generates much of the interesting analysis of the category.

The definitions of what counts as nonvaluable rubbish and of reusable-though-often-unwanted waste have varied as a consequence of many factors, including the nature of the goods that have entered the domestic realm, the manner of their acquisition and disposal, the available technologies of disposal, attitudes toward health and cleanliness, and environmental concerns. For example, the 19th-century slop pail and grease pots gave way in the 20th century to the waste disposal systems and casual binning and in the 21st century to widespread domestic recycling. In the first instance, food scraps were seen as valuable components for subsequent meals, as raw materials for new domestically produced goods such as candles, and as feed for animals. During the mid-20th century, the same food waste was widely regarded as the justifiably disposable remnant of an abundant and convenient consumer culture of food production. In the 21st century, there has been a recognition that not only are food scraps again useful (though in a different manner) but also that it is somehow morally and environmentally preferable to reuse than to dispose of them.

Repairing Objects

Until the beginning of the 20th century and the consolidation of a widespread and intransigent consumer society, the options for nondisposal of used goods was widespread. Giving away, mending, remaking, and reworking into other things were all part of the habits of daily life. Consider, for example, the historical variability in attitudes toward, and practices of, repair.

Mending and repairing objects depends on a consciousness of materials and of the tools to work

them, something widely and highly developed in preindustrial times when many people were involved directly in both hand production and consumption. Consequently, many goods were repaired by those who had fabricated them. The mass production associated with 21st-century consumer society in many instances broke this direct link, and the repair of such alien goods required far more knowledge of materials, components, and the intentions of the products' manufacturers.

Intentional Obsolescence

However, mending and repairing also depend on goods that lend themselves to being mended or repaired. Over the course of the 20th century, many objects have increasingly become more difficult to repair due to a variety of reasons. The most obvious is the increase in the range and number of goods designed for disposal; for example, tea bags, diapers, sanitary wear, razors, paper towels, paper plates, and plastic carrier bags. Increasingly, goods that may superficially suggest repairability do not fulfill this promise.

The use of molded and sealed carcasses, the specialization of fastenings and of the associated tools needed to open them, and the functional overreliance on often irreplaceable discrete components have all been legally reinforced by the widespread use of manufacturer's warranties, which explicitly forbid unprofessional repair.

In addition, the phenomenon of in-built obsolescence can be divided into three forms. First, in-built technological obsolescence often renders whole classes of goods irreparable. The goods may still function, though be in need of repair: however, the introduction of new ranges of functionally similar goods often renders the stock of replacement parts and repair services redundant. The phasing out of a manufacturer's willingness to repair often occurs over a much shorter time period than that over which the product may be expected to fail. However, when it does, repair is no longer a technological option. One welcome consequence of this for the producer is that it acts as an invitation or inducement for more consumption in order to replace the functionality of the now-broken and nonrepairable object. Such repeat consumption also acts to drive further disposal, often of perfectly useful, once-repaired, goods. On occasion, such technical obsolescence can occur as a result of health considerations; for example, the widespread outlawing of mercury batteries immediately created a potential increase in post-consumer waste of those products dependent on such batteries, at least until the development of mercury-free alternatives. Less benignly, there has also been a recent rise in the number of products that are designed to inform the consumer of their own functional demise and of the need to either replace them as a whole, or at least an apparently essential component. For example, the filter replacement indicators of many purifying water jugs are run by an internal battery and chip that times and indicates the expiration of each filter according to a predetermined time span, for example, four weeks. This is irrespective of the amount of water that has passed through the filter—the key indicator of the use of a water filter rather than time. The discovery of continued and surprisingly prolonged durability is often the outcome of ignoring these in-built suggestions to discard, dispose, and replace.

Second, in-built stylistic obsolescence, or fashion, renders whole classes of objects redundant on the basis of their styling. It is a matter for argument as to how susceptible consumers are to such injunctions to dispose of a functionally intact product; however, dramatic product redesigns are often accompanied by both aggressive promotional campaigns and restricted supply of the restyled replacement product. Third, many objects, especially complex electronic ones such as computers, are embedded in networks of associated add-ons, extras, peripherals, and the like. Once the central object is rendered obsolete by some means, the whole system of supporting objects may also become so. To these obstacles to repair, one may also add less direct ones, including the pressure on time for consumers to act to prolong the life of objects or for the autonomous production of use-values. Moreover, the general reduction of domestic storage space, associated with much 20th-century housing design, may lead to throwing out often being the only option. The changing culture of repair, then, is indicative of the manner in which the material that constitutes post-consumer waste is culturally variable and informed by many complex social processes.

Waste Categorization and Collection

According to Susan Strasser, the disposition of waste products was integral to the development of industrialization in the 18th and 19th centuries as the return of household waste as a raw material for further production was inherent in production. For example, the distribution of many consumer goods was done by peddlers who both took scrap and various waste away and supplied—often through barter—new manufactured goods. Waste products, then, acted as raw materials for other industrial processes; they were part of the productive cycle. Waste acted as both store of value and medium of exchange.

However, toward the end of the 19th century, practices of waste separation and sorting started to become more prominent. The separation of disposal from production eliminated the potential of waste as a raw material for further production and reuse. The literal sorting and separation of waste, which was increasingly legally enforceable, made easier the development and deployment of new technologies of disposal, including complex systems of municipal collection. Much of the matter collected was initially fed back into production as raw material, hence the requirement to sort. In a sense, however, post-consumer waste was born as rubbish collection and disposal increasingly became the responsibility of the technical expert removed from its production or consumption. Waste was still important to the economy, but the growth of the economy instead depended on the disposal of objects to make way for new replacements. Waste collection encouraged the throwing out of objects as responsibility for these unwanted or broken items was formally passed on to others. In order to further ease this transition, other factors were employed in order to change the character, definition, and handling of consumer waste. For example, mending, repairing, and reuse came to be associated with poverty and shame, rather than with the stewardship of objects. And, the objects themselves came increasingly to be seen not only as worthless and to be disposed of but also as increasingly unseemly, dirty, and reprehensible. In addition, the orderly, clean, efficient, and respectable way of life increasingly came to be defined in relation to these new technical methods of dealing with waste. Massive urban population explosions resulted in exponentially growing amounts of waste, much of it filthy, polluting, and dangerous, as well as being unsightly—adding to the growing designation and formation of post-consumer waste.

20th-Century Developments

Developments in the 20th century, including incineration of waste, the use of landfill sites, and the widespread adoption of waste disposal systems in the home, further eroded the sense of potential value in consumer waste and discouraged reuse. Eschewing the requirement to separate and sort rubbish, these technical solutions both literally and figuratively homogenized waste. It is doubtful that this would have occurred so readily without all of the other cultural factors working in concert. The enforceable separation of various categories of waste is, however, firmly a feature of post-consumer waste processing in consumer societies. However, while early legally enforceable separation was built organically on a sensibility toward waste that had emphasized reuse, repair, and remaking for hundreds of years, 20th-century attempts to enforce separation are somewhat different. They continue to sit uneasily in a consumer society in which repair and reuse are not highly valued and in which the aspiration to consume is marked. These injunctions also awkwardly follow a century of waste homogenization and are, hence, often regarded with suspicion or ignored in practice. Revelations that much of this sorted post-consumer waste actually ends up in landfills tends to undermine, in many consumers' minds, the purported rationale offered for sorting in the first place.

The spatial dimension of the sorting and classification of post-consumer waste is also significant and subject to cultural and historical variation. It is often argued that discarded objects that are still perceived as being useful or of having value initially remain in the house and are located in various transitional spaces before they enter various circuits of disposition, including reselling via Internet auction sites or garage sales, giving away directly to others, or through giving to charities for further philanthropic disposition. Waste, on the other hand, has its own places and spaces, including the waste bin, the dustbin, the skip, the municipal dump,

and illegal fly-tipping. The net movement in both instances is away from the location of its production as post-consumer waste, and, once it leaves the confines of private property, such waste tends to be overwhelmingly regarded as public matter that others are free to claim, valorize, or further dispose of. In previous centuries, practices such as throwing waste out of the house directly into the street were commonplace and acceptable, so the claiming of one's waste by others is not historically novel. Skip diving and dumpster living have their historical precedents.

However, the historical landscape of opportunities for disposition and disposal has radically altered. Means of disposition of useful goods based around the close geographical proximity of friends and family have given way due to the breakup of that traditional proximity. Similarly, waste is no longer seen so much as a neighborhood resource, and the various trades depending on this resource, such as rag and bone men, have all but disappeared. Furthermore, the sheer volume of material goods that enter an average household is far greater than at any time in the past. It is thus very likely that goods will accumulate, and they may be waiting to be used, used up, partially used, waiting for divestment of some form or another, or they may constitute an addition to the collection of objects whose place in the home is secure and permanent. Some consumers may experience a range of complex ideological and material impediments to easy disposal of what, in other circumstances, would be identified as post-consumer waste.

These factors may encourage and ensure a net accumulation of goods over time. Such bottlenecks and backlogs of goods can be seen as a normal constituent of contemporary consumption and divestment practices. Often, however, such spatial discrimination breaks down, such as in hoarding, whereby waste matter is accumulated, often along with much reusable material, within the household. This tendency is often identifiable in less-extreme forms of household storage, including cluttering or the semipermanent storage of potentially reusable items in outdoor buildings, yards, and gardens.

Perhaps the biggest cause for current concern in relation to post-consumer waste is that of electronic waste, largely due to the novelty, complexity, toxicity, and sheer scale of discarded electronic goods and components. Despite some attempts to alleviate the problem, including insisting on producer responsibility for the disposal of e-waste and some experiments with design for disassembly, much e-waste, along with its inherent technical, environmental, and health challenges, is simply exported to less developed countries, where its handling is unburdened by the legislation in force in the countries of origin.

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See Also: Consumerism; Culture, Values, and Garbage; Fly-Tipping; Household Consumption Patterns; Pre-Consumer Waste.

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Power Plants

Power plants are industrial facilities built and used for the purpose of generating electric power. Their size, layout, and design vary greatly, but nearly all power plants are built around a generator that converts mechanical, chemical, or nuclear energy to electrical energy. This generator can be fueled by a vast array of energy sources. First, the process of fueling a power plant generates a stream of waste that varies in form and content, depending on the source of energy used. Nuclear power plants, for example, generate radioactive waste that, according to the Environmental Protection Agency (EPA), poses a direct threat to human health for as long as 10,000 years. This opens the door to several challenges. Where should such power plants be built? How and where should the nuclear waste be stored? How can a society ensure that the waste is

still properly taken care of 5,000 years from now? Power plants using other types of fuels have other challenges attached to them in terms of generating and handling waste and pollution. Second, there are power plants that literally use what qualifies as trash in the rest of society as fuel. Thus, "garbage" in many settings, is given a new status as a commodity to be traded in an international market as fuel for power plants. This also affects the daily life of millions of households that contribute to the process through waste sorting. Because of the sheer size of a power plant and the need to handle a waste stream or bring large quantities of fuel to the plant, the construction of a power plant frequently results in substantial changes in the built environment of an area. Thus, the process of siting a power plant is often complicated, and the final decision is frequently unpopular with the local population.

Fossil Fuel Power

Large-scale generation of electricity has, since the emergence of the first power plants based on water power or coal in the 1880s, been tightly linked to the advancement and development of the modern world. The role of electrification in many social and historical processes cannot be underestimated; consider the Industrial Revolution as a case in point. Many of the technologies people have relied on for social, economic, and material growth would not have existed without the distribution of electricity. The role of power plants in this is obviously considerable. However, most types of power plants have generated waste or pollution, which has been associated with some form of negative externalities. In other words, power plants do not only generate power but they also affect the environment. The burning of coal, one of the more-common fuels in power plants, has historically been linked to local air pollution in the form of smog as well as the more global phenomenon of acid rain. When the latter is described as a global phenomenon, it is because the areas that are affected by the rain might be thousands of kilometers away from the site causing the problem. Further, the burning of coal in power plants has been pointed to as one of the main drivers of global warming. Many power plants are fueled by other fossil fuels, such as petroleum products or natural gas. These facilities are associated with many of the same problems as coal power plants.

Nuclear Power

In the 1950s, nuclear power plants became available as a commercial possibility. Through a combined promise of extremely cheap and abundant energy, this solution quickly grew in popularity, even though it could never deliver the promised energy that is "too cheap to meter." During the latter half of the 1970s, social movements emerged that strongly protested nuclear power. Fear of radiation and associated health hazards, concerns about storage of nuclear waste, and fear of accidents made nuclear power a defining political topic in many countries. The catastrophic accidents at Chernobyl in 1986 and Fukushima in 2011 are two of the few actual examples of such incidents; another less-horrifying

The disaster at Chernobyl (above) in 1986 is one of the most catastrophic examples of a nuclear power plant accident. Twenty-five years later in Japan, the Fukushima Daiichi power plant was wrecked by an earthquake and ensuing tsunami.

example was the partial core meltdown in one of the reactors at Three Mile Island, Pennsylvania, in 1979. Concerning hazards to health, studies carried out by the Committee on Medical Aspects of Radiation in the Environment (COMARE) suggest that residents living close to nuclear facilities have increased risk of leukemia and non-Hodgkin's lymphoma.

Renewable and Waste-to-Energy Power

Publicized hazards related to fossil fuels and nuclear power have resulted in an increased interest in the development and implementation of power plants that use renewable energy sources. Examples include solar power, wind power, geothermal power, hydropower, and various types of biomass. There are also some lesser-known examples, such as the world's first salt power plant, which was opened in Norway in 2009. These ways of generating electricity are often labeled "green," indicating that they are friendlier to nature than their fossil and nuclear counterparts. In many places, the same social movements that protested nuclear power have embraced these technologies. In some regions, this has resulted in long-standing political lines of division. In Sweden, for example, proponents of nuclear power stood against what has been labeled an "alternative" movement favoring, in particular, bioenergy since the 1970s.

Another movement in the same technological direction has been the increased use of waste-to-energy (WTE) technologies. As the name implies, this is a group of technologies that use waste as fuel, converting it in a power plant to energy in the form of electricity, heat, or both. In many corners of the world, this has made garbage a commodity in high demand. Using this technology to generate electricity also influences other spheres of people's lives. Waste sorting, for instance, becomes more important because the content of the garbage influences its quality as fuel.

Traditionally, the power plants in most industrial countries have been relatively large facilities producing vast quantities of electricity distributed to large areas. Many scholars predict, however, that as the development of renewable energy advances, this will change and there will be a movement toward more-distributed electricity production. This means that the facilities will be smaller in size, producing smaller quantities of power for a more local market.

Economic Development

In rapidly developing countries, however, the need for more electricity on a large scale means that highly pollutant fossil power plants are still built in large numbers. This has led to a global debate over the moral responsibility for reducing emissions of climate gases, versus the rights of developing nations to increase their standards of living. A concrete example of such a debate is the quarrel over what will be the world's largest dry-cooled coal power plant, located in Medupi, South Africa, scheduled for 2012. It is expected that this power plant alone will increase the country's emissions of greenhouse gases by around 6 percent. On the other hand, the power plant will generate much-needed electricity in the country. The International Energy Agency (IEA) stipulates that global coal demand will leap by 73 percent from 2005 levels by 2030, fueled by the growth of—among others—China and India.

Siting

These types of power plants, however, are not the only issues that stir up controversy. The siting of a power plant is often a notoriously difficult process, strongly affected by what have become known as Not in My Backyard (NIMBY) protests. Given the potential hazards related to nuclear and fossil power, it is perhaps not surprising that these types of power plant provoke high emotions, but the siting of power plants using "green" energy sources is also frequently difficult in many corners of the world. Wind parks are often said to cause aesthetic pollution, whereas hydro power plants often leave rivers dry, potentially affecting fishing, tourism, and other benefits associated with this type of nature. Power plants based on biomass are often large structures associated with chimneys, smoke, and odor, requiring much infrastructure to bring fuel to the plant.

Conclusion

Imagining the world without power plants would be both difficult and meaningless. The generation of power is an integral part of any industrialized society, and as emerging regions develop further, they will want to increase their production of—and secure their access to—electricity. Managing the risks associated with power generation is a chal-

lenge that can be addressed both politically, through the design of processes for handling waste, siting, and other difficult questions; as well as technologically, through the development and deployment of new technologies and new types of power plants.

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See Also: Acid Rain; Emissions; Externalities; Incinerators; NIMBY (Not in My Backyard); Nuclear Reactors; Radioactive Waste Disposal; Radioactive Waste Generation.

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Pre-Consumer Waste

Pre-consumer waste, sometimes referred to as "post-industrial waste," is generally defined as material that would have become trash if it were not diverted from the waste stream during the manufacturing process. An example of pre-consumer waste diversion is the use of sawdust from logging to create fuel pellets or engineered lumber. Beyond this there is no agreed upon definition for which materials can be claimed as pre-consumer waste, and the definition varies from country to country among industry, government organizations, and environmental groups. How pre-consumer waste is interpreted impacts many facets of environmental and economic policy. For instance, in many countries, pre-consumer waste is considered part of municipal or everyday waste policy and disposal because it is not hazardous or toxic.

Pre-consumer waste is a significant portion of the waste stream and is determined by the type of waste specific industries generate. It is estimated that between 2 and 6 percent of most industry's annual production is pre-consumer waste. Depending on the market, recycling rates are higher for pre-consumer waste than for municipal waste, with more than a 50-percent recovery rate for paper, cardboard, metals, textiles, and wood, which are more in demand than other types of materials. While pre-consumer waste is normally associated with recycling, incineration is another primary way that pre-consumer waste is diverted from the waste stream. While pre-consumer waste reduction limits carbon emissions and preserves natural resources, it is often considered a standard part of good business financial practices.

Ancient civilizations have always utilized pre-consumer waste out of necessity. Butchers still sell hides to tanners to make leather and animal bones for fertilizer. Gleaning, or the tradition of giving the poor the right to unwanted agricultural leftovers, is another ancient form of pre-consumer waste diversion. The black stones used in Roman mosaics were often made from basalt, the volcanic lava rock often left over from construction of Roman roads. Metals such as iron scraps were reused to make metal composites by the Spanish in the 15th century. It was not until the Industrial Revolution in the 18th century that pre-consumer waste became a significant economic and public health concern. "Dustmen" collected the ash from coal fires to use as a soil conditioner and for brick making, while "ragmen" collected textiles.

During World War I and World War II, demand for manufacturing materials and community efforts raised awareness of resource scarcity. This led to the postwar period, often called the "Golden Age of Consumption" (1950–80), during which manufacturing increased to meet greater consumption. The amount and type of pre-consumer goods processed and potentially diverted from the waste stream increase as technology improves. Industry has been pushed by economic and environmental pressure by the public, government organizations, and interest groups to create more products using pre-consumer recycled content; however, this is not always possible. Since the 1990s, this has been accelerated by the creation of the global commodities market, increased consumption worldwide, and advanced communication technology.

Industry

All states face similar industrial waste problems; the predominating industries and the regulatory environment of the states determine the types and amounts of waste produced, the cost of disposal, and the availability of markets. Often, regional programs are set up to create commodity exchanges for manufacturers to share information and facilitate waste reuse. One development has been the creation of ecoparks, or ecoindustrial parks, in which multiple related companies are located together to reduce transportation costs for pre-consumer waste and energy exchanges. Waste exchanges were created during World War II in order to conserve resources and equipment. The first exchange was the National Industrial Materials Recovery Association, created in the United Kingdom in 1942. Material exchanges were not popular again until the oil crisis of the 1970s, when they were used to promote waste exchange throughout Europe. While material exchanges are useful, they are not without their drawbacks. Companies that use their own direct contacts can often find higher market prices, and waste is only listed if it has been recognized as being useful to another industry. Small companies in urban and rural areas often recycle as part of municipal community recycling efforts. All of these approaches suffer when the economy declines and the need for pre-consumer materials drops due to a sharp fall in consumption.

Pre-Consumer Waste Approaches

Some manufacturers, such as Toyota, are attempting to reduce or eliminate disposal costs and generate revenue using management approaches that emphasize reducing waste. Toyota practices zero waste, a philosophy developed by Zero Waste Systems chemist Paul Palmer in the mid-1970s, which encourages the redesign of resource life cycles so that all products are reused. In the 1990s, Toyota developed lean manufacturing, or "Lean," based on the Toyota Production System (TPS), a production practice that considers the expenditure of resources for any goal other than the creation of value for the end customer to be wasteful, or "Preserving Value with Less Work." Another popular approach is Six Sigma, a business management philosophy developed by Motorola in the United States (1981), which is a systematic statistical method for improving the operational performance of an organization by eliminating variability and waste.

Companies often hire environmental engineers to create systems to track waste and find the most economical way to recycle or eliminate pre-consumer waste. Manufacturers can save significant money if they can reduce costs or increase value by selling pre-consumer waste. Pre-consumer waste is more valuable than post-consumer waste because it is cleaner, presorted, and better quality, which means that it needs less processing to be useful. Pre-consumer waste also saves energy because it takes less energy to produce, process, and transport than virgin materials. Advances have made it easier for manufacturers to incorporate pre-consumer recycled content into many products.

However, some scientists believe that it can save even more money and protect the environment more by designing processes that do not produce pre-consumer waste in the first place. They argue that giving pre-consumer waste value increases the likelihood that a manufacturer will artificially inflate the amount of waste it produces. They think that because pre-consumer waste would be recycled as part of the manufacturing process, it is more important to focus on post-consumer waste, which takes up more landfill space and more energy to collect and recycle.

The disparity in how pre-consumer waste is defined is increasingly important because a major green industry has been created to meet the demand of consumers wanting to buy goods made with high pre-consumer waste content. Many countries have designated governmental agencies, such as the U.S. Federal Trade Commission, to monitor pre-consumer waste claims. However, pre-consumer waste claims are difficult to regulate because of several factors. Industry is not required to label many of its products, and even then there are often no clear guidelines or criteria for industry to follow.

The most easily recovered pre-consumer waste recycling tends to fall into several main categories in a wide range of industries, including plastics, wood, animal and vegetable waste, textiles, and metals.

Plastics

Plastics have been recycled since the 1970s, and industrial plastic scraps and factory regrinds are

processed into plastic pellets. Because of the abundance of plastic material, such as plastic packaging, pre-consumer plastic recycling is one of the most recycled wastes. Plastic pellets are easy to transport and used by different types of plastics processing machines. One of the major advances in plastics recycling is the ability to mix many different grades of plastic together, especially pre-consumer waste with virgin plastic.

Wood, Animal, and Vegetable Waste

Wood waste most often comes from the logging industry, wood-manufacturing industries, pulp and paper manufacturers, and construction. Wood waste is often ground up to create fuel pellets, paper, wood composites, or mulch. Over 90 percent of paper pulp is made from wood.

One of the oldest forms of pre-consumer waste is animal and vegetable waste, such as fish farm sludge and fish bones sold as fertilizer. The food and beverage industry is still a major source of food waste, which can be reused to create products such as biofuel and animal feed.

Textiles

Textiles recycling is another traditional recycling activity. Almost 75 percent of pre-consumer textile waste is recycled for use in the paper, automotive, furniture, mattress, and other industries. Textiles, such as yarn waste, are often shredded to make filling material for car insulation, synthetic padding, and panel linings.

Paper, Cardboard, and Glass

The first paper mill to use recycled linen was started in Philadelphia in 1690. Paper and cardboard pre-consumer waste is valuable because each time paper is recycled, its quality decreases. The majority of paper comes from pre-consumer material such as trimmings, shavings, and unsold magazines. Historically, glass bottles that break at a bottling plant are turned into cullet. Glass cullet is used to create glass tiles, crushed to make coating materials, and as an abrasive.

Metallic Waste

Metals such as aluminum, steel, and gold are one of the most efficient and widely recycled materials throughout history because they can be melted to create new material. Recycling aluminum saves 95 percent of the energy cost of processing new aluminum and is indistinguishable from its virgin form. Many of the pre-consumer waste management approaches popular in the early 21st century were created by automobile manufacturers and later adopted by other industries.

Energy Production and Pre-Consumer Waste

Waste created by energy production is often used in pre-consumer recycling, such as mining waste, including fly ash, slag, and silica, which are often used in concrete production. Power plants produce gypsum, which can be recycled to make wallboard, conserving resources and using less open pit mining.

Upcycling

Upcycling (creating a product from waste while keeping its original form) is often associated with post-consumer recycling and small cottage businesses or hobbyists. However, because of the increased interest in recycled products, companies such as Teracycle, which upcycle or make a new product from recognizable waste such as drink foils, have started to use significant quantities of pre-consumer waste.

They do this because the growing demand for their products exceeds the efficiency and quantity of using post-consumer waste, while companies have seen the added value of upcycling misprinted or otherwise unusable waste to reduce waste, increase profit, or to position themselves as green companies.

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See Also: Industrial Waste; Post-Consumer Waste; Recycling; Zero Waste.

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Price-Anderson Act

The Price-Anderson Nuclear Industries Indemnity Act, commonly known simply as the Price-Anderson Act, is a U.S. law that governs liability and compensation procedures in cases of nuclear accidents involving commercial power plants. Originally passed in 1957 to stimulate nuclear power production, the Price-Anderson Act was amended to have its coverage extended through 2025.

Regulatory History

The U.S. government began regulating nuclear energy production in the aftermath of World War II, when the atomic bombings of Hiroshima and Nagasaki dramatically demonstrated nuclear power's capacity to cause massive death and destruction, even as members of the scientific community urged its use for peaceful purposes, such as electricity generation. In 1946, Congress passed the first Atomic Energy Act, which classified pertinent information, prohibited private ownership of nuclear production material and facilities, and established the Atomic Energy Commission (AEC), a federal government agency that would oversee nuclear energy research and development until it was replaced by the Nuclear Regulatory Commission (NRC) in 1974.

A second Atomic Energy Act, which reversed the 1946 legislation's prohibition on private ownership and established a system for licensing nuclear power producers, was passed in 1954. A few months later, the AEC created an incentive program to encourage nongovernmental nuclear power production, research, and development. Utility companies were slow to respond, however, because of the great risk involved and private insurance companies' unwillingness to underwrite more than a small fraction of their accident coverage needs. It was at this point that two Democratic legislators, Senator Clinton P. Anderson of New Mexico and Representative Melvin Price of Illinois, began working to secure legislation that would cap industry liability at $500 million and provide for the federal government to cover payouts beyond that cap. Although there was some initial controversy over the arbitrariness of the $500 million figure and the impracticality of generating realistic risk estimates, the Price-Anderson Act was signed into law as an amendment to section 170 of the Atomic Energy Act of 1954 on September 2, 1957.

Renewals and Amendments

When it was first passed, the Price-Anderson Act was set to remain in force for just over 10 years, by which point, it was believed, the nuclear power industry would have established a strong-enough track record to eliminate the need for the federal government to supplement private insurance coverage. This expectation went unfulfilled, however. In 1966, Congress renewed the legislation for another 10 years and amended it to standardize state laws so as to provide no-fault insurance in cases of "extraordinary nuclear occurrences," or accidents resulting in significant releases of radiation. In 1975, the act was renewed once again and amended to begin phasing out the government indemnity. It was renewed for a third time in 1988, when its coverage was extended through 2002 and allowances were made to adjust coverage rates for inflation and to compensate individuals for precautionary evacuation. Congress did not renew the Price-Anderson Act immediately upon its expiration in 2003, but then passed the Energy Policy Act of 2005, which, in addition to numerous other provisions to deal with the United States' mounting energy concerns, reinstated the Price-Anderson Act's coverage through the end of 2025.

Three Mile Island

Liability benefits under the Price-Anderson Act were issued for the first time in 1979 in the wake of the nuclear reactor accident that took place at Three Mile Island, Pennsylvania, in March 1979. Within days, an ad hoc insurance pool office was set up nearby, and more than 2,000 individuals received funds to compensate evacuation costs. In all, more than $1.2 million in evacuation claims and $92,000 in lost wages claims were issued in the immediate

aftermath of the incident, $25 million was assigned to public health and small business reparation funds by a settlement agreement in 1981, and over $70 million was paid out to claimants as a result of settlements and legal expenses that accrued over the next two decades.

Criticisms

While it does not often dominate headlines and is rarely a subject of popular political debate or public opinion polling, the Price-Anderson Act is highly controversial. Advocates maintain that the law is public and consumer oriented, since it ensures that members of the public will be compensated for losses and damages at the industry's, rather than taxpayers' expense. They also point out that the Price-Anderson scheme has been used as a model for legislation to protect members of the public from harm or loss from other hazards and cite the Three Mile Island experience as evidence of its success. In contrast, opponents charge that it amounts to a subsidy for producers of nuclear energy, which may have been necessary to get the industry off the ground in the 1950s but is no longer warranted. Some also emphasize that producers' limited liability extends even to cases of gross negligence and willful misconduct and that the act tends to play down the true extent of the risk involved in nuclear power production.

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See Also: Atomic Energy Commission; Nuclear Reactors; Radioactive Waste Generation; United States.

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Producer Responsibility

Producer responsibility involves integrating the environmental costs associated with goods throughout their life cycles into the market price of the products. The ultimate goal is to reduce the quantity of waste, increase recycling, and achieve more environmentally sound product development. This is particularly salient in environmentally hazardous industries such as packaging, wastepaper, tires, batteries, and electric and electronic products.

Voluntary commitments on producer responsibility in three product groups—office paper, agricultural plastic, and building and demolition waste—have shown signs of success, given that material recovery has increased in all three groups. Producer responsibility for packaging has not resulted in a decrease in the total quantities of packaging. Nevertheless, the quantity of packaging per pound of article has reduced primarily because of lighter packaging materials. Coordinating information between producers and local authorities has also been shown to improve recycling results and raise the level of awareness of service in collection systems.

Extended Producer Responsibility

Extended producer responsibility (EPR) is a pollution prevention policy that focuses on product systems, rather than on production facilities. It is based on the premise that the primary responsibility of waste generated during the production process and after the product is discarded is that of the producer.

The history of EPR laws can be dated back to the mid-1970s in Sweden, when the government mandated the recycling of aluminum cans. In 1982, the government further threatened to ban the use of these cans for carrying beer and soft drinks unless there was a system for recycling 75 percent of them by 1985. After trying and failing with several recycling schemes, including curbside recycling programs, the aluminum industry tried a deposit/refund system, which enabled recycling rates to increase to 92 percent in about 10 years. Germany's Ordinance on the Avoidance of Packaging Waste was passed in 1991 and is one of the best-known EPR mandates. However, the earliest form of the EPR system was the deposit refund system for refillable soft drink

and beer bottles initiated by the beverage industry in the United States nearly 100 years ago.

The main goal of EPR is sustainable development via environmentally responsible product development and recovery. In most cases, manufacturers do not bear responsibility for products after a sale. The product is disposed of after use, since manufacturers do not design things that can be easily repaired, recycled, refurbished, upgraded, and reused in order to encourage product obsolescence and higher sales for their newer models. However, governments in many countries are increasingly adopting EPR laws that mandate companies to take back and assume responsibility for the products that they sell, from television sets to ink cartridges. The assumption is that holding producers accountable for the waste and pollution will force them to incorporate a broader range of environmental considerations into both the product design as well as choice of materials, hence reducing consumption of resources at the different stages of the life cycle of the product or packaging.

The overarching goal is to encourage manufacturers to assess the full life cycle of their products. This will then force them to rethink and redesign their products so as to eliminate unnecessary parts, do away with unnecessary packaging, and design products that can be easily disassembled, recycled, remanufactured, or reused.

EPR laws also typically ban the landfilling and incineration of products, establish benchmarked reuse and recycling requirements, stipulate whether producers are to be individually or collectively responsible for returned products, and notify whether producers should charge a fee when they take back products.

Types of Producer Responsibilities

Thomas Lindhquist, often referred to as the "father of EPR," has identified five basic types of producer responsibility:

- *Liability:* The producer is primarily responsible for the damage caused by the product in question.
- *Economic responsibility:* The producer covers the full cost or part of the costs for collection, recycling, or final disposal of products that they manufacture and may charge a special fee.
- *Physical responsibility*: The manufacturer is involved in the physical management of the products or their impacts. This ranges from simply developing the necessary technology to managing the total "take back" system for collecting or disposing of products they have manufactured, for which they may charge a fee.
- *Ownership*: The producers assume both physical and economic responsibility.
- *Informative responsibility:* The producer is responsible for providing information on the product and its effects at various stages of its life cycle.

The take-back schemes usually combine both economic and physical responsibility.

Types of Producer Responsibility Instruments

There are four major types of instruments that are used to shift the responsibility from product and packaging waste from government and taxpayers to producers and consumers:

- *Deposit refund systems* can promote reuse, but more importantly encourage consumers to return the product or package and help establish an infrastructure for its collection and recycling. Almost every state in the United States, the Canadian provinces, and most European nations have enacted beverage container deposit laws. Deposit refund systems also exist for batteries and other hazardous wastes.
- *Product charges* are sometimes used to influence the choice of materials used by the producer. For example, in Belgium, an eco-tax resulted in the reduction of consumption of PVC.
- *Advanced disposal fees* are designed to influence the choice of materials used and can generate funds that may or may not be used by government for environmental projects. Consumers are unaware of them, even though they are sometimes refunded the fee. Austria has such programs for refrigerators and Sweden has them for automobiles.
- *Voluntary agreements tied to mandatory regulations* are used to phase out undesirable materials, encourage design for recyclability, or ensure high rates of reuse or recycling. Sweden's

aluminum can program enables the industry to achieve the government-mandated recycling rate.

Pros and Cons of Producer Responsibility

Holding producers responsible for their products' end of life impact or recycling under the laws has several advantages. Given that they face a financial or physical burden of recycling their products after use, the producers are compelled to design more sustainable, less-toxic, and easily recyclable products. They have incentives to use fewer materials and design longer-lasting products, hence lowering their costs and altering the industry standard of planned obsolescence. Producer responsibility programs also find support from environmental groups, government recycling and disposal facilities, and citizens across the country. Although producer responsibility laws have had positive intended effects for most products, such as packaging and diapers, they are more complex and difficult to break down and safely recycle for products like electronics. Producer responsibility laws increase the cost of electronics for consumers because producers would add recycling costs into the initial price tag of items. Firms would be mandated to transport the waste to a recycling facility or build their own facility, both of which would be very expensive. Many researchers and organizations feel that the mandate would slow technical innovation and impede technological progress. Other problems include lack of industry standards, regulations, or guidelines, as well as the inability to discern the actual benefits and outcomes, since most of the producer responsibility laws and mandates are relatively new.

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See Also: Computers and Printers, Business Waste; Economics of Consumption, International; Fast Food Packaging; Household Hazardous Waste; Mobile Phones; Packaging and Product Containers; Politics of Waste; Shopping; Tires.

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Public Health

The relationship between public health and effective waste management goes back centuries and remains crucial in both industrialized and agricultural societies. In the industrialized world, advances in waste management were crucial to reduce epidemic diseases in urban centers. While Europe and the United States developed extensive systems to manage sewage, drinking water, and solid waste by the end of the 19th century, serious public health threats to much of the world's population exist in the 21st century because of inadequate waste management.

Poor waste management at times triggers epidemics of some vector-borne or foodborne infections. Accumulated garbage leads to problems such

as infections due to pathogens, vector-borne diseases, and groundwater pollution. Health hazards are mainly due to the presence of human excreta, presence of wastes from hospitals and clinics, and unauthorized disposal of hazardous wastes from small-scale industries or municipal solid waste. Uncovered dumps of garbage attract many flies, mosquitoes, and pathogens, which are nuisances and spread diseases.

Moreover, rodents may be attracted from surrounding farms or they may be delivered to the site in a load of wastes. They destroy property, bite people, and transmit a variety of infections either by themselves, such as leptospirosis, or through vectors, such as plague. It is also possible that the leachate from dumping grounds may lead to adverse health consequences because of ground contamination. During long dry periods, the surface of a landfill can become very dusty, and airborne dust makes working conditions unpleasant. Infectious and allergic disorders, especially of the respiratory tract, are common under these conditions.

A government worker sprays smoke insecticide in an effort to eradicate mosquitoes in a rural village in Thailand. Uncovered dumps and waterlogging from heavy rains attract mosquitoes, which transmit diseases such as dengue fever and malaria.

Waste-Related Contaminants in Air, Water, and Soil

The release of contaminants from landfill sites occurs in one or all of three phases: liquid, solid, and gas. Liquid releases include contaminated runoff, direct aqueous discharges to surface water, and leachate to ground water. Air emissions can include volatile emissions from lagoons or landfill sites and direct atmospheric discharges from incinerator stacks. Stack emissions can include gaseous emissions (e.g., products of combustion, such as carbon dioxide and hydrogen sulfide; and products of incomplete combustion, such as trace organic gases) and particulate emissions (e.g., fly ash potentially laden with toxic metals).

Release of contaminants in solid form occurs in air (such as fugitive dust) and in water (such as suspended solids). These releases typically have contaminants absorbed to solids or dissolved in fluids. The contaminants, whose release is inevitable, move into the environment and respond to a number of interrelated natural and human-made factors.

Waste-Related Contamination of Air

Most of the processes in waste management can contaminate the air. Beginning in an open dump or bin, then with transportation and treatment or disposal, wastes can cause air pollution. Landfill sites and composting generate carbon dioxide and methane. Incinerators directly discharge particulate matter into the air. The uncontrolled fires at landfill sites also lead to the release of pollutants in to the air.

Fugitive particulate matter emissions generally originate from materials handling and surface areas such as those associated with roadways, open waste piles, staging areas, dry-surface impounds, landfills, land treatment operations, and waste stabilization basins.

Fugitive dust is usually a key concern at inactive waste sites. Two key parameters controlling fugitive dust are wind (which erodes and transports material from the site) and disturbance of the surface by human activities, such as vehicular traffic. The dust has the same contaminants as those

absorbed by the soil. Remediation of inactive sites generates dust from excavations, regrading, and truck traffic. The amount of soil lost due to wind erosion at inactive sites is a function of wind velocity, vegetative cover, soil properties like texture and moisture, and the area of exposed soil surface. Health-related issues include increase in particulate matter and emissions from vehicles going to and from the landfill site. Studies have shown that there is also an impact on unborn humans in the womb of people living adjacent to landfill sites.

Waste-Related Contamination of Water

Water is an excellent medium for the transport of contaminants in the environment. Controlled or uncontrolled releases of waste-related contaminants into surface water, such as rivers, are quite common. The varieties of aqueous waste streams with direct discharges to surface water are ubiquitous. Examples include effluent from treatment works, leachate from landfills, and treated wash water from recycling or reuse facilities. Virtually every industrial and commercial facility generates wastewater. Because the ability to clean up wastewater is—and always will be—limited, waste will continue to be a source, however small, for some contaminant release into the environment.

Controlled release of hazardous wastes to groundwater are rare. In fact, most controlled contaminant releases involve materials other than hazardous waste and occur on the land above the groundwater. The application of pesticides directly to the land is one such example. Another rather controversial example is the disposal of hazardous waste by deep-well injection, in which wastes are injected deep beneath the Earth into rock formations where permanent contamination is anticipated.

Uncontrolled releases of waste-related contaminants occur to both surface and groundwater. Leachate and contaminated runoff from landfills are excellent examples of uncontrolled releases to ground and surface water. The releases are a result of natural mechanisms, such as the impact of precipitation resulting in runoff or leachate generation. Uncontrolled releases as a result of human activity, such as spills, also occur.

Leachate is generated in landfills because of liquids coming into contact with waste. This may happen by either disposal of liquid waste in the landfill, precipitation falling directly onto the landfill, surface flows that run onto the landfill, and groundwater inflow through the portion of the landfill lying below the groundwater table. With the exception of the infiltration of direct precipitation, these sources of leachate can be controlled with proper siting and engineering.

If the material is below field capacity, water infiltrating into waste will first be absorbed by solid waste. When the waste becomes saturated, water moves through the waste via gravity. This water will become contaminated with waste constituents in a partitioning process. The concentration of the constituents in water depends upon the amount of leachable material in the waste, the ease of mass transfer, and the ratio of column depth to the infiltration rate. Other factors include contaminant solubility, surface area, contact time, and pH.

If the landfill is properly designed, (impermeable clay coating of the bottom as well as walls), either the leachate generation is minimal, or a system is provided for leachate collection and removal. However, if the landfill is not properly designed or the control facilities become damaged or wear out, the leachate can percolate into the groundwater or molecular diffusion might occur. When this water, containing hazardous material, flows underground, it comes across both consolidated (rocks) and unconsolidated geologic formations, including the soils on which crops may be growing. Harmful effects to humans can result both directly via water (drinking) or through ingestion of contaminated crops.

Waste-Related Contamination of Soil

At landfill sites (especially in developing nations), the unsegregated waste is deposited in layers and compacted. This waste is contaminated with hazardous substances, which get into the soil (some even form chelates), thereby polluting it. As with contamination via groundwater, ingestion of contaminated crops is a health hazard.

Biotic Transportation

The mass transportation of soil by burrowing animals also represents a significant and rapid pathway

by which the substances from waste may reach the surface from deep soil. Deep-rooted plant species also provide a pathway for the rapid transport and recycling of toxic elements.

Effect on Humans: Contamination by Inhalation, Ingestion, and Dermal Contact

A waste is considered hazardous to humans if it exhibits any of the four characteristics of reactivity, corrosivity, ignitability, or toxicity. Of these, the potential for toxicity, particularly to humans, has caused the greatest public concern and has prompted massive regulatory initiatives to protect human health by reducing the risk—if not the toxicity—of the substances in hazardous wastes to acceptable levels. The environmental contaminants can enter the human body by three routes: (1) inhalation (respiratory tract), (2) ingestion (gastrointestinal tract), and (3) dermal contact (skin).

Most of the toxic substances (except for corrosive agents, which cause harm at the point of entry) start showing the effect of exposure when the physiological processes of the human body interact to absorb, distribute, store, transform, and eliminate a substance. To produce a toxic effect, the chemical agent (or its biotransformation products) must reach the critical site of action at a sufficiently high concentration and for a sufficient length of time.

Another health hazard of waste comes for waste collectors and waste handlers, who are generally not properly equipped to deal with hazardous and medical waste in the normal waste stream. It is not only needles and hazardous waste but also sharp objects like broken glass and broken metal instruments from households that pose a health hazard.

Case Study: Epidemic

The mismanagement of waste causes epidemics, such as dengue fever or plague, which are spread by the vectors present on rodents or flies attracted to landfill sites.

The start and spread of a plague epidemic in India was also blamed on poor waste management. It can be seen from the measures taken in Surat, India, after the epidemic. The immediate cause of the plague in Surat was constant rain and repeated floods that lashed the city for more than two months, causing large-scale waterlogging in low-lying areas because of faulty and clogged drainage systems. Hundreds of cattle and other animals died due to the flood and waterlogging. Municipal officials were not prompt in removing carcasses, which created enormous sanitation problems. It was only when the flood receded that the community members initiated the cleaning operation. The *godowns* storing food grains remained under water for a considerably long time. It is believed that the plague spread because either poor people consumed cereals that might have been infected by rodents, or the people who were cleaning water-logged areas came into contact with infected rodents or carcasses.

The northern part of the city, most affected by plague and where the largest number of deaths were reported, did not have a sewage system provided by the municipal authority. Despite being one of the richest civic bodies in the country, the Surat Municipal Committee (SMC) failed to provide basic sanitation and clean drinking water to a vast majority of its citizens. As in any natural calamity or epidemic, the poor living in slums or dilapidated houses on the outskirts of the city, where potable water, sewage system, and garbage disposal were the least adequate, were affected the worst.

The most important initiative launched in the post-plague environmental management efforts by the SMC was to monitor, regulate, and streamline garbage collection and disposal. The emphasis was on garbage collection because of the widespread realization after the plague that filth and garbage, which had accumulated in the city, was the breeding ground of the dangerous epidemic. It was also realized that sanitation and public health are inseparable and need to be tackled in an integrated manner. Therefore, to keep the city healthy, garbage control was adopted as the key environmental management initiative.

The garbage collection and disposal system operating before the epidemic was inadequate in terms of both manpower and equipment. It was also riddled with lack of motivation and commitment among employees and the absence of an efficient monitoring and management process at the corporate level. These deficiencies were addressed at length while planning an efficient garbage management system.

Conclusion

A high-level inter-regional meeting on prevention and control of plague, organized by the World Health Organization (WHO) in March 1995, observed that environmental conditions pertaining to breeding of rodents, fleas, and mosquitoes, as well as the access to safe water and sanitation play dominant roles in the origin of many epidemics, including cholera, malaria, and plague. It is difficult to adequately quantify urban solid waste disposal impacts upon public health. This is explained by the fact that, as of 2010, no study had attempted to directly link disease outbreaks to unsanitary conditions resulting from poor waste-disposal methods. Nonetheless, a few studies have highlighted that the failures by urban authorities to properly dispose of tons of solid wastes undermine public health and that the poor are at most risk. According to one study, the urban poor constitute more than 45 percent of the total urban population in eastern and southern Africa. Many of them live close to waste dumps or in squatter settlements where they rarely receive municipal refuse removal services and cannot afford the cost of allopathic medicine when they fall ill. As a strategy to safeguard their health, they dig pits in the ground to dispose of uncollected wastes, which readily accumulate. Consequently, there is a high incidence of sanitation-related diseases among the urban poor, including outbreaks of cholera, diarrhea, asthma, and eye infections. Past research has shown that open solid waste dumps support large populations of synathropic flies, which are vectors of sanitation-related diseases like diarrhea, dysentery, and cholera.

Past research has also shown that open waste dumps are prime breeding grounds for mosquitoes because they contain old tires that provide a place where stagnant water can accumulate, allowing mosquitoes to multiply 100 times faster than normal. Mosquitoes pose serious human health threats because they are vectors for various diseases, including encephalitis strains and malaria—one of the leading causes of mortality in sub-Saharan Africa. Of particular note is the *Aedes aegypti* mosquito, which is a carrier of yellow fever and dengue. Quite often in Zimbabwe, uncollected solid wastes obstruct stormwater runoff, resulting in the formation of stagnant water bodies and puddles, which become breeding sites for mosquitoes. Since numerous open waste piles are often in the vicinity of residential areas, they pose serious threats to public health.

Regarding open waste burning, it has been observed that simple and low-temperature burning of solid wastes does not destroy all hazardous components of the waste but merely facilitates their dispersion in the atmosphere. In cases of high concentration, these can be inhaled by urban residents, leading to several respiratory problems, especially among those living close to waste dumps where solid wastes are repeatedly set on fire. Research has shown that carbon monoxide, which is the most common and widespread of air pollutants emanating from incomplete combustion processes, reacts with hemoglobin to form carboxyhemoglobin (COH), which reduces the oxygen-carrying capacity of blood. In cases of extreme exposure, it causes mental fatigue, malfunction, and intolerance for oxygen.

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See Also: Bubonic Plague; Germ Theory of Disease; Landfills, Modern; Public Water Systems; Sanitation Engineering; Sewage.

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Public Health Service, U.S.

The U.S. Public Health Service (PHS) is part of the Department of Health and Human Services, a cabinet department within the U.S. federal government. The mission of the PHS is to promote, protect, and advance the health and safety of the

American people; the history of the PHS shows a gradual broadening of responsibilities from providing medical care to specified groups of individuals to enacting wide-ranging public health measures intended to improve the health and welfare of the population in general.

Early History

The roots of the PHS lie in a bill passed by Congress in 1798 (the Act for the Relief of Sick and Disabled Seamen) authorizing the Naval Service to subtract $0.20 per month from the wages of sailors and to use the funds to establish hospitals in port cities. The money thus raised came to be known as the Marine Hospital Fund and the first hospital built using these funds was constructed on Castle Island in Boston Harbor in 1799. Later, hospitals were constructed using monies from the Marine Hospital Fund in many ports, including lake and river cities such as Chicago and Louisville, as well as seaports such as New Orleans and Norfolk, Virginia.

In 1870, the Marine Hospital Service was created to administer the funds and the position of supervising surgeon (which later became surgeon general) was created to oversee it.

Dr. John Maynard Woodworth was appointed the first supervising surgeon and began professionalizing the service by creating a system of examinations for applicants, requiring physicians to wear uniforms, and issuing annual reports. These reforms coincided with a time of major innovation in public health; for instance, Massachusetts created the first permanent state health department in 1869 and the American Public Health Association was founded in 1872. The National Quarantine Act of 1878 gave the Marine Hospital Service the power to impose quarantines to prevent the spread of infectious disease, a power previously practiced inconsistently by state and local authorities. In 1889, the Commissioned Corps of the Marine Hospital Service was created and organized along military lines, with titles and pay grades corresponding to those of the U.S. Army and Navy.

In 1902, the Marine Hospital Service was renamed the Public Health and Marine Hospital Service and charged with additional duties, including conducting medical exams of immigrants arriving at Ellis Island in New York City. In 1912, the name was shortened to the Public Health Service (PHS) and Congress enacted legislation broadening the powers of the PHS to include research into issues of public health and communicable disease, an affirmation of work the PHS was already doing.

For instance, the diagnosis of the first case of plague in North America (in San Francisco) was confirmed in a Marine Hospital Laboratory and the Hygienic Laboratory, founded in 1887, that had been granted the authority to regulate the production and sale of vaccines and antitoxins through the Biologics Control Act of 1902.

Early Work in Disease Control

PHS researchers have played instrumental roles in tracking down the causes of several dreaded diseases and developing ways to contain or prevent their spread. In the 18th and 19th centuries, yellow fever epidemics were regular occurrences in North America, particularly in the south. In 1898, Henry Rose Carter, working for the PHS, tracked the progression of yellow fever through two towns in Mississippi.

He noted that the disease was not directly transferred from the sick to the well, suggesting that there must be an intermediate host. This insight helped inform the discovery of Walter Reed (working for the U.S. Army) that the disease was transmitted by mosquitoes. Although no vaccine was available for yellow fever until the 1930s, the disease was brought under control by public health measures aimed at preventing mosquitoes from breeding.

In the early 20th century, hookworm, a parasitic disease that can cause anemia and death, was endemic in the American south. A 1914 survey found that 39 percent of children in 600 southern counties were infected. Charles Wardell Stiles, a zoologist and parasitologist who identified a new species of hookworm (*Necator americanus*), became the first director of zoology for the Hygienic Laboratory in 1902. He also helped establish the Rockefeller Sanitary Commission for the Eradication of Hookworm Disease, which led a campaign to eradicate hookworm in the south through sanitary measures, including construction of privies (the hookworms are spread through fecal matter) and public education. Through these efforts, hookworm was nearly eradicated in the United States by the 1920s and

similar programs modeled on the Rockefeller Commission's work were launched in other countries.

Trachoma, an infectious disease that can lead to blindness, was common in the United States in the early 20th century; for instance, surveys in the early 20th century found that 8 percent of the population of Kentucky was infected and that 23.3 percent of blindness in Oklahoma was attributable to trachoma. On some Indian reservations, the rate of infection was estimated at over 50 percent among schoolchildren. In 1913, President Woodrow Wilson signed an act providing funds to eradicate the disease and the PHS played an active role in this program, establishing hospitals and clinics specifically to treat the disease and also embarking on a public health campaign to prevent its spread through improved hygiene (the disease is spread through contact with secretions from an infected person). As part of this campaign, newly arrived immigrants at Ellis Island began to be examined for trachoma infection.

Pellagra, a debilitating disease characterized by a scaly rash and digestive disorders and which can result in dementia and death, was endemic in the American south in the early 20th century. For instance, in 1912, about 30,000 cases were reported in South Carolina, with a mortality rate of 40 percent. Pellagra was originally thought to be contagious because it often afflicted large numbers of individuals living in institutions such as prisons and orphanages, but was correctly identified as the product of nutritional deficiency by Dr. Joseph Goldberger, working at a PHS hospital in Spartanburg, South Carolina. Goldberger noted that people employed in institutions suffering from pellagra outbreaks (e.g., prison guards, doctors, and nurses) rarely came down with the disease themselves and hypothesized that the reason was diet: prisoners, for instance, were fed mainly cornmeal, while the employed personnel ate a more varied diet including eggs, meat, and milk. Goldberger demonstrated through experiments that either consumption of a balanced diet or of brewer's yeast could prevent and cure pellagra, although the specific deficiency, nicotinic acid, was only identified after his death.

World Wars I and II

During World War I, the PHS was assigned to improve sanitation in the cantonments, training camps for members of the armed service that offered the ideal conditions for the spread of disease. Issues addressed by the PHS included mosquito control, securing a clean water supply, sanitary disposal of human wastes, and control of venereal disease. The PHS developed a system of testing, contact tracing, and quarantine to help control venereal disease, and in 1918, the Army Appropriations Act created a PHS Division of Venereal Disease to work through state health departments to help control and prevent the spread of these diseases. During the Spanish flu epidemic of 1918, almost one-third of the Commissioned Corps of the PHS were assigned to flu work. In 1919, the PHS was charged with care for returning veterans, and by 1921, the PHS was running 62 hospitals and treating eight times as many patients as they had before the war.

Immediately before World War II, the PHS emphasized military readiness and a PHS officer charged with overseeing food inspection, sewage disposal, venereal disease, and tuberculosis control was assigned to each Army Command. The Surgeon General studied the management of civil defense and wartime health problems in Great Britain, and PHS officers were assigned to Civilian Defense Regions to coordinate development of emergency medical service plans and the efforts of hospitals that would receive casualties. Many PHS officers were assigned to different branches of the military services during the war, while research was focused on matters of military need, such as creation of synthetic substitutes for quinine and opium and production of a vaccine for typhus. From 1940 to 1945, the size of the PHS doubled (to 16,000) and the Commissioned Corps quadruped in size (to over 2,600).

Preventing and controlling malaria was a particular concern for the war effort, because many military training camps and other facilities were located in southern regions of the United States where malaria was endemic. In 1943, the PHS began a focused campaign, known as the Malaria Control in War Areas program, to control malaria in the southern United States and in the Caribbean through use of larvicides and by draining the swamps where mosquitoes bred. This program continued beyond the war and in 1946 was renamed the Center for Disease Control (CDC), which later expanded into the

Centers for Disease Control and Prevention, and today has many responsibilities for promoting public health and funding research.

Expansion of Duties

In 1930, the Federal Bureau of Prisons was created within the Department of Justice and charged with developing an integrated federal corrections system. The PHS was given responsibility for supervising and providing medical, psychiatric, and other scientific services to the prisons. Since that time, the medical facilities within federal prisons have been staffed by PHS personnel, including physicians, nurses, psychiatrists, and dentists.

PHS services were expanded during the New Deal beginning in 1932 and various public health programs were mounted for projects including controlling malaria, sealing abandoned mines, controlling rats in seaports, and constructing outhouses in rural areas.

The PHS produced Rocky Mountain spotted fever vaccine for the Civilian Conservation Corps, and in 1936, conducted a national survey to document the presence of chronic disease and disability. Results of this National Health Survey showed that there was a high correlation between income and illness: families on relief had a 57 percent higher rate of disability and 87 percent higher rate of chronic illness than those with adequate incomes.

The Commissioned Corps of the PHS, which originally consisted only of physicians, was expanded in 1930 and again in 1944 to include engineers, research scientists, dentists, nurses, and other healthcare professionals. The Commissioned Corps provides emergency medical services, conducts research, and provides care to underserved communities.

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See Also: Diet and Nutrition Surveys; Germ Theory of Disease; Public Health; United States.

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Public Water Systems

Public water systems (PWSs) are probably the oldest public services in human history. They have been at the center of human development and are predicted to be among the most important human assets for the future. A PWS is a facility that, through pipes and other constructed conveyances, provides water to the public for human consumption. Some insist that for any facility to qualify as a PWS, it must have at least 15 service connections or regularly serve at least 25 individuals for at least 60 days per year. PWSs mainly source their water from groundwater, surface water, conservation, or from the sea.

Sourced water is first treated and purified before redistribution for consumption. Public water treatment is mainly done through chlorination and fluoridization, with the purified water sometimes stored in reservoirs for further distribution. In most European countries, used water is again recycled through a wastewater treatment system, wherein wastewater is discharged and collected through a sewer system. A PWS can be either publicly, or privately owned. The United States boasted approximately 155,000 PWSs as of 2010. Providing potable or safe drinking water has often been politicized and seen as a public responsibility for many states. Those who argue that water is a "public good" also maintain that it is a core human right and should therefore be provisioned by the state. Until the 1980s, over 80

percent of PWSs were operated by states and local governments.

For many scholars, the development of PWSs stands at the beginning of statehood, emergence of cities, and beginning of civilization. The development of high culture has been linked to PWSs. Civilizations such as the Inca, Romans, Mesopotamia, ancient Egypt, Indus Valley, and China are known to have developed complex water, distribution systems, which supplied water to public baths, households, and public monuments, as well as for irrigation.

Governance

Because public water systems require efficient regulation and management, low access to potable, or safe, drinking water in many developing countries is often linked to poor governance, corruption, and instability; it is sometimes also identified as a vector for conflicts. PWS governance often involves issues such as water safety, allocation, efficient pricing, water classification, regulation of market power, regulation of quality, structural issues, ownership arrangements, and standard practices. PWSs are often run by special government departments, communities, and special management institutions and are regulated by law and international conventions, strengthening the argument of water as a political resource.

Responsibility is often shared between those enforcing policy and regulation and those mainly charged with service provision. While public water policy is mainly developed by government ministries and the legislature, public water regulation is sometimes entrusted to various agencies with the aim of protecting consumers and increasing efficiency. These agencies are expected to be independent from government institutions but in most instances have remained under government influence.

In the 21st century, the link between water and statehood is no longer shared by everyone. Research has described societies and cultures that established extensive public water systems without developing statehood. Because of the importance of water to human survival, agriculture, and other human activities, many societies established different PWSs as a public resource.

Types

There are two main kinds of PWSs: one provides irrigation water for agriculture and the other provides drinking water to the population. The second variant was a later development but became crucial for city development.

In the 21st century, water systems for agricultural use are contested for the quantity of water they use. Drinking-water systems are much more questioned in terms of quality and safety. They are supposed to provide the ever-growing numbers of city dwellers with clean, safe, and reliable drinking water. Apart from these, different states and communities develop different classifications and categorizations of PWSs. For the most part, they are generally classified according to the number of people served, the types of customers served, and the frequency of supply.

Community water systems supply water to the same population year round. Examples of such include towns and rural water districts. Nontransient, noncommunity water systems are systems that regularly supply water to at least 25 of the same people at least six months per year, but not all year round. Examples include institutions that operate their own water systems, such as schools, office buildings, hospitals, and factories. Another classification is the transient noncommunity water system, which provides water in a place such as a fueling station, campground, park, or rest stop where people do not remain for long periods of time. Other classifications include very small water systems serving 25–500 people; small water systems serving 501–3,300 people; medium water systems serving 3,301–10,000 people; large water systems serving 10,001–100,000 people; and very large water systems serving over 100,001 people.

Europe

In European culture, the Romans are recognized as master builders of PWSs. Some of their constructions became icons (such as the aqueduct Pont du Gard) and others are still functioning into the 21st century. After the fall of the Roman Empire, PWSs fell into disuse for many centuries. Only with the rise of European cities from the medieval ages onward did the provision of drinking water become an issue again. Source water was caught

and transported through wooden channels to supply public fountains inside the city.

The fountaineer (the public servant charged with the maintenance of this system) became a very important person and was held personally responsible for the quality and reliability of the water supply. Members of individual households in the city had to fetch water at the fountain and carry it home.

Only in the 19th century (first in the larger, then also in the smaller cities) did public utilities begin to deliver drinking water directly into individual households. This was made possible by the construction of pressure water systems. From the 1830s onward, the wooden channels were replaced by cast-iron pipes. The junctions were sealed with lead. These pipes could be pressurized and thus provide water to households up several stories. To create the pressure, water had to be pumped into reservoirs on hills or on top of water towers. At first, the water of natural wells was used.

To provide enough water, wells as far as 20 miles away were bought by the growing cities. But as the water quality of wells was unreliable and the quantity never enough, new solutions had to be sought. Cities on rivers or beside lakes developed waterworks that could process water from these natural reservoirs into drinking water safe for consumption. This was done, for example, in the Swiss city of Basel by pumping water from the Rhine River into a forested area, where it was spilled on the ground. Further downstream, the water was pumped out of the ground again. It was cleaned while flowing through the soil and gravel.

Some cities tested the drinking water quality with live trout. The trout swam in a glass tube through which drinking water was passed. If it showed signs of problems, then that water was deemed not safe to drink.

The water from rivers and lakes was fit for drinking purposes only if those natural reservoirs were reasonably clean, because the water was only filtered mechanically and chemical substances could not be eliminated. Public waterworks in cities were thus often at the forefront of the effort to ensure cleaner water courses and to protect this resource via purification plants and legislation on the discharge of industrial waste into rivers.

Public water providers have also engaged in measures aimed at limiting water use. For example, limits on the water flow to taps have been enacted in some cities. The policies to save valuable drinking water have been successful in parts of Europe, such as in Switzerland. For the water providers, this meant that they had to maintain the same PWS as before but with less consumption. Paradoxically, this meant that consumers had to pay higher prices for less water.

Privatization

Public water privitization involves the sale of entire water supply and treatment systems to private owners as well as the long-term leases of water supply systems or contracts to manage PWSs. This approach means that public institutions delegate all or part of the public water service to the private sector for a given period, usually 4 to 30 years. For most countries, the arrangement is a long-term lease, with very few countries ever successful in regaining total ownership. Quite often, the practice is for states to lease out water supply rights to a private company, after which they reclaim ownership. PWS privatization covers a large category of water utility operations, management, and ownership arrangements. Three main privatization models exist. The first model is outsourcing, in which both private contracting for water utility plant operation and maintenance as well as private provision of various services and supplies, such as laboratory work, meter reading, and supplying chemicals, are privatized. The second model, called "design, build, and operate," involves the negotiation of a contract with a private firm for coupling design and construction services with comprehensive operating agreements for new, expanded, or upgraded facilities. In the last model, called "asset sale," the government sells government-owned water and wastewater assets to private water companies. Some state four different models exist, including (1) management contract water utility privatization, (2) lease contract water resource privatization, (3) concession type privatization, and, (4) asset sale or full privatization.

Because water is a multibillion dollar industry, a few multinational corporations have developed in the sector. Examples include Thames Water from the United Kingdom, together with Suez and Veolia

from France. Over 10 percent of the world's PWSs are operated by private agencies or corporations. This movement toward privatization became popular in the 1980s following economic downturns, consumer requests for higher quality standards, and efficiency in the public sector. Its contenders argue that water, just like electricity, gas, and telecommunications services, should be treated essentially as a private good. Hence, government monopoly over water regulation, purification, containment, and distribution should be relinquished to private individuals and agencies, leading to efficiency in the sector. Privatization of PWSs usually involves part—and sometimes whole—ownership by private agencies. However, only a few countries have fully ceded their public water systems to the private sector. Because water is generally defined as a public good, attempts at privatization have divided opinion among both politicians and scientists. Proponents of privatization state that it is the only way toward efficiency, good governance, effective management, and better consumer protection. In developing countries, where access to water is hampered by state failures, privatization proponents argue that the privatization of water will go a long way toward quenching the thirst of many poor people without access to potable water. Mismanagement of public funds, red-tape, favoritism, corruption, and other bad governance structures ensure that PWSs in poor countries mainly cater to the needs of the wealthy, elites, middle class, and political supporters. However, PWS privatization is a very controversial subject and has been met with protest worldwide, especially from water activists who define water as a basic human right and, therefore, an essential public good.

Following the privatization of public water resources, consumers have often experienced rises in tariffs and greater financial demands. These price increases are generally observed in developed, transition, and developing countries. They further impact negatively on many households and business and result in increased cutoffs. Privatization proponents argue, however, that water price hikes constitute the most effective means to improve both water efficiency and control of water wastage, especially in developed countries. Regarding the environment, they argue that price hikes would ensure better valuation of public water. Since many public water corporations are subsidized and hardly recover costs invested in water treatment and distribution, pro-privatization analysts insist that higher water costs would attract investors into the public water sector, consequently leading to better water supply. They argue that in developing countries, for example, access to potable water through PWSs is much higher where water privatization has occurred. Opponents argue that increasing water tariffs further deprive already-thirsty people from getting water, further widening the gap between rich and poor. They argue that corrupt government practices can further make privatization disastrous. In some countries, privatization has led to drops in access to potable water from 70 to 60 percent. In other cases, subsidized water was supplied to mainly wealthy quarters, with poorer neighborhoods receiving only about 4 percent of subsidies, while also experiencing sporadic water cuts.

In 1992, the town of Rostock in eastern Germany privatized its water and sewage systems as a 25-year concession to Eurawasser (owned 50 percent by Lyonnaise des Eaux). Two years later, water consumption fell sharply, so income was lower than expected. The shortfall triggered price-adjustment clauses in the Eurawasser contract. As a result, in 1995, water charges in Rostock were increased by 24 percent and sewage levies by 30 percent. In 1999, the city of Atlanta, Georgia, entered into a 20-year contract with United Water Resources, Inc., to run its drinking water system. However, because of hundreds of residents' complaints about brown water and poor service to the city, Atlanta terminated its contract with United Water in 2003. It is reported that the company failed to repair a recurring leak that had been a problem for over two years, until the state threatened to hire a contractor to fix the problem and to charge the company for the cost.

Conclusion

Water, especially safe drinking water, is already a scarce resource in the 21st century. In the future, it will be even more so. The effects of climate change, rising oceans, and higher ambient temperatures will endanger the PWSs that provide tap water for millions of people. Already, a worldwide shuffling has started as a number of global public service companies try to put themselves into good positions

for the fight for the water resources that is thought to be looming. PWSs are thus under great pressure from an ever-more-demanding environment and from speculators who are aiming to cash in on a scarce resource.

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See Also: Developing Countries; Public Health; Safe Drinking Water Act; Sewage.

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Race and Garbage

The term *environmental racism* refers to the likelihood of environmental devastation occurring predominantly in communities where poor and minority populations tend to reside. Once the dumping begins, whether from municipal dumps, hazardous waste facilities, or a variety of other industrial sites, the problems are often exacerbated. Fly-dumping (secretive, illegal dumping into vacant lots), considered acceptable by some because the neighborhood is already in a perceived state of disrepair, escalates as others increasingly view the neighborhood as blighted.

People who are poor are often unable to control their economy because of a lack of resources such as education and legal access. For example, Altgeld Gardens, a black ghetto on the South Side of Chicago referred to as a "minefield of toxic hazards," has a disproportionate number of Chicago's toxic facilities as well as one of the highest cancer rates in the United States. The dilapidated housing project was built on top of a former landfill, with problems such as approximately 70 percent of residents experiencing respiratory infection intensified by literally tons of pollutants from a nearby sludge plant, steel mill, paint company, a huge incinerator, and an 80-foot-high landfill. Similarly, in Chester, Pennsylvania, whose population is approximately 70 percent African American, five of seven countywide waste facility permits are granted. Chester and Altgeld Gardens became dumping targets, not specifically because the communities were predominantly African American but rather because community members have neither the financial means nor the political know-how to stop companies from siting facilities there.

History

Environmental racism, the foisting of a disproportionate amount of pollutants on minority and low-income communities, represents a great injustice: having to choose between health and claims of economic stability amid acceptance of hazardous pollutants. Exposure to pollution in the 20th century not only included placing waste sites in minority communities but also involved hiring members of those communities to handle wastes. The Memphis Public Works Department, for example, hired hundreds of African American men to pick up the city's garbage under dangerous conditions that prompted the workers to strike in 1968. By the 1980s, communities in several urban and rural areas actively resisted and began researching the racial dimensions

of waste handling. In an effort to stem the tide of environmental discrimination, grassroots organizations sprang up across the nation, attempting to fight for the right to live healthily.

In an attempt to move from purely anecdotal case studies to empirical evidence, several studies have been conducted. In the first such attempt, Dr. Robert Bullard examined population data of Houston, Texas, among communities hosting landfills and incinerators, finding that while African Americans made up only 28 percent of the city's population, three-quarters of incinerators and over 88 percent of landfills were located in predominantly African American neighborhoods. Following this study, in 1991, the General Accounting Office (GAO) conducted a study of the racial demographics of hazardous waste sites, reporting that three-quarters of commercial hazardous landfills in the southeast United States were located in predominantly African American communities. In 1995, the United Church of Christ Commission for Racial Justice found that within zip codes housing one waste plant, the minority population was double that of zip codes with no waste plant. Within zip codes housing more than one waste plant, the percentage of minority residents was three times greater than that of communities with no waste facilities.

Legislation

In 1994, U.S. President Bill Clinton issued an executive order with environmental justice as part of its mission, using a poorly defined section of the Civil Rights Act of 1964 as an authority for environmental programs. Citing the act's nondiscrimination clause, prohibiting the use of federal funds for states that racially discriminate, the Environmental Protection Agency (EPA) created the National Environmental Justice Advisory Council. Backlogged with complaints, the reality of environmental racism crept into both state and federal land-use decisions.

While Title VI of the 1964 Civil Rights Act does not directly prohibit or limit siting in minority neighborhoods, it strongly discourages the operation of polluting and waste facilities in such areas. By 2010, the regulatory development process at the EPA was undergoing significant change to assure that all decisions incorporate environmental justice. A Symposium on the Science of Disproportionate Environmental Health Impacts is purposed to lay the groundwork for developing a systematic and scientifically defensible approach for incorporating environmental justice concerns into the EPA's decision-making process.

Denying the Impacts of Environmental Racism

Despite both anecdotal and empirical evidence, critics claim that environmental racism does not exist. Opponents claim that prohibitions or disincentives to site in minority and low-income neighborhoods are likely to economically harm the residents of those neighborhoods. Proposals to prohibit, limit, or discourage polluting facilities from locating in minority and low-income communities deny those areas the economic benefits associated with hosting industrial and waste plants.

Opponents argue that, in many cases, these benefits far outweigh the costs of hosting such facilities, so affected communities should be allowed to make trade-offs, deciding for themselves whether or not to accept approved industrial activities. For example, in 1995, the Brooksville, Mississippi, local chapter of the National Association for the Advancement of Colored People (NAACP) supported a Federated Technologies of Mississippi (FTM) proposal to construct an incinerator and landfill within the town of Brooksville. When local businesses and environmentalists opposed this proposal, the NAACP argued that dump opponents, by preventing dumping, were keeping minorities socially and economically oppressed.

Denials about the impacts of environmental discrimination continue in the 21st century largely because of the effects of Not in My Backyard (NIMBY) syndrome, a structural lack of education and resources, and economic reality. Rather than merely convenient and easy, it has become economically expedient to dump in disenfranchised areas. The reality is in the economic correlation between dumping fees and profits. If manufacturers were to pass on the true cost of waste disposal, the loss of profit would result in an increased retail cost that most consumers would not be willing accept.

Conclusion

There is no question that low-income, minority neighborhoods are starved for jobs and commu-

nity services. But at what cost? Jean Guana, co-director of the Southwest Organizing Project, eloquently refers to the industry's offers of payment in return for dumping rights as "blackmail." A study by the Commission for Racial Justice concurred, concluding that waste sites are an environmental justice issue because poor communities are forced to choose between their environment and their jobs. As a result, industry and businesses often take advantage of minorities and low-income neighborhoods in order to dump with minimal backlash. The people in these communities seldom have the means, know-how, or political clout to prevent the siting of polluting facilities.

Thus, these disadvantaged communities, because of their state of destitution, are often willing to jeopardize their health in order to improve their economic status. This is not to say that the disadvantaged should not try to improve their situation but that they alone (and not wealthier communities) are forced to make that choice.

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See Also: Capitalism; Crime and Garbage; NIMBY (Not in My Backyard); Politics of Waste.

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Radioactive Waste Disposal

Radioactive waste is the general term for a variety of hazardous by-products generated in both the military and civil nuclear industries. Both the volatility and longevity of most radioactive waste present a unique set of safety concerns for its handling and disposal.

As nuclear waste decays, it releases, or "radiates," dangerous emissions (principally, alpha and beta particles, as well as gamma rays) that can cause cellular and genetic damage when absorbed by humans, animals, and plants. Due to the threat that radioactive by-products of nuclear energy production pose to public health and safety, this so-called radwaste cannot be disposed of through the public waste stream's normal channels.

The radioactive elements, some having half-lives of thousands of years, cannot simply be buried in conventional sanitary landfills or incinerated, since doing so would inevitably expose living beings to particles of radwaste that are mutagenic and lethal. To dispose of this waste in unregulated ways poses a threat not only to those living near the disposal sites but also to those distant in time and space. The specter of radioactive elements slowly decaying over hundreds of thousands of years presents a virtually interminable problem of containment, and these elements, when released into the atmosphere or water table, can travel surprising distances.

Radioactive fallout from the Chernobyl disaster, for example, was later detected in British livestock thousands of miles away. The dangers this type of waste present and the amount of oversight radwaste requires after its disposal, however, vary, depending on its source, concentration, and atomic structure. Scientists charged with its management have

therefore divided radioactive waste into three basic categories: high-level, transuranic, and low-level.

High-Level Waste

High-level waste is comprised of the spent uranium assemblies that fuel a nuclear reactor. These assemblies consist of pellets of fissionable uranium, approximately the size of a pencil eraser, that are stacked on top of each other in long, thin tubes, which are then bundled together. These fuel assemblies can be raised or lowered into the reactor tank as a means for slowing or accelerating the nuclear chain reactions through which electricity is generated. The uranium used to drive this reaction is regularly replaced after one to three years of use. The spent fuel is not inert, however. It continues to emit potentially harmful radiation for many years after it has been removed from the reactor. The 110 operating nuclear reactors in the United States produce approximately 40,000 cubic feet of high-level waste every year (enough to cover a regulation football field to a depth of almost one foot). With reprocessing, this amount can be decreased dramatically: 400 cubic feet per reactor can be reduced to as little as 3.4 cubic feet of radioactive material. However, the intense radioactivity of this distillate requires dilution for transportation or storage, so industry claims to the effect that a nuclear reactor's waste for a year could be stored comfortably under a desk, while technically accurate, do not tell the whole story. Because, as of 2010, there was no permanent disposal site for this high-level waste material, nuclear utilities keep the spent fuel on site in pools or in sealed casks that are designed to contain the emission of harmful radiation while the fuel slowly decays.

Transuranic Waste

Transuranic waste is a class of waste containing radioactive isotopes with atomic numbers greater than uranium. The most common and notorious variety of transuranic waste is plutonium—the explosive material used in atomic weapons. A portion of this waste plutonium is a by-product of technologies developed to reprocess spent fuel, while the rest of it comes from decommissioned nuclear

The first step in land burial of radioactive waste requires mixing the waste with material (typically glass) to form a solid that is easier to transport and less prone to leaching. The solid waste is then transported in heavily fortified containers via rail or truck to the disposal site. Permanent disposal options have been sought for decades and are fraught with social and political controversy; U.S. legislation requires that remote geologic repositories, a mile or more beneath the Earth's surface and well below the water table, be used for high-level waste.

weapons. Because nuclear weapons cannot simply be thrown away, treaties drafted in the wake of the cold war to mitigate the dangers presented by an unnecessary surplus of nuclear ordnance have created an equally troubling problem of plutonium disposal. Like high-level waste, the transuranic variety was initially stored at the sites of its reprocessing. However, a national depository for this material has been created at the Waste Isolation Pilot Plant located outside Carlsbad, New Mexico, a site where much of this waste has been interred.

Low-Level Waste

Low-level waste refers to most everything that does not fall into the other two categories. Fuel-cycle sources of low-level waste include clothing, tools, the filtered precipitate of the reactor's cooling water, radioactive reactor components removed from service due to normal operational wear, and any other materials that might have come into contact with radioactive material during the operation or maintenance of a reactor. Non-fuel-cycle sources of low-level waste can be found in hospitals that use radioactive materials as tracers (nonlethal radioactive materials that are injected or consumed by patients in routine diagnostic procedures) as well as in universities and industries that deal with research and development of nuclear technology. Low-level waste in the United States was initially shipped to one of six disposal sites located around the country.

These sites initially relied on "shallow land burial," which consists of digging a trench to put the radioactive material in, then compacting and capping it with earth—much like a typical sanitary landfill. Within a few years of construction, however, a few of these sites developed leaks, leading to revisions in the design of disposal facilities as well as the Low-Level Radioactive Waste Policy Act of 1980, which called for states to begin disposing of their own low-level waste regionally, rather than shipping the waste material to remote sites around the country. Confederations of states from each region, rather than the federal government, have been delegated the responsibility of deciding how to deal with their own low-level waste problems and with maintaining their own disposal facilities, the majority of these being reinforced versions of the "shallow land burial" design.

It is important to note that the terms *high* and *low* designate the origins of the materials to be disposed of and do not necessarily reflect the severity of the threat to human and environmental health. Low-level waste comes in different gradations—A, B, and C—such that class C waste, such as pieces of equipment from the inside of a decommissioned nuclear reactor, can be just as dangerous as high-level spent fuel. So-called front-end as opposed to back-end wastes—that is, those wastes produced by the mining, milling, and processing of fissionable uranium versus those produced by that fuel's use—present yet another minor division within the taxonomy of waste. These front-end wastes, which include everything from uranium tailings to plutonium, might be classified either as low-level or transuranic and disposed of accordingly.

Disposal

The problems in disposing of high-level waste, however, have yet to be dealt with in a systematic and nationally coordinated fashion. The failure to find an adequate solution to the problem of radioactive waste disposal presents a significant impediment to the continuation and expansion of the nuclear energy infrastructure that many see as offering a potential solution to global climate change caused, primarily, by the burning of fossil fuels for energy production. There are three methods for dealing with the excess: storing it indefinitely on-site (the de facto method in 2010), reprocessing it, or disposing of it through some method of burial or isolation.

Reprocessing

Reprocessing, which seems at least in theory like the ideal solution, has met with mixed results. The idea is that instead of the "once-through" process of mining, burning, and burying the uranium, fissionable isotopes might be extracted or—through bombarding the nucleus with ions—reconstituted. This solution relies on the fractionation (the separation of highly radioactive components of the waste from less-hazardous elements) and the subsequent transmutation (irradiation of the separated elements to create fissionable elements) of the high-level waste. In reality, however, reprocessing leads mostly to the production of weapons-grade plutonium, rather

than the specific isotopes of uranium used to fuel reactors. Many critics worry that reprocessing poses a threat to national and global security in that the excessive production of plutonium at home, as well as the potential export of this technology to foreign nations for ostensibly peaceful purposes of energy production, could easily allow terrorists to gain access to bomb-making materials. A federal moratorium on reprocessing imposed by President Jimmy Carter in 1977 responded to these fears and hampered the development of the technology for many years. Even since the ban was rescinded by President Ronald Reagan, little progress has been made in reprocessing technology. The PUREX plant in Hanford, Washington, the last major reprocessing operation, closed in 1987.

Burial

Many novel ideas for disposing of high-level waste have been proposed. Drilling under seabeds, shooting payloads of spent fuel into space, and allowing the high-temperature waste to melt its way down through the thick sheets of ice lining the Antarctic continent have all been considered and rejected for various reasons of safety and expense. Land burial, however, remains the most likely solution. The first step in this process requires the vitrification of the waste, wherein the radioactive sludge stored in tanks at industrial and defense storage sites is mixed with material (typically glass) to form a solid that is easier to transport and less prone to leaching. The solid waste is then transported (a process fraught with dangers and controversy) in heavily fortified containers via rail or truck to the disposal site.

Options for some form of permanent burial have been sought since the passing of the Nuclear Waste Policy Act of 1982, which called for the siting of deep geologic repositories for the nation's high-level waste. The idea is to bury the waste deeply enough (a mile or more beneath the surface of the Earth and well below the water table) and in such a remote location that none of the harmful effects of radiation can ever reach human populations. Locating sites, however, has proven difficult, raising politically contentious issues of social and environmental justice. Salt deposits, which are stable, arid, and self-healing when breached, offer the best medium for permanent storage, though tuff, a stratum of welded volcanic rock, is also a suitable alternative. Such siting requirements, however, generate political controversy. Although most nuclear generators are located in the eastern part of the United States, nearly all the sites proposed have been in the west, many of them on lands owned by Native Americans. While it might be argued that these western sites, which best satisfy the geologic requirements for long-term storage, are the logical choice, people living in these potential sites point to the inequity of being asked to take on the risks inherent in storing such hazardous materials when they receive no tangible benefits from the production of that waste.

Grassroots antinuclear groups rallying around a platform of Not in My Backyard (NIMBY) have successfully stymied plans to locate a permanent storage facility. Yucca Mountain, the contender as of 2010 for a high-level waste disposal facility, was scheduled, after numerous setbacks, to begin receiving shipments in 2019. Many groups, however, continue to protest the decision. With ample time remaining for such public interest groups to postpone the opening indefinitely, the possibility of ever locating a disposal site that all concerned parties can agree upon remains an open question.

Social Activism

The threat of anthropogenic climate change has made nuclear power generation an attractive alternative to the more common, carbon-intensive methods of electricity production offered by coal- and gas-fired plants. However, public outcry against nuclear energy in the wake of a near-catastrophic meltdown at Three Mile Island in 1979 and a disastrous reactor explosion in Chernobyl in 1986 have consistently scuttled plans for the continuing development of nuclear energy production in the United States. Contemporary anxieties about the danger of global climate change, along with recent innovations in computer-automated reactor safeguards and the successful record this new nuclear technology has maintained in pro-nuclear countries like France and Japan have caused many, including former "anti-nuke" activists like Greenpeace founder Patrick Moore, to reconsider their adversarial stance toward nuclear power. Though no new

reactors have been licensed or built in the United States since the 1970s, the nuclear industry in the early part of the 21st century has been forecasting a nuclear renaissance.

The Tennessee Valley Authority's reinstatement of one inactive nuclear reactor and plans to complete the construction of another—along with the guarantee of federal loans for the construction of new nuclear plants having been publicly declared by the administration of President Barack Obama—suggest that public opinion about the viability of nuclear energy production began to undergo a sea change in the new millennium. Concerns were renewed, however, following the nuclear crisis at the Fukushima plant in Japan caused by a massive earthquake and tsunami in 2011.

Although industry and environmental spokespersons have offered compelling (albeit controversial) arguments for viewing nuclear as a "green" alternative to wind, water, and solar technologies, the lack of any long-term disposal strategy for nuclear waste continues to hinder efforts to expedite a wide-scale conversion from fossil to nuclear power. Advocates of nuclear power, however, insist that fears of radioactive waste are often incommensurate with the facts, that the vehemence of anti-nuclear rhetoric, coupled with public ignorance of nuclear science, has clouded the issue, and that many viable ways exist to address the difficulties of radioactive waste disposal.

The issue of nuclear waste involves a careful negotiation of risk, and since the term *nuclear* is—thanks to highly publicized disasters and the military applications of nuclear technology throughout the cold war—historically fraught with negative and even apocalyptic associations in the public imagination, nuclear advocates argue that public perceptions of risk consistently fail to conform to risk assessments based on scientific inquiry. People tend to consider risks that they exercise control over as less threatening than those that they do not—the classic example being people who feel no anxiety driving to the airport but then are terrified to fly, despite statistical evidence proving that they are much more likely to be involved in a fatal car wreck than a plane crash.

The perceived danger posed to human health by radiation is likewise easily exaggerated in the human imagination because of its involuntary nature, accounting for the public outcry that attends federal attempts to locate sites for radioactive waste disposal. According to a 2001 National Research Council committee's report on the issue of nuclear waste disposal, "the biggest challenges to waste disposition are societal."

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See Also: Atomic Energy Commission; Hanford Nuclear Reservation; Hazardous Materials Transportation Act; High-Level Waste Disposal; NIMBY (Not in My Backyard); Nuclear Reactors; Radioactive Waste Generation.

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Radioactive Waste Generation

Radioactive waste is simply any waste product that contains radioactive material, which includes not only waste generated by the nuclear power industry but also certain medical and industrial wastes, as well as naturally occurring radioactive material (NORM) from fossil fuels. What all radioactive waste has in common is that it is undergoing radioactive decay, meaning that unstable nuclei are losing energy over time through emissions of ionizing particles. This ionizing radiation has a number of biological risks, from the immediately apparent (burns) to the more insidious (a significant impact on cancer risk). Radioactive decay is often described in terms of a substance's half-life (the time it takes for half of the substance's atoms to decay). The more advanced the decay, the less dangerous

the substance is. For this reason, radioactive waste must be segregated for some period of time before it has decayed enough to be relatively harmless. The handling of such waste is a considerable concern for the nuclear power industry, and the dangers of such waste are one of the main foundations of objections to such power sources.

Types of radioactive waste produced by the nuclear power industry include high-level waste; spent nuclear fuel; transuranic waste; by-product materials, like uranium mill tailings; and low-level waste, which by definition is everything else. Low-level waste has a legal definition that varies by country and often includes the radioactive wastes produced outside the nuclear power industry, which may include highly radioactive materials lumped into this category simply because the view of radioactive waste is informed so heavily by nuclear power.

Spent Nuclear Fuel

Spent nuclear fuel is nuclear fuel used by a nuclear reactor that has reached the point that the radiation it gives off is no longer useful in sustaining a nuclear reaction. It includes fission products, about 3 percent by mass, which may be separated from the fuel for industrial and medical uses, or may be disposed of along with the waste. About 1 percent of the mass of spent nuclear fuel consists of plutonium isotopes, which may have applications in nuclear weaponry. This is why concerns are raised over countries that operate nuclear power plants but are, according to international treaties, not supposed to have nuclear weapons. The plutonium created by an ordinary nuclear reactor is reactor-grade plutonium, containing more plutonium-240 and less plutonium-239 than one would ideally want in a nuclear bomb. This does not mean that it is impossible to use in a bomb, only less than ideal. Further, it is not difficult to operate a reactor in a nonstandard fashion to shorten the irradiation period and produce weapons-grade plutonium with plutonium-239 levels of up to 93 percent. Most of the remaining mass is uranium, with traces of minor actinides like neptunium, americium, and curium. The composition of the spent fuel depends in part on the type of fuel it was in the first place—whether it was reprocessed or natural uranium, or a highly enriched fuel such as that used by research reactors. Nuclear reprocessing separates spent nuclear fuel into its constituent parts, most of which may be put to use rather than being disposed of.

Transuranic Waste

Transuranic waste consists of waste, other than high-level waste, containing transuranic isotopes with half-lives greater than 20 years. It originates as a by-product of weapons production, nuclear research, and nuclear power production. Under U.S. law, this waste, because of its lengthy half-life, must be handled more carefully than low-level waste. Much of it is disposed of at the Waste Isolation Pilot Plant, an underground salt dome facility, in order to isolate the waste. Countries other than the United States generally do not designate this waste separately from the other categories.

Medical Waste

Radioactive medical waste includes isotopes used for treating thyroid conditions, cancer, and lymphoma as well as those used for radiotherapy and brachytherapy. Many of them have short half-lives measured in days instead of years; after brief isolation, they can be disposed of with normal waste.

Industrial Waste

Industrial radioactive waste includes neutron emitters from activities including oil well logging and gamma, alpha, or beta emitters from fields like radiography. Further, industrial waste includes NORM like coal, oil, and gas. Coal contains small amounts of uranium, barium, and thorium, which become concentrated in the fly ash because they do not burn well. The levels of concentration are low, close to what is found in the Earth's crust, but present a concern because of the amount of aerated fly ash that ends up in the atmosphere. Oil and gas residue contain radium—often large amounts of it—which can also present a danger.

Low-Level Waste

Examples of low-level waste under U.S. regulations include the paper, rags, clothing, filters, and other objects that become radioactive through exposure. In the disposal process, low-level waste is divided into four classes according to its radioactivity.

Intermediate-Level Waste

Intermediate-level waste is radioactive enough to require shielding when being handled and includes chemical sludge, residue, and the fuel cladding from a reactor, as well as material contaminated in the process of decommissioning a nuclear reactor. Often, it is encased in concrete for disposal. Short-lived waste (a designation not used in the United States), like nonfuel materials, may be buried in shallow repositories.

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See Also: Atomic Energy Commission; Environmentalism; Fusion; Hanford Nuclear Reservation; Hazardous Materials Transportation Act; High-Level Waste Disposal; Nuclear Reactors; Radioactive Waste Disposal; Uranium.

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Recyclable Labels

The three chasing arrows that make up the universal recycling symbol are recognized around the world. In 1970, Gary Anderson, a University of Southern California senior, designed the symbol for a competition sponsored by the Container Corporation of America (CCA) on the first Earth Day in the United States. Anderson based the design on a continuous Mobius strip "to symbolize continuity within a finite entity." His original design was slightly altered by Bill Lloyd, CCA's public relations manager. CAA initially owned the symbol and licensed its use for a fee. However, an environmental group challenged CCA's service mark registration application on the grounds that the symbol was becoming widely recognized as an icon for recycling and its use as a proprietary trademark would lead to confusion. The CAA let the symbol fall into the public domain. Because of this, its use is not regulated and anyone is free to use it. The U.S. Federal Trade Commission and other governing bodies have created guidelines, standards, and even local laws to reduce the confusion that often results from its appropriation. Through this standardization, there are symbols that indicate that an object is recyclable or that it contains recycled materials. Resin identifiers on the bottom of plastic containers are a second genre of standardized symbols that use three chasing arrows, but they are not related to recycling.

Symbols for Recyclable Paper

The American Forest and Paper Association used the universal recycling symbol to develop two variations of symbols for paper and paperboard products. White arrows without a circle around them indicate that the product is recyclable where facilities exist. A variation of this icon uses black arrows instead of white ones when visibility on light-colored objects would be an issue. While this symbol indicates that the product can be recycled, it does not mean that every municipality has facilities to recycle it. Furthermore, many objects are recyclable that do not carry this symbol. Thus, when determining whether a product is recyclable, consumers should rely on their local recycling authorities.

Other Symbols for Recyclability

There are other symbols that indicate recyclability for glass (a G-shaped arrow, or a person within three arrows putting a bottle in a bin), aluminum (three chasing arrows with ALU written in the center), steel (the chasing arrows with four-sided stars instead of arrow heads, the chasing arrows with "FE" written in the middle, or an image of a magnet attracting a steel drum), and corrugated cardboard (one circling arrow with a box inside). In 2010, the United Kingdom launched a symbol to identify biodegradable plastics (a sprout making a loop with its tail). Few of these symbols have controlling agencies that standardize their meaning, but all indicate that the material is recyclable where facilities exist.

The Green Dot symbol (two swirling arrows in a yin-yang configuration) indicates that a product can be recycled within a financing system where manufacturers pay for the cost of collection and recycling of their products. The system and symbol were developed by Duales System Deutschland in 1994 and are in use in several European countries.

Symbols for Recycled Material

A second set of symbols indicates how much recycled material was used to produce a product. White arrows within a black circle mean that the product is made entirely from recycled material. Black arrows within a white circle indicate that the product is partially made of recycled materials. A number inside the arrows indicates how much of the object was made from recycled fiber. In both cases where the product is made from recycled content, there is usually additional information about what percent of the recycled content is post-consumer waste, if any. For example, a product displaying black arrows within a white circle might read, "80 percent recycled paper with 50 percent post-consumer content." This statement means that 20 percent of the raw materials used to make the product were virgin materials, and 80 percent of the raw materials were scrap, of which 30 percent were from factory processes and 50 percent were from curbside consumer recycling programs.

Symbols for Plastics

A final genre of standardized symbols is the plastic resin identification coding system developed by the Society of the Plastics Industry (SPI) in 1988. It is an internationally recognized series of symbols placed on the bottom of plastic products to identify their polymer group. They do not, however, indicate that something is recyclable or made from recycled materials. The symbols are made of three stylized arrows arranged clockwise in a triangle with a number in their center and an acronym below the triangle. Each number and acronym corresponds to one of six polymer types (with a seventh category for "other" plastics). For example, number 6 is for polystyrene (PS), the material used in foam cups and egg cartons. However, foam cups are not recyclable or made from recycled material, though egg cartons can be recycled where facilities exist. In 1994, 11 U.S. state attorneys general accused the plastics industry of misleading consumers by using the universal recycling symbol within the resin identification coding system and conveying an environmental benefit that did not necessarily exist. While an 11-state recycling coalition voted to remove the recycling symbol from the SPI resin identifier system, it remains in use in the 21st century.

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See Also: Paper Products; Recycling; Recycling Behaviors.

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Recyclable Products

Many 21st-century environmental issues have resulted from activities and strategies spearheaded during the Industrial Revolution. Believing mistakenly that resources were unlimited, "cradle-to-grave" thinking became the dominant model for product manufacturing. William McDonough and Michael Braungart describe that framework as a system where resources are extracted from the Earth (the cradle), fashioned into products, sold, and then disposed of in landfills or incinerators (the grave). They report that as much as 90 percent of extracted material becomes waste in the extraction and production process. Products made from the remaining resources are often designed to have a short life cycle to accommodate new technological advances and to encourage customers to purchase newer and better items. Not only does this waste crowd landfills but also its value as material for new products is lost. Because materials for these prod-

ucts are usually virgin, extraction depletes natural resources and production both uses energy and emits greenhouse gases.

Cradle to Cradle

Challenging the dominant strategy, McDonough and Braungart advocate a "cradle-to-cradle" model in which waste material and discarded products are viewed as either biological or technical nutrients. Biological nutrients can, for example, return to nature as fertilizer. Technological nutrients are designed to reenter the production process as material for new products. They note that changing to the cradle-to-cradle model presents challenges because many 21st-century products are "monstrous hybrids," combining biological and technical materials in such ways that they cross-contaminate each other, making it virtually impossible to reuse in either a biological or technical system. Tom Szaky explains "monstrous hybrids" as products that, on their own, might degrade or be recycled, but can do neither when they are combined. Monstrous hybrids also include products that combine material that can be recycled individually but are cross-contaminated when combined, becoming garbage. In most areas, boxes for beverages cannot be recycled because they are coated with a chemical to make them stronger if they get wet. Pizza boxes often cannot be recycled because they are tainted by food remnants or grease. Cotton clothing, which could break down in compost, is contaminated if it contains tags made with synthetic materials or if it includes plastic buttons or decals.

To achieve cradle-to-cradle manufacturing, the production of monstrous hybrids must cease; instead, products should be designed to become biological or technical nutrients when they are discarded. Although this can be achieved a number of ways and new strategies are continually being developed, making recyclable products is the most widespread and popular approach in the 21st century. As do other cradle-to-cradle methods, recycling offers a number of benefits. It reduces the need for dumping waste products in landfills or disposing of them in incinerators; it reduces pollution that comes when virgin materials are manufactured; it saves energy and decreases greenhouse gas emissions; and it conserves natural resources such as wood, minerals, and water.

Paper

Recycling relies on manufacturers producing products with recyclable material, including paper, plastic, glass, metal, and textiles. Paper and paperboard, accounting for 31 percent (77.42 million tons) of the municipal solid waste (MSW) in the United States in 2008, is recycled at a rate of about 55 percent. Paper is used for commercial and residential printing, books, packaging, and a multitude of other purposes. Recovered paper is combined with water and processed to remove contaminants. The resulting pulp can be used to make products entirely out of recycled fibers, or it can be combined with virgin fibers. As paper is recycled, the fibers become shorter; after five to seven cycles, they become too short to use. Newspapers, for example, have short fibers and can only be recycled into other paper products using short fibers. Many consumers believe that they are purchasing environmentally friendly products when they purchase any paper labeled as recycled. However, only paper products with post-consumer fiber have undergone this recycling process. Pre-consumer fiber comes from scraps of paper left over from manufacturing, such as when sheets are trimmed.

Plastics

Plastics are another type of recyclable product. According to the Environmental Protection Agency (EPA), in 2008, plastics accounted for 30 million tons (12 percent) of MSW in the United States. Plastics are polymers created from the combination of petroleum and other materials that are heated to produce monomers. Different plastic resins with unique characteristics result from specific combinations of monomers. Some are softer and easily molded; others are hard, strong, and durable. Extrusion, injection molding, blow molding, and rotational molding—all of which use heat or pressure—transform plastic resins into their final forms. In 1988, the Society of the Plastics Industry (SPI) introduced a voluntary coding system to facilitate identification of plastic content.

Not all plastics categories can be recycled, and some of the categories that can be recycled are frequently not recycled because it is too inefficient. Number 1 (PET), Number 2 (HDPE), and some Number 5 (PP) plastics are the only categories that

are recyclable. However, just because an item is recyclable, does not mean it will actually be recycled. The item must be collected, either through curbside services or drop-off locations. In the United States, only 2.1 million tons (6.8 percent) of plastics were recycled in 2008. Once the plastics are collected, they are sent to a material recovery facility for sorting, after which they are baled and dispatched to a reclaimer. There, trash and dirt are removed from the plastic, which is then washed and ground into small flakes. After further processing, flakes are formed into pellets, which manufacturers can be use to create new plastic products. Some of the products made from recycled plastic include containers, bottles, clothing, tote bags, fleece, and even doghouses. New products are continually introduced as consumers have demonstrated a desire to purchase recycled products.

Glass

Most frequently, glass is used to create food and beverage containers, but it is also used in construction, electronics, vehicles, and consumer durables. Almost 5 percent (12.15 million tons) of glass were in the MSW of the United States in 2008, with just over 23 percent of that recycled. Glass can be recycled repeatedly without losing functionality or purity. Cullet (crushed pieces of recovered glass) is used by glass manufacturers, thereby reducing the amount of raw materials and energy required in the production process. Cullet can range from high to low quality, depending on the consistency of the pieces. Mixed colors, for example, diminish the quality of the batch. By 2010, demand for high-quality cullet exceeded the available supply.

Aluminum

Metals, including aluminum and steel, are also recyclable and are frequently recycled. Aluminum, used for packaging, consumer durables (such as utensils), vehicles, machinery, electronics, and construction, represents 1.3 percent (3.4 million tons) of U.S. MSW. About 21 percent of aluminum in the waste stream is collected for recycling, and most of the recovered aluminum is in the form of used beverage containers. These are refined and melted into can sheets, which form the body of beverage cans. Most beverage cans contain 40 percent recycled content. It takes significantly less energy to make a can from recycled aluminum than if the manufacturing process began with bauxite ore. The entire loop is surprisingly fast. According to the EPA, it takes only six weeks for a can to be manufactured, filled, sold, recycled, and remanufactured. This process is the closed loop of the cradle-to-cradle system, with recycled aluminum being the technical nutrient in the production of beverage cans.

About 21 percent of aluminum in the waste stream is collected for recycling; most is in the form of used beverage containers, which contain 40 percent recycled content. The entire manufacturing, recycling, and manufacturing loop takes only six weeks.

Steel

Steel, with a wide range of uses from food containers to construction, accounts for 6.3 percent (15.7 million tons) of U.S. MSW. Steel is forged in one of two ways: the basic oxygen furnace (BOF) process and the electric arc furnace (EAF) process. The former uses 25–35-percent used steel, while the latter uses virtually 100-percent recycled steel. Like aluminum, recycled steel requires much less energy to create than steel made from virgin mate-

rial. The resulting recycled steel becomes the technical nutrient for cars, appliances, containers, and construction material.

Textiles

Many unwanted textiles, such as clothing, towels, bedding, and window coverings, never need enter the waste stream. They can be sold at vintage or consignment stores or donated to charitable organizations, which often resell the items. Not only do these items provide accessible, inexpensive clothes to the community but they also help the organization raise much-needed funds. Even if not reused, the recycling process of textiles is extremely efficient. Recovered material can be made into rags, paper, insulation, or upholstery. Any remaining natural fibers can be composted. However, in 2008, 12.37 million tons, or almost 5 percent, of U.S. MSW was textiles.

Programs

Although recycling has a long history and is familiar to many, recycling rates are still incredibly low. Having recyclable products if they are not collected for recycling is pointless and wasteful. Some local or state governments use bottle deposit programs to improve recycling rates for plastic and glass containers, and some countries have legislation that provides inducements for reducing source material or using recyclable or recycled material in their products. Additionally, many state, local, and national governments provide purchasing guidelines recommending or requiring acquisitions to meet minimum environmental standards, for example, having recyclable or recycled content.

Bioproducts and Composting

While recycling represents one alternative in working toward a cradle-to-cradle model of production, it is not the only option for dealing with waste. Catalyzed by consumer demand and environmental pressures, manufacturers are offering new and innovative material out of renewable and compostable resources. Ingeo has developed a corn-based fiber used in accessories and tote bags. A number of companies have developed forms of bioplastic from sources such as corn, beets, and potatoes. The compostable bioplastic is then used for carry-out containers, cups, and utensils. Recycled paper pulp and reed pulp can also be used for boxes, clamshells, and trays. Hemp, a strong, renewable, and compostable fiber, is used in a wide variety of packaging and products. Composting takes these biodegradable and compostable products, as well as organic waste, and turns them into biological nutrients that can be returned to the soil. Composting can be done on an industrial scale or residentially. One form of composting simply collects compostable waste; in another, vermicomposting, worms eat the organic waste and their excrement is used as fertilizer. When organic material is allowed to decompose in this way, it becomes food for the Earth, turning waste into fuel.

Innovations

Forward-thinking companies continue to innovate to create recyclable content and use recycled content. Pangea Organics originally sold bar soap without a package, but it became damaged as it moved from manufacturer to consumer. When Pangea decided to package its soap, it investigated a number of alternatives and decided that clamshells made from 100 percent post-consumer waste newsprint were most environmentally friendly. However, it went a step further and inserted herb seeds into the paper. Consumers then have packaging that not only biodegrades, it becomes something living and useful. Other companies are offering paper products infused with seeds as well, so that an individual can send a letter to a friend, and that friend can actually plant the letter or card. A unique company, the Great Elephant Poo Poo Paper Company, collects elephant waste, which is full of medium and long fibers the animals have eaten. These fibers are cleaned and made into paper products such as notepads, note cards, and bookmarks. A portion of the profits made by the company go to elephant welfare and conservation programs.

Innovation in product design is not limited to boutique companies. Ford Motor Company provides industry leadership in developing and testing renewable and recyclable materials. Rather than utilize petroleum-based foam in seat cushions and seatbacks, Ford has produced a soy-based biofoam that it uses in most of its vehicles as well as licenses it to other companies, such as Deere and Company, which plans to use the biofoam in agricultural applications.

Conclusion

Progress toward the cradle-to-cradle mindset is encouraging and exciting. New materials and product designs eliminating monstrous hybrids promote closed-loop manufacturing. However, the availability of recycled products does not ensure recycling. Products must be created with recycling, composting, or reuse in mind, with an awareness of how they will become a biological or technical nutrient. These products and their packages must then be collected. Consumers have a responsibility to utilize available curbside and drop-off collection locations, and the recovered material must be processed into a form that manufacturers can use. For the system to be successful, manufacturers need to include recycled material in their products. With that, the process begins again, when consumers purchase recycled and recyclable products. Over time, making the system easier to use should help achieve a cradle-to-cradle model with no waste a real possibility.

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See Also: Consumerism; Landfills, Modern; Overconsumption; Packaging and Product Containers; Post-Consumer Waste; Recycling Behaviors; Zero Waste.

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Recycled Content

Recycled content is a commonly used term that identifies products manufactured from material items that have been diverted from conventional disposal processes, such as landfills, for another use. Although the term *recycled content* is all-inclusive, it can be broken down into two categories that further specify its meaning: pre-consumer and post-consumer content.

Pre-consumer content is material generated by manufacturers and processors. It consists typically of scrap, trimmings, and other by-products that were generated during the normal manufacturing process but never entered the consumer market. For example, scraps of paper or metal might fall on the factory floor or be shaped incorrectly, and thus cannot be sold as quality products. Instead of throwing these bits and pieces in the trash bin, where they eventually make their way to a landfill, manufacturers reincorporate these materials into their manufacturing process.

Post-consumer content, on the other hand, are materials that have completed their life cycle as consumer items and, instead of being discarded as solid waste in a landfill, are recycled to create new products. Examples of post-consumer materials include paper, cardboard, aluminum cans, plastics (such as bottles), and metals. Most often, these products are collected in commercial and residential recycling programs. To be considered recycled material, products may contain some pre-consumer waste, some post-consumer waste, or both. A product need not contain 100 percent recovered materials to be considered recycled, but the higher the percentage of recycled content, the greater the amount of waste that has been diverted from landfill or incinerator disposal.

Distinction

However, while understanding these differences and making purchasing decisions based on this information, the more essential step in maintaining the cycle of recycling is, quite simply, economic feasibility. In other words, consumers must provide a demand for recycled products and packaging by choosing these items over those made from virgin materials.

Labeling

Because post-consumer content is regarded as more environmentally friendly than pre-consumer content, manufacturers tend to advertise the percentage of their products that are made from post-consumer material. However, the consumer must take care not to be misled when choosing products made from recycled material. The recycling symbols that appear on packaging do not guarantee that the material is made from recycled content or is even recyclable. Given the ubiquity with which manufacturers use recycling symbols to identify their products as "recycled," consumers can become confused about how much of the product is either recyclable or made from recycled material.

To address this issue, the Federal Trade Commission (FTC) issued its Environmental Guide in 1992. The guide specifies the standards by which labeling and marketing claims can be made concerning the degree to which a product is considered environmentally friendly. Independent, third-party organizations such as the Sustainable Forest Initiative (SFI) or the Forest Stewardship Council (FSC) certify and label products, such as paper, so consumers can make informed decisions about purchasing products from socially and environmentally responsible companies. While there are market-based incentives that encourage companies to practice environmentally responsible manufacturing methods, a fundamental step in the recycling process is the consumer's participation by purchasing from these companies.

Consumer Demand

Recycled content is part of a system that involves three basic steps. The first is the physical act of recycling, such as choosing to use the recycling bin rather than the trash bin at work or at home. The second step involves companies' using these recyclables to manufacture new, post-consumer products. The final step is the consumer's choosing to purchase the products that are made from recovered materials. The Environmental Protection Agency (EPA) identifies several steps that comprise the process of recycling. The most important step, they argue, is the consumer's making the active choice to purchase products made from post-consumer recycled content.

A primary component in the recycling process is consumer demand for products made from recycled content. Additionally, the existence of businesses whose purpose is to remake the recycled materials into new products is vital. One can recycle an empty soda can, but if no business exists to convert the aluminum into something new, the cycle is broken. Post-consumer content is an important piece of the puzzle when it comes to waste management. One issue that pervades waste management is simply that there is too much waste to be disposed of properly throughout the world, most notably in developed countries. Making the effort to purchase products made from post-consumer recycled content minimizes the volume of material requiring landfill or incineration disposal.

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See Also: Post-Consumer Waste; Pre-Consumer Waste; Producer Responsibility; Recyclable Labels; Recyclable Products; Recycling.

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Recycling

Recycling is an industrial practice in which recyclers collect used or abandoned materials and transform them into their constituent parts to create raw materials for new objects. Though such reprocessing has been around for centuries in artisanal, domestic, and industrial contexts, the term *recycling* was only coined in 1926 to describe sending partially refined oil back through the refining process. In the 21st

century, recycling refers to two distinct but related practices: the industrial system of reprocessing materials and consumer-side recycling motivated by environmental values.

History

Before the advent of mass production in the industrializing United States, industrial and consumer sides of recycling were inextricably intertwined. Manufacturers depended on consumer waste for many raw materials, including rags for paper and bones for fertilizer and glue. Peddlers and ragmen traded old materials for new goods and allowed people with little cash to obtain consumer items. Thus, as historian Susan Strasser has described, waste and recycling were essential parts of women's domestic economies, especially in rural areas. Disposal and production linked consumers and manufacturers in a symbiotic relationship.

By the end of the 19th century, recycling entered a new paradigm. With increasing urbanization, industrialization, and mass production, household commodities were more affordable and increasingly ubiquitous. Domestic reuse declined, while waste increased and became more concentrated in cities. The first curbside recycling program was introduced in Baltimore in 1874 to manage urban waste and simultaneously create "wealth from waste" by diverting useful materials to industrial processes. By the turn of the century, peddlers and small collectors were replaced with specialized transatlantic businesses that traded in massive quantities of consumer and commercial discards.

This new economy of recycling set the stage for the differentiation between industrial and consumer scales and methods of recycling. From this time to the early 21st century, most items made from recycled materials have drawn their raw materials from industrial scraps or waste from an industry's own production (such as when the sludge created from cutting granite is used in ceramic floor tiles), rather than from consumer discards, which require more time and energy to collect and sort. The known origins and homogeneity of industrial scraps allow reprocessing to become more streamlined and lets producers skip sorting altogether. Motivations for industrial recycling are almost exclusively internal. Industries can and often do save money by not having to pay for additional raw materials or disposal. In the United States, however, the extraction of virgin materials is often subsidized while the recycling industry is not, meaning that virgin materials are often cheaper than their recyclable counterparts.

Effects

Recycling can reduce waste, the need for virgin materials, energy consumption, air pollution, and landfill leachates, but the reduction occurs in varying degrees for different processes. Although recycling is usually more environmentally friendly than obtaining and processing virgin material, it is not environmentally benign. First, recycling institutionalizes disposables by treating them after they have been created. Second, while recycling can decrease resources required to make a product, it still necessitates expenditures of energy and virgin materials and produces pollutants, greenhouse gases, and waste. For example, recycling paper involves using water and electricity to separate paper fibers, which must then be de-inked, a process that results in toxic sludge. Recycling can create products that are "downcycled" because they are not as robust as their predecessors; nor are such products usually recyclable (polyurethane plastics, for example, are often turned into asphalt or other end-of-the-line objects). These criticisms come to bear on different materials in different ways. For example, recycling aluminum uses 95 percent less energy than processing bauxite ore and eliminates some of the most environmentally detrimental aspects of mining. Glass and paper recycling have smaller energy savings and use many of the same processes that virgin materials require.

Aluminum

Aluminum recyclables are shredded into smaller pieces and melted. Pure aluminum melts at 600 degrees Celsius, while bauxite ore must be melted at 900 degrees Celsius. Pure aluminum can be melted and remolded without any changes in its material, allowing it to be recycled indefinitely. However, many recyclables, such as soda cans, contain two different aluminums for the body and top and include paint and other coatings. These are burned off as impurities, resulting in air pollution. When the two aluminums are melted together, they result in a weaker downcycled product.

Ferrous Metals (Iron and Steel)

Ferrous metals are the most recycled material in the United States. Their separation from other waste is accomplished with magnets and can be automated. Higher-temperature furnaces can reprocess scraps without adding virgin material, while lower-temperature furnaces can handle around 25 percent scrap. If scrap metal is relatively uncontaminated, it can be recycled without downgrading the final product. Like aluminum, melting metals that have paint or plastics on them results in carcinogenic dioxide emissions.

Paper and Paper Products

Post-consumer paper waste has to be manually sorted into different types, such as paperboard, office paper, and newsprint. Staples are removed with a magnet. The paper is chopped into small pieces and added to water and chemicals. Denser objects that are not paper sink. Any inked or colored papers must be deinked with sodium silicate or sodium hydroxide. Some paper pulp is also bleached. The effluent of the pulping process, called "sludge," includes chemicals, inks, clay (from glossy paper), plastics, and short paper fibers. This sludge can be toxic and is landfilled or incinerated. When paper is recycled, the fibers break down and become shorter, requiring the input of virgin material. If virgin pulp is not added, the pulp can be used in lower-quality paper products, such as cardboard or newsprint.

Glass

Though glass can be recycled indefinitely, raw materials are so inexpensive that economic motivation to recycle glass is low. Glass must be separated by color before it is reprocessed. It is then crushed and melted in a furnace, often with virgin material. It can be blown or molded into new glass products, or it can forgo the melting process and be used in glassphalt (road asphalt made of approximately 30 percent glass cullet). Two pollutants of glass recycling are glass dust, which can include carcinogenic silica, and air pollution from burning impurities.

Plastics

Plastics include a wide range of resin polymers that must be cleaned and sorted for different processes (the numbers on the bottom of plastic containers are resin identifiers and do not denote whether or not the object is recyclable). Not all plastics are recyclable. Thermoplastics, which make up the majority of 21st-century plastics, are recycled by shredding, heating, and forcing the material through a die that makes long thin strands of plastic. The strands are cut into pellets, which are shipped as raw materials to manufacturers. Thermosetting plastics, including polyurethane and epoxy, cannot be remelted once they are cured and are not recycled into new plastic. They are usually chopped or ground and used as fillers in asphalt or insulation. Finally, biodegradable plastics, most of which are created by using starches to adhere fine plastic strands together, are not recyclable.

Electronic Waste and Other Materials

Electronic waste (e-waste) includes discarded computers, cell phones, televisions, and other electronic devices. Direct disposal is frequently banned because e-waste contains toxic materials, including lead, cadmium, mercury, and brominated flame retardants, which can leach in landfills. In the United States, e-waste is crushed or shredded, then plastics, glass, and metals (such as copper, silver, gold, tin, iron, and aluminum) are separated using magnets, water currents, and screens. However, because of high costs and environmental regulations, most U.S. e-waste is exported to countries with less-stringent labor and environmental laws. Sorting is done by hand, and components are frequently burned to obtain valuable metal parts. Guiye City, China, one of the largest e-waste recycling sites in the world, is notorious for its polluted soil and water and the poor health of its inhabitants.

Batteries, rubber, textiles, wood, biodegradable waste (including sewage), construction and demolition waste, and other nonferrous metals such as copper and lead are also recycled.

Recycling Culture and Participation

Since the 1960s in the United States, consumer-side recycling, or "blue-binning," has increased in popularity and has come to symbolize an act of environmental responsibility. Within popular culture, recycling has come to signify a range of environmental activities that deal with waste beyond collecting

recyclables for industrial reprocessing, including reuse or repurposing, such as weaving purses out of plastic bags. The universal recycling symbol was created for the first Earth Day in the United States in 1970 and continues to promote curbside recycling in the 21st century. The chasing arrows symbolize continuity within a finite entity and are part of a larger environmental rhetoric about resource scarcity, stewardship of the Earth, and the immorality of wasting.

Environmental responsibility is now the dominant frame within which to understand and encourage recycling. Some scholars, such as Gaye Hawkins, have described this ubiquitous environmental framing as a monopoly of interpretation. Within consumer recycling, the diversion rate, or recycling rate, refers to the number of recyclable materials separated from regular municipal solid waste. The diversion rate is measured by weighing collected recyclables over all waste generated (recyclables and garbage). While diversion rates do not measure how many recyclables remain in the waste stream, they are often expressed as a percent. The national recycling rate in the United States hovers just over 30 percent, though this percentage varies by locality and material. Furthermore, each municipality may or may not include commercial waste, lawn waste, and construction and demolition waste in its figures. A myriad of strategies exists for increasing consumer diversion rates, including laws, fines, bottle bills, and pay-by-weight trash collection.

Environmental Movements

There are several environmental movements that marry the industrial processes of recycling with popular notions of environmental stewardship. These movements tend to advocate 100-percent or near-100-percent recycling rates for consumers and industry—a scenario that would involve systematically changing how goods are designed, created, distributed, and reprocessed. Zero waste is a philosophy based on the lack of waste in nature. As a philosophy, the zero waste movement has overarching statements about the role and ideal uses of waste and recycling, but it does not make technical recommendations for achieving these goals, nor does it comment on the state of 21st-century recycling processes, all of which produce waste.

In comparison, the cradle-to-cradle model is based on specific biomemetric techniques of redesign and recycling. The founders, Michael Braungart and William McDonough, a chemist and an architect, respectively, work with businesses to ensure that all products are either "technical nutrients" (100-percent recyclable, nontoxic, and designed to avoid downcycling) or "biological nutrients" (100-percent compostable). The zero waste movement and the cradle-to-cradle model, as well as other criticisms of industrial recycling, posit that recycling has potential to radically increase environmental benefits if changes become more systematic and include the design and planning of both domestic and industrial waste, rather than apprehending a fraction of waste after it has been created.

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See Also: Packaging and Product Containers; Recyclable Labels; Recyclable Products; Recycled Content; Recycling Behaviors; Sustainable Waste Management; Waste Reclamation Service.

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Recycling Behaviors

Recycling involves turning materials that would otherwise become waste into valuable resources. It involves collecting recyclable materials that would

otherwise be considered waste; sorting and processing recyclable into raw materials, such as fibers; manufacturing raw materials into new products; and purchasing recycled products. These programs can be run by private organizations or by government entities and involve returning used bottles, cans, and newspapers to the curb or a collection facility. Such programs generate several financial, environmental, and social returns, which benefit both local and global arenas.

The recycling process begins by having a collection and processing system in place. The collection can be done by any of the four primary methods: curbside pickup, drop-off centers, buy-back centers, and deposit/refund programs. Regardless of the mode of collection, the recyclables are sent to a materials-recovery facility to be sorted and prepared into marketable commodities for manufacturing. After cleaning and separation, they are used for manufacturing. Increasingly, more products are being manufactured using total- or partial-recycled content. Common household goods such as newspapers and paper towels, aluminum, plastic and glass soft drink containers, steel cans, and plastic laundry detergent bottles are made of recycled materials.

Buying recycled products completes the recycling loop. All types of buyers, such as governments, businesses, and individual consumers, play significant roles in determining the success of the recycling process. A greater demand for environmentally friendly products will nudge manufacturers to continue meeting that demand by producing high-quality recycled products.

Although some municipalities benchmark recycling success by participation rates, others base their judgment on economic performance. Curbside programs are particularly subject to market swings and may be profitable in some years and incur losses in others. By signing long-term contracts with processors, local governments can moderate fluctuations in the market. Often, local governments ensure avoiding losses by limiting the types of products that are collected as recyclables. For example, the city of Albuquerque, New Mexico, collects paper, corrugated containers, steel, aluminum cans, and plastics at the curb, but residents who wish to recycle glass have to take it to one of 15 locations throughout the city. This policy enables the city to keep the recycling fee under $2 per month per household, and it is simultaneously able to divert about 20 percent of its waste stream.

Why Do Consumers Recycle?

Several studies have alluded to so-called green guilt as being the major reason why consumers recycle. This guilt refers to the feeling that consumers have when they believe they are not doing everything they can and should do to protect the environment. According to a survey conducted by the Opinion Research Corporation, 50 percent fewer U.S. residents admitted to having such feelings in 2010 than in 2009.

Most Americans recognize the economic benefits of environmental consciousness, with nearly 80 percent indicating that they buy green because they see long-term cost savings. More than half of the respondents indicated a willingness to pay for ecofriendly

Studies show that most Americans recycle due to "green guilt," a recognition of the benefits of being environmentally conscious, and a realization of cost savings. Most survey respondents indicated they would pay more for ecofriendly products or services.

products (57 percent) or services from ecoconscious companies (55 percent). Recycling household products has become increasingly more convenient as retailers, businesses, and community recycling programs have made it more convenient to drop off used items where consumers live, shop, and work.

Another way to persuade the consumer to recycle is to encourage people to take advantage of the several free or money-saving products and programs that are Earth friendly. For example, Home Depot began the holiday season in 2009 by having a Power Drill Trade In, Trade Up event, which offered customers the opportunity to bring in a used or broken power drill and get up to 15 percent off a new drill. These promotions serve a threefold purpose: educate customers about take-back programs, offer cost savings on products, and keep waste out of community landfills.

Consumers also identify accessibility and know-how as additional obstacles to being environmentally friendly. For example, in 2009, the Kansas Department of Health and Education (KDHE) launched a Long Haul contest, which challenged schools and businesses statewide to recycle the most rechargeable batteries and cell phones between Earth Day and America Recycles Day. The event was promoted by offering commemorative T-shirts, prizes, and recognition for participants. Overall, education programs were responsible for increasing battery recycling efforts by 6 percent in 2009 over the previous year.

Product stewardship, which entails proactive involvement of manufacturers, retailers, and government in environmental concerns, shifts the burden of financial responsibility for a product's proper disposal to the firm that either makes or sells the product. The primary goal is to divert waste from landfills and lessen the negative environmental impact by making it economical and convenient for consumers to recycle products. The success of electronic waste collections can be primarily attributable to such programs.

Penalties for Not Recycling

Many cities have begun implementing strict fines for either not recycling or not following appropriate rules. For example, in San Francisco, households must sort their garbage into three color-coded bins: blue for recycling, green for compost, and black for trash. There are strict penalties for throwing tea bags or coffee grounds into the wrong bins. In other cities, residents must bag their trash in clear plastic so that municipality officials can monitor whether or not recyclables are being tossed out with the garbage.

Clevelanders will soon have to use recycling carts equipped with radio frequency identification chips, which will enable the city to remotely monitor residents' compliance with recycling regulations. If a chip shows that a recyclable cart has not been brought to the curb in weeks, a trash supervisor will sort through the trash for recyclables. Trash carts containing more than 10 percent recyclable material could lead to a $100 fine. The United Kingdom already has a similar system in place and the fines can be as high as $1,500.

In Philadelphia, anyone not putting out their recyclables can be fined $50 per offense. According to the Departments of Streets, such citations brought in almost $1 million during the 2009 fiscal year. Recycling Alliance of Philadelphia has estimated that more than 90 percent of what should be recycled is not. The more recyclables the city can sell, the less it must pay to dump the remainder of its trash.

Skepticisms About Recycling

Recycling has also had its critics. For example, *New York Times* writer John Tierney argued that mandatory recycling programs were bad for posterity. They offered mainly short-term benefits to a few groups—namely, politicians, public relations professionals, and environmental firms—while diverting money from genuine social and environmental problems. Conventional curbside recycling was shown to cost, on average, 60 percent more per ton than conventional garbage disposal. It also found that it cost between $34 and $48 more per ton to recycle material than to send it to landfills or incinerators. Hence, unlike commercial and industrial recycling, mandatory household recycling is a money loser.

Recycling garbage has become an interstate business, with 47 states exporting waste material and 45 states importing it. It is perhaps more economical to dispose of it within borders. Also, moving waste materials is more hazardous than moving

other types of commodities. Others have pointed how because of several innovations, people use much less material and produce twice as much output per unit of energy as people in the 1950s and five times as much as people 200 years ago. For example, automobiles use only half as much metal as in 1970, and one optical fiber carries the same number of calls as 625 copper wires did in the 1980s. Bridges are built with less steel because of stronger steel and improved engineering.

In a study done in supermarkets and grocery stores in New York City in 2010, reusable synthetic grocery bags were found to contain unsafe amounts of lead. These bags posed a long-term risk of seeping into groundwater after disposal, and paint from the bag could flake off over time and come in contact with food. Overall, informed voluntary recycling conserves resources and raises a society's wealth. However, mandatory recycling programs in which consumers are compelled to alter behaviors may not be beneficial to society. Moreover, government-run recycling programs often give the impression of being run without cost, when in fact they consume valuable resources.

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See Also: Dump Digging; Environmentalism; Industrial Waste; Organic Waste; Producer Responsibility; Recycled Content; Recycling; Recycling in History; Resource Recovery Act; Sociology of Waste; Street Scavenging and Trash Picking; Sustainable Waste Management; Trash to Cash; Zero Waste.

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Recycling in History

Basic human needs for food and shelter have long been accompanied by questions of what to do with the remains of gathering, hunting, farming, and sustaining lives. As individuals organized into families, tribes, and, eventually, cities and nation-states, the commodities and resulting refuse required scaled management. Recycling has been an important part of this scaled effort throughout the past 5,000 years and continues to evolve in terms of scope and sophistication. To better understand the impact of recycling on human waste management, it is important to consider recycling through history in terms of behaviors, materials, and legal practices.

Early History

In the ancient world, Crete generated some of the earliest-known landfills, while Athens required waste to be deposited more than one mile from city walls. Both communities enjoyed citizen-based waste maintenance and recovery because, in part, of a slower production of goods in earlier civilizations. Early Chinese and European communities relied on bronze recovery foundries as worldwide appetites for metals increased. Because of its durability, malleability, and construction qualities, metal recovery and recycling

has remained a ubiquitous practice into the 21st century. Early cities also recycled more than wood and metal when laws focused more specifically on hygiene. Early Londoners crafted clean street regulations, leading so-called rakers to repurpose garbage in informal markets. Early German villages required merchant wagons to leave market spaces with the same quantity of refuse as wares sold or traded each day. In both instances, the legal requirements of public life included constraints on waste disposal that increased, in turn, the likelihood that cast-off materials would be valued and therefore recycled.

Industrial Revolution

As the industrial era began, metals, textiles, and paper grew in distribution. Spain built copper recycling facilities in response to continental appetite. England developed rag recycling in response to aristocratic regulations on textiles. Dust yards, or trash sorting spaces, sprang up in a number of European cities, whereby debris was gathered from city streets, sorted by human hands, and sent to secondhand merchants. Remaining dust and cinders from coal and wood fires were sent to fertilizer makers. Eventually, increased industrial-era waste could be attributed to conspicuous consumption of ever-more goods and products. Ubiquitous waste precipitated municipal health laws, which were crafted to protect citizenry from the by-products of disposal. Additionally, these laws positively affected the health of dust yard sorters and made citizens generally aware of disposal practices, including the need to reuse much of what had been previously discarded. As economies industrialized, they encouraged small businesses formed to reclaim rags, metals, and other goods from consumers and return them to paper mills, steel mills, and other manufacturers willing to pay for secondary materials. In the United States, the trade provided opportunities for thousands of first-generation immigrants to establish businesses between the Civil War and World War II. Some of these became the largest scrap recycling businesses of the 20th century as demand for secondary materials increased.

The 20th Century

The 20th century brought a number of waste and recycling innovations for the industrial and postindustrial eras. Total waste incineration grew into fashion for a period of time, decreasing the practice of recycling in the West. World wars resuscitated scrap and resource recycling drives in various nations to supplement large-scale material needs for military production. War efforts tended to commingle the reasons for recycling as both a patriotic affair as well as an economic need. The 1920s and 1930s brought about the massive expansion of plastics usage that has continued into the 21st century. Plastics had previously been used through the forms of Parkesine and Xylonite for packaging, cellulose nitrate for waterproofing, and Bakelite for myriad consumer goods. The discovery of superpolymer properties led to injection molding and the creation of plastics from petroleum in the 1920s and 1930s. Polystyrene, acrylic, epoxy resins, silicone, and PVC led to the production of adhesives, high-tensile-strength construction, hygienic surfaces, recording equipment, household plumbing, and water bottling. Plastics made the recycling and storage of foodstuffs more widely available as well. Meanwhile, recycling of plastic materials took much longer to establish in many developed and developing countries. To underscore how this recycling gap is ongoing, consider the Environmental Protection Agency's estimates from 2008 that U.S. landfills are still nearly one-third full of containers and packaging, much of which is plastics.

Mass consumption practices combined with a long history of reuse and recycling behavior precipitated humankind's postindustrial age of materials recovery facilities (MRF) and integrated sustainable waste management (ISWM). Landfills such as New York's 1948-established, 3,000-acre Fresh Kills complex have given way to state-of-the-art facilities such as the Toronto-based Guelph Wet/Dry Recycling property. Communities worldwide continue to seek new ways to recycle paper, metals, glass, plastics, cardboard, chipboard, and waste oil. Laws such as Germany's groundbreaking 1990s packaging constraints, worldwide landfill engineering, curbside recycling across thousands of municipalities, and treaties such as the Basel Convention and its concern with how to limit and recycle electronic waste all demonstrate the importance of recycling practices in civic life. And while the debate continues over the economic and environmental impacts of post-consumer waste recycling versus post-

industrial waste recycling, it is clear that recycling has played a long and storied role in the history of human consumption and waste in terms of myriad valuation and collection behaviors, materials, and legal praxis.

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See Also: Fresh Kills Landfill; Recyclable Products; Recycling; Recycling Behaviors.

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Rendering

Rendering is the process by which bones, butcher's waste (offal), animal carcasses, and waste meats are converted into products, including grease (the oily liquid from melted fat), tallow (defined as somewhat-hardened animal fats), glycerin, and fertilizer. The materials are heated in a closed vessel with steam. Grease and fats rise to the top of the vessel where it can be skimmed off. The remaining solid materials (called tankage) also have a number of uses.

Historical Rendering

In the early to mid-1800s, rendering was often done in an iron vat with a tight lid. The vat was filled with water and the materials were boiled. The lid kept the steam inside the vat, but the pressure was generally not allowed to rise above a few pounds per square inch. After the grease was removed from the surface of the water, the larger bones were charred and used as a filter medium in sugar refining. The remaining solids, because they were rich in nitrogen and phosphorous, became a feedstock for fertilizer manufacture.

Rendering produced noxious odors, which frequently prompted complaints. Another drawback to boiling was that the water became a foul, smelly soup that was simply poured into the nearest body of water.

However, the desire to remove putrescible wastes from cities, the demand for industrial feedstocks, and the need to dispose of animal carcasses in the era before the internal combustion engine made rendering plants in or near cities a necessity. In July 1853 alone, 1,113 tons of butcher's offal and 425 dead horses were removed from Manhattan Island for reprocessing into grease and fertilizer.

The development of closed tanks for rendering allowed higher pressures and had the added benefit of allowing noxious gases to be captured. Higher pressures also caused bone to disintegrate. These tanks were heated by introducing steam through a pipe opening into the bottom of the tank. Pressures of 50–60 pounds per square inch were possible. By 1874, technologies were introduced that would direct any noxious gases created during the digestion process into the same fires that were used to create the steam. These technologies were far from perfect, and the odors from rendering plants continued to be a public nuisance.

Rendering plants were highly profitable. During the 1800s, the recovered grease was refined and used for manufacturing soap, candles, paints, and lubricants. At the start of the 20th century, New York City was able to finance its garbage collection entirely through the sale of recovered grease.

During the 1890s, rendering technology was used by large cities to process household and restaurant food wastes—a process known as "waste reduction." The fertilizing value of the tankage was not as great as that produced exclusively from animal flesh, but there was still sufficient nitrogen, phosphorous, grease, and potash to make recovery profitable.

In addition to steam heating, at the start of the 20th century, there were two other commonly used rendering technologies. Crushed and dried

food wastes were extracted with gasoline. Another method was to extract wet wastes with gasoline at a temperature equal to the boiling point of gasoline. The advantage of this approach was that both water and grease were removed in the same step. Whichever process was used, the tankage was usually pressed to recover the last of the grease.

Modern Rendering

Modern rendering plants are an important component of the agricultural sector. It is estimated that one-third to one-half of every animal raised for meat, milk, eggs, and fiber will not be consumed by humans. There were approximately 300 rendering plants operating in the United States at the start of the 21st century. The greases and fats produced by the industry can be broadly divided into inedible and edible tallows, grease, lard, and poultry fat. According to the National Renderers Association, total production of these materials averaged between 4 million and 4.5 million metric tons between 2003 and 2008. In the same period, production of meat and bone meal, tankage, poultry by-products, and feather meal averaged between 3.6 and 4.1 million metric tons annually. The largest use of rendered products is as animal feed for livestock, poultry, aquaculture, and companion animals. Increasing amounts of rendered fats are used for biodiesel production. By 2009, approximately 30 percent of the feedstocks used to manufacture biodiesel came from rendering.

Rendering plants still use heat and pressure to process the raw materials, followed by pressing the residual grease out of the tankage. The process operates on a continuous basis and odor control devices capture the noxious fumes.

Critics of the industry contend that rendering does not remove traces of pesticides, drugs, and other agricultural chemicals from the animal tissues fed into the process. Plastic packing materials may also enter the process when spoiled meat or other surplus foods are rendered.

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See Also: Farms; Food Waste Behavior; Organic Waste; Public Health; Recycling.

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Residential Urban Refuse

Historically, most people lived in rural settings, sustaining themselves by growing or otherwise procuring their food locally. Generally, each household, or a nearby craftsperson, manufactured clothing, furniture, and other household necessities.

Because people lived so much more simply, they produced minimal household waste and disposed of it in the same place close to their house for long periods of time. There is consistent evidence for this in the prehistoric and historic archaeological record, and disposal patterns are described in archives from around the world.

Refuse Archaeology

Residential trash began to pile up in conjunction with the acquisition of excess. The advent of excess food occurred about 10,000–12,000 years ago throughout most of the world, during what is commonly known as the agricultural revolution. This is known because new forms of storage containers, such as ceramic vats, appear at about this time in history.

People living in this era became more sedentary, and social complexity grew increasingly intricate. Residences became closer together in general. Most scholars agree that an evolution of refuse indicates social complexity and density of populations: who was using what and where.

Urban residential garbage intrigues archaeologists and anthropologists. Household-level, as opposed to municipal- or regional-level refuse repositories, provide empirical information about the day-to-day behavior of families and other people who live in or frequently visit a given house. From such refuse, archaeologists glean data regarding factors about the composition of individual households, including the number of household members, as indicated by the relative quantity of garbage. An archaeologist can determine with some certainty whether they are male or female, as indicated by the gendered material culture in the family repository. The researcher can often determine the family's level of status or income, as indicated by the quantity and type of disposed of objects, as well as the family members' ages and taste preferences. The archaeologist can then compare these individual households' compositions to the rest of the settlement.

Further, the archaeologist can learn about the variability of consumption and discard behavior and measure the degree to which these change over time. The garbage can indicate if the family was throwing away more or fewer objects from one year to the next—if it was a time of scarcity or plenty in the home. Household trash can reflect change in communities, including growth, movement, and structural differentiation, such as a change in the composition of the household.

Urban residential refuse is a valuable source of data for archaeologists studying both the past and the present. Using only slightly different methods to analyze premodern or modern trash, archaeologists can provide answers to these same sorts of inquiries about the present. What people say they do, and their actual behaviors, often diverge. This applies both to the quantity and type of material culture people consume, use, and discard and to the ways they discard trash. People often underreport taboo or socially unacceptable behaviors in their homes, and evidence for such practices often manifests in the garbage. In the trash, one can find medicine bottles, non-nutritive food, cigarette packages, and other paraphernalia that family members would rather keep secret. For this reason (in addition to sanitation reasons), people often close their trash containers, keeping the contents invisible to the archaeologist or other inquisitive investigator. Maybe that is why residential urban refuse is so fascinating: its very untouchable nature reveals the truth of dirty little secrets.

Increasing Quantities of Household Refuse

As the world's population has grown exponentially in the 20th and 21st centuries, the issue of what to do with excess residential waste has become an important allocation of municipal policy-making energy and money. Not only are there many more people on the planet than before but also as of 2008, the Population Reference Bureau states that at least 50 percent of the world's population resides in urban settings. Most people live crammed into dense housing in bustling cities, importing food and household materials from long distances.

Consumption has increased vastly, and interior spaces and discard patterns reflect this fact. Although people are increasingly conscious of the consequences of consumption patterns, it is rare that when a consumer purchases a new couch or box of cereal, the consumer immediately considers its inevitable end. Rather, especially in the United States, people fill their homes with underutilized and often extraneous objects; sometimes to the point that it is difficult to navigate through living spaces. Some even have a so-called junk drawer to catch the excess stuff that is seldom used. In wealthy nations, consumers have this luxury of choice.

Beyond literal excess objects (something irreparable or food that has spoiled), "value" and "trash" are subjective constructs. Wealthier people have the privilege to decide when and how to dispose of objects—not just when they break and cannot be repaired but also when tired of them. In contrast, remote and less-wealthy people must repair their possessions.

The urban Western accumulation frenzy leads to rapid disposal patterns. At some point, householders must throw something away. As a consequence, waste management in cities is a rapidly growing problem, including both industrial and residential waste. In 2008, the Environmental Protection Agency (EPA) found that approximately 65 percent of U.S. trash derived from homes.

Aside from the secret objects in trash, the quotidian stuff that modern urban households throw away varies from context to context, such as economic status and the cultural values of the region

and individual family. Generally, however, there are two universal types of household refuse: unwanted objects (including organic nonfood waste) and food. While quantification of household waste has continually been a difficult methodological problem relying on data derived from continual transfer station monitoring, food scraps made up an estimated 12.7 percent of the 250 million tons of what U.S. households put into landfills in 2008, and organic material such as yard trimmings made up the majority of the contents of urban and rural landfills. Wealthy urbanites throw away a substantial amount of food forgotten in the refrigerator and excess food that spoiled, while many people around the world starve.

The EPA suggests composting as a viable solution for recycling organic household refuse because it makes food for plants. Many charitable organizations have begun projects to rescue nontoxic, residential food waste and gather it to feed hungry people.

Quantities of objects in trash are difficult to measure, but common nonorganic objects households throw away include paper and paperboard, scrap metal, dense plastics, textiles, and glass, according to the international Organisation for Economic Co-operation and Development's (OECD) decades-long research on household waste behavior.

What People Do With Household Trash

On the residential level of analysis, there are two overarching types of solutions to what to do with inorganic household material waste. These do not include informal solutions such as backyard burning or illegal dumping, though these are often popular options in nonindustrialized and rural settings in industrialized nations. Factors that influence what households do with their trash include everything from their age (young families consume and discard more than elderly people), education levels, and even the weather.

First, recycling, both formal and informal, is the option more amenable to the environment. Formal recycling is more available in Western urban settings and is also becoming increasingly so in both non-Western nations and rural areas of Western nations. Formal recycling is the transporting of specific types of refuse to a designated recycling center, where it is processed into another form and reused. When the Harris Organization polled 2,372 U.S. adults online in 2007, it found that while approximately 77 percent of respondents recycled something at home (primarily aluminum cans and waste paper), most of those people were relatively affluent and lived in urban settings along the coasts. Social capital appears to strongly influences the degree to which people around the world formally recycle their household refuse.

The most common rationale people gave for not recycling in the home is that it is unavailable in the area or generally inconvenient. Further, several types of common household objects usually cannot be recycled, especially napkins, tissues, most diapers, aluminum foil, technological objects such as computer parts and many types of batteries, and many types of plastics. Most people in the United States who do not recycle live in the Midwest and very remote parts of the country where the service is unavailable, according to the Harris Organization poll.

Informal recycling of household refuse is ubiquitous but scholars often overlook it as a mechanism by which objects circulate and stay out of the landfill. Throughout time, families have repurposed and redistributed household objects. The first aspect of informal recycling—repurposing—is gaining popularity in the early 21st century, likely because of the poor economic situation. Depending on a family's wealth and other variables, such as leisure time and do-it-yourself inclinations, they might not discard a broken table, for example, but restore it to its original status or a new look altogether. Additionally, if shipping of replacement parts of household objects is very expensive, families tend to innovatively repair the objects instead of discarding them.

A second example of household informal recycling is redistribution. Redistribution of household material culture includes gifting objects (a traditional topic of anthropological inquiry), selling them at a yard sale, or donating them to charity. This equates to returning unwanted material culture intact or in parts to the larger system of potentially functional object circulation. Parents might gift a tired lamp to a child who has recently left for college. In the United States, one can often see a run-down sofa in front of a home with a "free" sign on top—it is not meant to be hauled to the dump but to be reused in another home.

Composting is seen as a viable solution for recycling organic household refuse such as yard trimmings and discarded food because it creates nutrients for plants. In 2008, organic materials made up the majority of the contents of urban and rural landfills.

The other overarching option of residential urban refuse disposal is the manner in which it decays, usually later rather than sooner, into the planet's soil or water. In this process, it is seldom intercepted for human reuse. Especially in rural settings, families are left to solve their residential waste-disposal issues themselves. Their options can include illegal or informal dumping or they might haul their waste to a designated, centralized facility. Cities and towns might provide a service of taking the refuse away, but they might not carry larger objects, such as furniture.

Municipalities are usually responsible for solving the problem of how to decontaminate excess household waste. Not only are piles of household refuse aesthetically displeasing with regard to smell and sight, but also, with refuse comes disease. Vectors, such as insects and mammals, are attracted to rotting garbage—especially food waste—and they spread bacteria and viruses to people. Dense populations in cities with less-developed infrastructure are particularly subject to such infestations.

In urban settings around the world, economically disadvantaged people scavenge through individual residences' trash containers as well as dumpsters next to restaurants and other businesses, seeking reusable or otherwise recyclable objects, which, in some cases, they can sell. These individuals are also seeking food; comparatively wealthy families often dispose of food that hungry people consider edible.

This sort of informal recycling of residential refuse is a means of survival for cities' poorest residents, some of whom actually reside in and around trash dump sites. The workers generate income by repurposing and selling disposed of residential waste. Cities with less-developed infrastructures—such as Mumbai, India, and Tijuana, Mexico—have privatized their trash collection services and now house large-scale "trash economies," wherein the most impoverished citizens are the primary employees of the municipal dump and recycling centers.

Regardless of the city, less-wealthy people tend to live closer to waste disposal areas, creating and reinforcing a spatial power relation with regard to residential urban waste disposal sites. Scholars of public space have long addressed this inequity, wherein the residents living closer to the trash tend to have poorer health.

Rendering waste sustainable, minimal, and reusable are popular concepts, particularly in Western Europe and Canada, as well as in the United States. A Website called Freecycle pioneered the organized redistribution of local household goods in 2003 with an expressed intent of keeping families' refuse out of municipal landfills, rendering it "another man's treasure." Even more creative options include repurposing post-consumer waste into "refabricated" houses; the Internet provides many examples of such projects. Several movements throughout the world are also reusing household material culture and refashioning it into art, making statements about the subjectivity of value and power as embedded in residential rubbish.

Household Waste Solutions

Beyond the logistical issues of how to safely and responsibly manage discarded household material,

the aesthetics of piles of urban refuse reflect a tension between many city dwellers' stated beliefs and their measurable behaviors. While on one hand, many Western urbanites tend to subscribe to a "green" or environmentalist philosophy that people should consume and waste less in homes and thereby conserve natural resources, general behaviors trend toward rapid acquisition and discard. Careful selection and maintenance of residential goods would result in far less detrimental impact on the environment. Further, people perceive household garbage as ugly and nonhygienic; nonetheless, families living in cities around the world are acting in a manner that is disharmonious with the media-enforced rhetoric of "reduce, reuse, and recycle" and the adage "waste not, want not."

Some cities are offering incentives for families to reduce their waste, weighing garbage on a regular basis and providing tax breaks for lesser amounts. Alternately, many cities, especially in Europe, are charging families by weight for trash pickup service. This has had mixed success. Some families have reduced their waste but not their consumption.

As the world's population increases, especially in urban areas, residential trash will increase. Recycling is becoming part of everyday vernacular, at least in more privileged settings; however, less-industrialized cities have informal recycling systems that contribute to the maintenance of landfills. Further, families have always participated in a reuse cycle that extends the life of many types of objects. Nonetheless, a substantial amount of the types of trash households discard cannot be repaired, reused, or formally recycled, and end up taking space in the landfill, waiting hundreds or thousands of years to decompose.

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See Also: Archaeology of Garbage; Recycling; Recycling Behaviors; Zero Waste.

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Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) has significantly shaped waste management in the United States since it was signed into law in 1976. The act expanded upon the resource recovery efforts launched with the Resource Recovery Act (RRA) in 1970. The goal of the bill was to find the best way to dispose of any kind of discarded material. However, shifting priorities and a lack of enforcement spelled the end of federally funded resource recovery. By the end of the 1970s, hazardous waste, rather than municipal solid waste (MSW), became the focal point of environmental concern.

Goals

Gerald Ford signed the RCRA shortly before losing the 1976 U.S. presidential election to Jimmy Carter. Originally, it looked as though Carter was going to ask for the act's full funding in his budget. His Presidential Urban Policy Program (PUPP) grants provided a funding mechanism for the RCRA budget. The new act still provided funding for new technology, but it also focused on providing administrative help to cities considering the new processes. The goal was to assist cities with all of the legal and financial issues involved in establishing a resource recovery plant. A total of 63 cities received PUPP grants to build plants. Unlike the RRA, this money was only given to cities using an already-tested technology, rather than to those demonstrating a new type of method. Carter proposed to give over $2 billion

to fund research for resource recovery techniques that could produce synfuel, which could be used for transportation (oil was the most pressing resource shortage at the time). After he lost the 1980 presidential election, however, those plans were abandoned.

Shift to Hazardous Waste

The Environmental Protection Agency (EPA) had always felt that hazardous waste disposal was a more appropriate federal issue than the highly localized and ubiquitous issue of solid waste management. When the Love Canal disaster began to receive a great deal of media attention in late summer of 1978, the U.S. Congress began to shift its concern to hazardous wastes, passing the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund, in 1980. The idea of resource recovery had been very popular with Congress, but by the end of the decade, politicians wondered why more cities were not building resource recovery plants. It had funded the demonstration of technologies and it had helped cities navigate through the legal and financial obstacles, but the only places that tried resource recovery were the ones getting paid to do so. Congress had expected the federal funding to give cities a boost into resource recovery but not to be a continuous source of financing. Furthermore, federal support for MSW management did not mesh with the funding priorities of the Reagan administration, which cut the Office of Solid Waste Management down to one employee in 1981. By the 1982 Senate hearings to reauthorize RCRA, nearly all of the discussion focused on hazardous waste management.

Even though RCRA stopped funding resource recovery efforts and shifted its focus to hazardous wastes, the act permanently changed solid waste management in the United States. It finally banned all open dumps, and it required all new disposal sites to be approved and permitted, as well as to meet state and federal regulations. Subtitle D landfills, named after Subtitle D of the RCRA, were the new standard. Landfills had to be located in areas where they would not likely affect any nearby sources of water. Additionally, they had to be lined with layers of clay and plastic. In some cases, it took over a decade for cities and states to develop the new required solid waste management plans and implement new landfill laws. Even though the new landfills were far safer than the old open dumps, their expense made them larger and more centralized. Consequently, they met with increasing resistance from people who did not want to live near other people's trash. A common solution to the problem became the exportation of MSW. By the 21st century, all states were importing or exporting waste. Some worked with a neighboring state toward a regional solution, but others sent their waste to open areas across the country. This phenomenon is at least partially a result of RCRA regulations.

Ultimately, the RCRA had little to do with conservation or resource recovery. It originated with the same tone and goals as its predecessor, the RRA, demonstrating a faith in high-tech solid waste management solutions that could help conserve U.S. material resources. But politics and new environmental concerns, as well as persistent resource recovery failures, shifted the focus from solid waste to the more threatening hazardous waste. RCRA's Subtitle D landfill helped create the nation's waste disposal patterns and has made a significant impact on the country's MSW management.

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See Also: Landfills, Modern; Love Canal; NIMBY (Not in My Backyard); Resource Recovery Act.

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Resource Recovery Act

The Resource Recovery Act of 1970 was an amendment to the 1965 Solid Waste Disposal Act, the first federal piece of legislation to deal with municipal solid waste (MSW) management. The new act, which provided $463 million to waste utilization efforts, reflected changing national priorities. Whereas the Solid Waste Disposal Act (SWDA) emerged during a period of unprecedented consumption, the Resource Recovery Act (RRA) was conceived of during a new period of environmental concern, characterized by intense worries regarding resource shortages. The act inspired hundreds of cities, universities, companies, and engineers, hoping to receive funding, to search for highly technological solutions for waste management. A handful of new techniques were chosen for use in demonstration plants, which received extensive financial and administrative support from the Environmental Protection Agency (EPA). Despite the support, all of the demonstration plants and most of the other less-funded resource recovery efforts ultimately failed.

History

Maine senator Edmund Muskie introduced both the SWDA and the RRA. Muskie's enthusiasm for solid waste legislation was not shared by U.S. President Richard Nixon. Although the president's administration was involved in many aspects of the environment, he never showed much interest in federal involvement in solid waste management. He had requested much less money for the issue in his own budget. Consequently, although the House of Representatives and the Senate unanimously passed the Resource Recovery Act, most members of Congress expected the president to pocket veto the bill in October 1970, letting it become law without his signature. The president surprised everyone, however, when on the night before the RRA would be enacted with or without his support, he signed the bill into law. Nixon's support for funding resource recovery endeavors still continued to be spotty. In 1972 and 1973, both the president and the EPA continued to submit budgets requesting far less money for solid waste management than the RRA allotted, frustrating many members of Congress who continued to support resource recovery throughout the decade.

The notion of recovering the resources lost in garbage was extremely popular with Americans in the early 1970s. In the 1960s, after two decades of unprecedented consumption, Americans had begun to worry if there was enough room for all of their waste. The proliferation of litter and ever-growing heaps of MSW had caused the federal government to mandate, through the SWDA, that states get involved in what had traditionally been a very local issue. By the late 1960s, however, a vocal group of scientists began warning that a pending population boom would likely create a dire shortage of resources. The RRA created the National Commission on Materials Policy to develop strategies for calculating resource management, and the numerous resource recovery plans the act funded provided the technology meant to ensure maximized use of valuable resources. The 1973 oil crisis shored up support for resource recovery with many politicians and their constituents, who believed that using waste as a source of energy was just good sense.

Section 208 of the act provided funding for different recovery methods. The two most common types of resource recovery funded under the RRA were refuse-derived fuel (RDF) and pyrolysis. In RDF systems, waste was burned in the same facility as another energy source, usually coal. MSW used as fuel could supply 10–20 percent of a city's energy needs. For a brief time, as concern over sulfur dioxide emissions from coal became more prevalent, burning trash was even seen as environmentally helpful. Pyrolysis could be equated to cooking waste. Instead of burning, pyrolysis systems heated waste in an oxygen-deprived chamber until it changed form. Waste undergoing pyrolysis was typically converted to varying amounts of oil, gas, and carbon (or char). These methods, along with most other types of resource recovery, usually utilized recycling techniques, removing metals and sometimes paper before the materials without any other market value were processed. The systems were highly complicated and consisted of many parts. Their complexity doomed most of the plants to failure, as cities could not afford the time or expense involved in repairing them.

The Resource Recovery Act and the inventions it supported characterized a special time in the history of solid waste management. It represented the apex of federal support for solid waste issues, and it stirred the greatest period of innovation for waste disposal in U.S. history. Unlike earlier incinerators or later waste-to-energy plants, both of which were based largely on European technologies, resource recovery was an American effort to reconcile the country's consumerism and faith in technology with the harbingers of environmental scarcity. The act was replaced in 1976 with the Resource Conservation and Recovery Act, but the new act's focus on hazardous wastes and the nation's exclusive preoccupation with oil shortages meant the end of the push to obtain the most possible value from America's waste.

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See Also: Landfills, Modern; Population Growth; Resource Conservation and Recovery Act; Solid Waste Disposal Act.

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Restaurants

From a five-star restaurant to a hot dog vendor on a busy street corner, the commercial food industry caters to all types of customers. This industry includes restaurants, fast food enterprises, large-scale grocers, cafeterias, as well as the "Mom and Pop" corner store. Regarding the former, the U.S. Economic Census has defined restaurants as subsectors of the commercial food industry that provide prepared meals, snacks, and beverages to customers who order select items for either immediate on-premise or off-premise consumption. In 2007, the same government agency reported that there were approximately 566,020 restaurants in the United States. Although the restaurant industry provides consumers with an abundance of food options, this convenience comes with a growing cost—food waste. For example, there has been a surge in the amount of nonrecyclable forms of garbage that are filling landfills. It has been reported that up to 50 percent of garbage consists of organic matter. With that in mind, different types of restaurant food waste must be identified to increase restaurants' abilities to reduce, reuse, and recycle organic matter.

Types of Food Waste

According to the Environmental Protection Agency (EPA), Americans discard approximately 25 percent of all prepared foods, which results in roughly 96 billion pounds of food waste annually. Green Seal has also reported that restaurants within the United States produce approximately 100,000 pounds of garbage per location on an annual basis. The EPA has identified two main types of food waste: pre-consumer and post-consumer. Of the two, pre-consumer food waste tends to produce the most waste, with recent reports from LeanPath stating that 4–10 percent of all food in restaurants becomes waste prior to reaching the intended consumer. Much of this waste is the result of overproduction, expiration, spoiling, and contamination. On the other hand, post-consumer waste consists primarily of food scraps that have gone uneaten. Overall, both pre- and post-consumer wastes present an ever-growing problem pertaining to the issue of restaurant food waste.

Viable Solutions

In order to combat both pre- and post-consumer waste, it is important to remember that a large majority of these types of waste consist of organic matter and thus can be recycled. Although recycling remains a viable form of reducing restaurant food waste, in reality, it is the last and final option concerning the

alternatives to producing waste. Unfortunately, the general public tends to focus on recycling, rather than paying attention to the other two "Rs": reduction and reuse. While recycling plays a critical role in the reduction of trash that amasses in landfills, it is important for individuals to rethink their consumption of recyclable products in the first place.

Recycle Food Waste

The notion of recycling is a familiar concept to most Americans, although the concept of food recycling is not as widely recognized. The process of food recycling is commonly referred to as composting and involves a system in which organic materials (such as food scraps, yard trimmings, and manures) are broken down into carbon dioxide, water, inorganic compounds, and biomass. These elements decompose in a process in which they are specifically engineered to reduce the excretion of methane gas as well as other biogases associated with traditional landfill breakdown of food waste. The option of composting enables foods that traditionally cannot be donated (such as bakery items, or spoiled fruits and vegetables) to be recycled into soil amendment, thus greatly reducing the amount of nonrecyclable food waste. Typical restaurant food items that can be composted are coffee grounds, eggshells, fruits, and vegetables. On the other hand, food items not recommended for composting are dairy products (such as milk), fats (such as grease, lard, and oils), and types of meat because of their tendency to produce unpleasant odors, which in turn attract pests and can offset the composting process.

Although there are many different types of composting, the simplest form for individuals involved in the commercial food industry is off-site composting. Off-site facilities enable individuals to engage in composting without applying for a permit or having to build an on-site composting facility. In order to participate, members of the larger commercial food industry can become involved with existing food collection programs or contact their local recycling organization to see if there are future plans for local composting. Once a restaurant has located a specific facility, it can either arrange to have its food scraps picked up by the company or haul the food waste to the site.

Another development within the food recycling community is the process of converting "fat to fuel." According to the EPA, fats, oils, and greases (FOGs) are being converted into biodiesel, which is an alternative to traditional fossil fuels. As a result, oils and other fats that would have been disposed of using conventional methods (such as landfills or poured down drains) are being recycled, while at the same time reducing society's dependence on nonrenewable forms of energy. Oils such as soybean, canola, and palm, which are frequently used in restaurants, serve as the best options to produce biodiesel.

Reuse Food Waste

Another key component for reducing food waste is the process of reusing excess food. One way in which restaurants can effectively reuse food items is by implementing a donation system. Donations serve as a viable alternative for restaurants looking to reduce their total food waste, while at the same time benefiting local communities. Both nonperishable and unspoiled food items (such as seasonal items, promotional goods, discontinued products, or production overruns) can be donated to local food banks, soup kitchens, and shelters. The process of donating perishable goods is protected under the law. According to the Bill Emerson Good Samaritan Act of 1996, companies and organizations are protected from both criminal and civil liability so long as they abide with certain rules and regulations. This specific legislation formulates a liability standard for individuals donating food items, identifying specific cases of "gross negligence" for the misuse of food donation.

Not only are individuals protected under the law regarding food donation, but according to U.S. legislation, they may also benefit from a tax refund. Section 170 of the Internal Revenue Code enables restaurants and other organizations to earn an increased tax deduction by donating surplus, including food items. According to this legislation, food that is donated must be properly kept and given to a preapproved agency in order to qualify for the tax benefit. In regard to the tax deduction itself, according to Food Donation Connection, the code states that individuals will receive approximately the equivalent of one-half of the food item's appreciated worth, with the total deduction not to

exceed more than twice the original cost. Furthermore, restaurants and other members of the commercial food industry can use their discarded food scraps in an effort to help humans and animals.

The process of utilizing food waste for animals is not a new concept. For years, hog farmers have relied on table scraps to feed their livestock. According to the EPA, if food scraps are free of meat, federal laws and regulations do not apply to the donation of the food items to local farmers. When scraps contain meat or other animal products, the food waste must meet standards put forth by the Federal Swine Health Protection Act. Overall, the option of reusing food waste for the consumption of hogs and other animals produces both economic and environmental benefits for all participating parties.

Reduce Food Waste

The significance of reducing food waste in the service sector has become more important over time. While there remain different levels of sophistication concerning the steps individual restaurants can implement to control waste (such as menu modification, cooking to order, or portion control), technology exists to help simplify the task of tracking food waste. LeanPath, one of the nation's leading technology companies, provides individuals within the larger commercial food industry with the most advanced tools to conduct waste audits. Waste audits enable restaurants to actually see the amount of food waste that amasses during the course of the day. LeanPath focuses on waste control through an industrial software system, which tracks all pre-consumer waste (such as spoilage, expiration, and overproduction).

Besides conducting waste audits, there are other, simpler steps individuals within the commercial food industry can implement to begin reducing their production of food waste. First and foremost, individuals can rethink the way they consume food products. Whether it is the way restaurants handle and store produce or their method of recycling, there are a few key steps to reducing unnecessary organic waste. Regarding the latter, restaurants can ensure that they are utilizing proper storage measures to reduce the amount of food discarded due to spoilage. Furthermore, rather than having foods prepared prior to customers ordering, it is important that restaurants cook food to order, thus avoiding the overproduction of certain items. Another simple measure that restaurants can implement is to monitor the portions of their entrées and other items on their menus. By carefully observing the amount of uneaten food returned by patrons, restaurants can reduce the amount of organic matter that is thrown away daily.

Future of Food Waste in Restaurants

Besides implementing food waste reduction strategies that revolve around the theme of reduce, reuse, and recycle, it is vital that individuals become conscious of the amount of food waste produced daily throughout the United States. To ensure the existence of a thriving planet for future generations, society must reassess its consumption patterns. Whether this awareness is developed through the implementation of public information campaigns or other consciousness-raising techniques, it is important that Americans recognize 21st-century practices concerning food waste. In order to achieve such a desired effect, various companies throughout the United States have identified a set of environmentally friendly design standards. These standards ensure that not only will restaurants be reducing their total amount of food waste but will also enable customers to make informed choices concerning the environmental footprint of their dining experience.

For example, the Green Restaurant Association (GRA) provides restaurants with an official certification once they have met all seven of GRA's environmental standards, including water efficiency, waste reduction and recycling, sustainable furnishings and building materials, sustainable food, sustainabile energy, limited or no disposables, and chemical pollution reduction. This certification enables restaurants to become members of the larger GRA network, which serves as a platform to link environmentally conscious dining patrons with like-minded restaurants.

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See Also: Composting; Fast Food Packaging; Food Consumption; Food Waste Behavior; Post-Consumer Waste; Pre-Consumer Waste.

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Rhode Island

The smallest of the United States with just 1,045 square miles, Rhode Island's 1,052,567 residents face unique and complex waste management challenges. In Rhode Island, per capita consumption is lower than the national average, the diversion rate for municipal waste lags many states, and commercial waste management presents complex problems. Notable in its state-level provision of waste management facilities, the Rhode Island government continues to struggle with questions of in-state disposal capacity as it seeks to rid itself of corrupting influences within the state agency responsible for waste management. At the same time, Rhode Island has been at the vanguard of state-level recycling programming since the 1980s, actively and creatively striving to balance priorities of materials flows, sustainability, and system financing within the state's small, dense footprint.

Consumption

In 2005, Rhode Island generated 594,919 tons of municipal and 771,709 tons of commercial solid waste. Combined, this translates to a per capita generation rate of 1.29 tons per year, lower than the national average of 1.38 tons per year. This pattern may reflect a lower-than-average consumption rate overall among Rhode Island residents, who rank 49th out of 50 states in overall energy consumption. A number of factors, including a relatively mild climate, an overall unemployment rate that has ranked above the national average for many years, shorter-than-average commute distances, and a New England tradition of frugality, contribute to the state's modest consumption by U.S. standards. Known as the "Ocean State," much of Rhode Island's economic activity is based around its coastal resources, including tourism, outdoor recreation, and fishing as major activities. These features are reflected in details of its waste management. In 2005, the state piloted a successful program to recycle the plastic used to wrap boats in winter drydock storage. Fish and seaweed waste generated by commercial and municipal functions is a major source of organic inputs for composting operations.

Solid Waste Management Overview

Rhode Island is notable in that the state not only regulates waste management but also provides recycling and disposal services to most generators. In contrast to many other states, which leave waste management to localities, in Rhode Island, these functions are provided by Rhode Island Resource Recovery Corporation (RIRRC or "the corporation"), a quasi-state agency governed by a seven-member board of commissioners. The corporation owns and operates a complex of facilities to which the vast majority of Rhode Island's waste is routed via private or municipal haulers, including the Central Landfill, a materials recovery facility, a household hazardous waste drop-off station, a commercial compost site, a leachate treatment facility, and

several landfill gas power generation plants, all located on a roughly 1,000-acre parcel of land in Johnston, in the north-central section of the state. The Rhode Island Department of Environmental Management, a separate agency headquartered in Providence, is responsible for all aspects of solid and hazardous waste regulation, including facility inspection and permitting through its Office of Waste Management. It is also technically responsible for enforcement of municipal and commercial recycling regulations, but in practice has lacked staff to carry out these functions for over a decade.

Under a 1986 amendment to the state's Solid Waste Act, each Rhode Island municipality is responsible for collecting waste from residences of three units or fewer, as well as public institutions such as schools. As of 2010, 38 of the 39 municipalities in Rhode Island utilize the Central Landfill. One community, Tiverton, located at the tip of the easternmost peninsula in the state, utilizes its own municipal landfill solely for its residential waste generation. Commercial waste, which includes waste generated from multi-unit apartment buildings, is collected by privately contracted carters, many of whom use the Central Landfill for disposal.

Waste History

As in many other states, sanitation in Rhode Island became an issue as its cities gained population with waves of immigration and industrialization in the 18th and 19th centuries. Providence and Newport were important ports of trade in the colonial era, with Providence becoming a major hub of textile and jewelry production from the mid-19th century on. Early practices of open-pit dumping and hog swilling gave way under the sanitary reforms of the late 19th and early 20th centuries to more rationalized methods of collection and disposal. The status of Newport as a summer haven for rich New Yorkers drew it earlier into the march of sanitation progress than other small, nonindustrial cities. In early 1895, New York City Department of Street Cleaning commissioner George Waring described a technological innovation for ash collection consisting of a metal cylinder placed within a canvas bag. Waring credited Newport engineer Robert Frame with its invention and testing. In that same year, in response to complaints in the summer colony over garbage handling, Newport revamped its collection system with the introduction of sanitary carts and scows.

Municipal waste throughout the state was dumped at open landfills or burned during the first half of the 20th century. Following the federal Solid Waste Disposal Act of 1965, the first statewide laws governing solid waste management were passed in 1968, including regulations on the construction and management of disposal facilities and the banning of open burning. The disposal of wastes remained a municipal function until 1974, when the state General Assembly created the Rhode Island Solid Waste Corporation. The corporation took over operation of the Johnston landfill that year, purchasing the property in 1981. Throughout the 1970s and 1980s, small, municipal landfills across the state continued to close down, with cities and towns increasingly utilizing the Central Landfill.

Rhode Island passed the nation's first statewide recycling law in 1986, mandating source separation of paper, metal, plastic, and glass from municipal collections. A mandatory statewide program began in 1987 and was fully implemented by 1995. In 1996, the corporation was renamed to reflect its resource recovery mission. Expansion of the recycling requirements to include additional materials was implemented that year under the Maximum Recycling Program, with a target diversion of 40 percent. In 2000, Rhode Island became the first state to implement a permanent, statewide collection program for electronic waste and was the first to establish a statewide in-store recycling program for plastic bags in 2005.

Diversion Accomplishments

The prevention, reuse, recycling/composting, combustion, and landfilling hierarchy is codified in Rhode Island law. A 1990 statewide waste composition analysis estimated that 61 percent of Rhode Island municipal waste consisted of materials designated for recycling under the Maximum Recycling Program. Nonetheless, the state continues in 2010 to struggle to attain the diversion goals it set in 1995. As of the state's 2007 Solid Waste Management Update, Rhode Island's diversion rate for residential and institutional waste was 21.5 percent, with only 14.5 percent of this diversion coming from curbside recycling of paper, metal, glass, and

plastic (the balance was from leaf and yard waste composting). The state provides incentives for municipal recycling through several mechanisms. It sets a cap for each municipality, pegged at 0.487 tons per resident per year, under which disposal at the Central Landfill is charged a reduced-tipping fee, with tonnages exceeding the cap in any year tipped at a substantially higher rate. Municipalities entering into contracts with the corporation are eligible to receive annual bonuses based on the market value of recyclables generated and may apply for grants for program improvement. In addition, eight municipalities have unit-based pricing systems for refuse generation, charging residents a set fee per bag of refuse to encourage recycling and composting. These municipalities have overall diversion rates exceeding 30 percent.

In contrast to the municipal sector, commercial waste recycling is not widely practiced, and commercial recycling regulations, technically codified in the General Law, are rarely enforced. Data is lacking for diversion in the commercial sector, which includes waste generated by the 16 percent of households occupying multi-unit housing, but the corporation's estimates put it at a low rate, roughly 3 percent. As of 2010, even under the higher tip fee assessed to commercial generators disposing of waste at the Central Landfill, market incentives for commercial waste diversion are insufficient to stem the flow of most materials to disposal.

Landfill Capacity and Self-Sufficiency: Clashing Priorities

By the corporation's own admission, the state's reliance on disposal fees, in particular those from commercial disposal, to fund solid waste management overall place it in an awkward position—relying on a short-term, unsustainable practice of landfilling to promote sustainability through diversion in the longer term. Commercial usage of the landfill is also one of the drivers of its capacity exhaustion, with the expected life of the landfill as configured set to end if substantial increases in municipal and commercial diversion are not attained.

Because of this arrangement, Rhode Island, in contrast to states in other regions where landfill space is plentiful, has a direct incentive to pursue diversion over and above the environmental and job-creation benefits of reuse, recycling, and composting. In the event of the landfill's closure, out-of-state export is a possibility, but this would remove a major funding source for statewide waste management and would rob the state of self-sufficiency, exposing it to the risks of increasing out-of-state tip fees. Alternatives, including siting a new landfill or construction of a combustion/gasification facility, have met and will likely continue to meet with stiff community opposition in this populous, small state.

The trade-offs among tip fee revenue, landfill capacity consumption, and diversion have been negotiated for some time. In 1987, the state enacted flow-control legislation, requiring that all waste collected in Rhode Island be managed at state facilities. In 1991, in the case of *DeVito Trucking v. the State of Rhode Island*, the U.S. District Court ruled that infringement of interstate commerce was not justified on health, safety, or environmental grounds, and the legislation was overturned. Between 1994 and 1998, the closure of several large landfills in southeastern Massachusetts and an increase in regional tip fees resulted in a dramatic upswing in commercial solid waste disposal at the Central Landfill, reaching crisis levels in 1998. The state sued several principal waste haulers in the region, reaching a consent order in which they agreed to cease all deliveries of out-of-state waste.

Since that time, usage of the landfill has stabilized, but the facility was near full capacity as of 2010. Efforts to expand its footprint have been complicated by ethical violations involving land purchases made by the corporation between 2000 and 2005. In 2008, the Rhode Island Bureau of Ethics released the results of an investigation of the RIRRC's board and executive director, alleging years of mismanagement between 1998 and 2007. Among the allegations was collusion among RIRRC executives and Johnston elected officials to convey land to the corporation at inflated prices as well as the retention of this land for an unrealizable project to develop a recycling industrial park. In 2008, a new executive director was appointed and the board of supervisors disbanded. A new board was appointed in 2009.

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See Also: Landfills, Modern; Massachusetts; Sanitation Engineering; Solid Waste Disposal Act; Waring, George.

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Richard the Raker

Richard the Raker (d. 1326) was one of the earliest recorded garbage collectors in England. The term *raker* applied to employees of the city whose job it was to collect all manner of refuse from the London streets. In addition to *raker*, other terms for the predecessors of modern garbage collectors were *gong farmers* and *night soil men*. By most accounts, the duties of these three groups often overlapped. Gong farmers and night soil men were essentially medieval septic cleaners.

Latrine Cleaning

The earliest attempts at sewage control were latrines and cesspools. Depending on the financial means of a particular homeowner, a cesspool pit might be dug in the basement and a privy or garderobe constructed directly above. Outdoor latrines placed over a cesspool pit in the yard were also common. When a pit was full, a raker or gong farmer was contracted to remove the contents of the pit. The term *night soil men* arose from the fact that, by city ordinances, cesspools were only to be cleaned during the night. Rakers, gong farmers, and night soil men all had to transport the fruits of their labors outside the city walls. If the waste was disposed of properly, it was taken to either a so-called laystall, which was a designated garbage dump, or sold to farmers to be used as fertilizer. More often than not, the easier method of disposing of waste was to either dump it in the Thames River or anywhere along the roads surrounding London. By the mid-14th century, each ward in London had at least one assigned raker. Rakers were supervised by beadles and underbeadles who served the role of city inspectors. The unsavory nature of the job actually resulted in salaries that were often better than other laborers, such as masons. This was especially true beginning in 1348 as the Black Death began to ravage the London population.

It should be remembered that the type of garbage removed from medieval London was markedly different from that found in any modern city in a developed country. A good deal of waste at the time derived from livestock kept in the city. In addition, lack of a central sewer system meant that gutters were often used as an open sewer. The gutter system was an ineffective method of removing human waste, particularly during times of drought. In 1349, King Edward III wrote to the mayor of London about the filth in the city, complaining: "the streets and lanes through which people had to pass were foul with human faeces and the air of the city poisoned to the great danger of men passing, especially in this time of infectious disease." The primary reason Richard the Raker is known to history is his unfortunate death. According to the London Coroners' Roll for 1326, Richard seated himself in a privy when the rotted boards gave way, depositing him in the cesspool below where he drowned in a dreadful manner.

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See Also: Bubonic Plague; History of Consumption and Waste, Medieval World; Sewage; Street Scavenging and Trash Picking.

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Rio de Janeiro, Brazil

The city of Rio de Janeiro is the capital of the state of Rio de Janeiro, the second-largest city in Brazil and the third-largest urban agglomeration in South America. It was the capital of the country for nearly two centuries (1763–1960). It is also the most visited city in the southern hemisphere and is known for its beautiful natural settings and landscapes, carnival celebrations, samba, and beaches. Some of its most famous landmarks include *Christ, the Redeemer*, an impressive statue on the top of Corcovado Mountain, which has been nominated as one of the new seven wonders of the world. Sugarloaf Mountain (Pão de Açucar) and the Maracanã soccer stadium, one of the largest in the world, are also well known.

History

The history of Rio de Janeiro dates back to the discovery of Brazil. The city was first encountered when a Portuguese expedition led by Gaspar de Lemos, the captain of a ship in Pedro Álvares Cabral's fleet—the explorer who discovered the country on April 22, 1500—arrived at Guanabara Bay on January 1, 1502. By that time, the area was already inhabited by indigenous groups of different nations, including the Tupi, Puri, Botocudo, and Maxakalí. About 50 years later, French settlers led by Nicolas de Villegaignon occupied one of the islands of Guanabara Bay, attempting to establish the France Antarctique colony.

The city of Rio de Janeiro was properly founded by the Portuguese Estácio de Sá on March 1, 1565, who named the city São Sebastião do Rio de Janeiro, as a tribute to the Portuguese monarch, Dom Sebastião. Until the 18th century, the city was threatened or invaded many times by pirates and buccaneers, mostly French, such as Jean-François Duclerc and René Duguay-Trouin. In 1763, it became Brazil's capital when the colonial administration for Portuguese America was moved from Salvador to Rio, occupying this status until April 21, 1960, when the capital was moved to Brasília.

In 1808, the Portuguese royal family and most of the Lisbon nobles, fleeing from Napoleon's invasion of Portugal, arrived in Rio de Janeiro, transforming it into the kingdom's capital. It was the only European capital outside Europe. This transformation was one of the main drivers of the population explosion that followed this process and the beginning of a chronic urban problem of insufficient infrastructure and lack of adequate urban planning. As there was no physical space and no infrastructure available at the time, many inhabitants were simply evicted from their homes in order to accommodate the nobles who were arriving from Portugal. There was also a large influx of African slaves to the city. Even after the independence of Brazil in 1822, Rio de Janeiro continued to be the capital of the country.

In this sense, the process that started in the 19th century is one of the main causes of the social disparities that are part of the city's history. By 2010, approximately 20 percent of Rio's population lived in shantytowns, called *favelas*. They can be defined as highly consolidated invasions of public or private land developed by the poor on lands lacking infrastructure and without following any kind of urban planning. They exist in large numbers and are spread across the city.

In the favelas, households are illegal, and housing is not regulated, except for a number of efforts that different governments have attempted in the 21st century, aiming to improve the quality of life of these communities. In Rio de Janeiro, the favelas occupy an area of around 23 square miles in the city, corresponding to approximately 7 percent of its total area. The population living in these areas has been growing since the 1990s.

One of the major problems of Rio de Janeiro is the crime rate, especially homicides, in poor areas controlled by drug dealers and gangs. In 2006, the murder rate was more than 37 per 100,000 people. The urban warfare involves not only the battle against drug dealing but also corruption within the police and the increase of *milícias*, criminal orga-

Approximately 20 percent of Rio de Janeiro's population live in shantytowns, called favelas. *They can be defined as highly consolidated invasions of public or private land developed by the poor into lands lacking infrastructure or urban planning, which worsens the impact of a large urban population on the environment. Despite the common problem of poverty, many favela families have amenities such as a television, car, personal computer, and cell phone. The waste generated in these areas poses a disposal and collection problem.*

nizations that involve policemen, firemen, politicians, and even the military to control some favelas in order to keep them free from drug dealers. In exchange for protection, milícias collect a fee from the local dwellers and small entrepreneurs. The milícias also control the provision of many services, such as alternative transport (as the public transport does not reach many of the favelas), distribution of gas, and (illegal) cable TV.

By 2010, the city of Rio de Janeiro, which is located in the southeast region of Brazil, had a population of about 8 million people living in an area of 734 miles. Its metropolitan area is made up of 17 municipalities (Rio de Janeiro, Belford Roxo, Duque de Caxias, Guapimirim, Itaboraí, Japeri, Magé, Nilópolis, Niterói, Nova Iguaçu, Paracambi, Queimados, São Gonçalo, São João de Meriti, Seropédica, Mesquita, and Tanguá), which have more than 11 million people altogether. It corresponds to 74 percent of the total population of the state of Rio de Janeiro and the city has the second-largest municipal gross domestic product (GDP) in Brazil, accounting for more than 5 percent of total national GDP.

Benefiting from being the capital, the city became an administrative, financial, commercial, and cultural dynamic center. For many years, Rio de Janeiro was the second-largest industrial hub of Brazil, with oil refineries, shipbuilding industries, and steel, metallurgy, petrochemical, gas, chemical, textile, printing, publishing, pharmaceuticals, beverages, cement, and furniture industries. However, a sharp transformation in its economic profile occurred after the 1980s, and the city is becoming a major national hub of services and businesses. The Stock Exchange of Rio de Janeiro (BVRJ), which trades only government securities, was the first stock exchange founded in Brazil in 1845.

Rio de Janeiro became an attractive place for companies to locate when it was the capital of Brazil, as important sectors of society and of the government were present in the city. The city was chosen

as headquarters for state-owned companies, such as Petrobras, Eletrobrás, Caixa Econômica Federal, and Vale (which was privatized in the 1990s). After the transfer of the capital to Brasília in 1960, Rio de Janeiro kept attracting more companies, especially after the discovery of oil in the Campos Basin, which produces most of Brazil's oil. This spurred many oil and gas companies to be based in Rio de Janeiro. The headquarters of the Brazilian Development Bank (BNDES), an important state institution, is also in Rio de Janeiro. The city is also the headquarters of large telecom companies.

The city's industries produce processed foods, chemicals, petroleum products, pharmaceuticals, metal products, ships, textiles, clothing, and furniture. The service sector dominates the economy, however, and includes banking and the second most active stock market in Brazil, the Bolsa da Valores do Brasil. Tourism and entertainment are other key aspects of the city's economic life, and the city is the nation's top tourist attraction for both Brazilians and foreigners.

To attract industry, the state government designated certain areas in the outskirts of the city as "industrial districts" where infrastructure is provided and land sales are made under special conditions. Oil and natural gas from fields off the northern coast of Rio de Janeiro state are major assets used for developing manufacturing activities in Rio's metropolitan area, enabling it to compete with other major cities for new investment in industry.

Consumption and Waste

As one of the biggest cities in Brazil with high concentrations of population and industries within its metropolitan region, Rio de Janeiro has several environmental problems, as do many other large cities in the country and in the developing world. Air and water pollution, sanitation, oil spills, and heavy metal contamination are the most pressing environmental problems.

Inadequate housing and lack of urban infrastructures in fragile areas (like favelas) contribute to worsen the impact of a large urban population on the environment. Even though there are many poor families within these areas, many of them have a car, refrigerator, television, DVD player, personal computer, and a mobile telephone.

The waste generated within these areas poses problems not only in terms of collection (as many of the favelas are controlled by criminal groups, either drug dealers or milicías) but also in terms of disposal. Rio de Janeiro produces 8,343 tons of solid waste per day. Of this waste, 1,951 tons go to controlled landfills administrated by the municipal government in partnership with private agents; 6,124 tons go to sanitary landfills, and 268 tons are recycled. The metropolitan region (17 municipalities) generates 12,812 tons, which are taken to open dumps (called *lixões*) because there are no alternatives for solid waste disposal; 2,868 tons are sent to lixões located in wetlands; 2,848 tons to controlled landfills; 6,805 to sanitary landfills; only 268 to composting facilities; and about 3 tons to incinerators.

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See Also: Developing Countries; Landfills, Modern; São Paulo, Brazil.

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Rittenhouse Mill

Rittenhouse Mill is the first paper mill in the United States, established in 1690 on the north bank of Monoshone Creek near Germantown, outside Philadelphia. The founder, William Rittenhouse, was born in Germany and learned the papermaking skill in Holland. He was one of the first German settlers who came to Germantown. The mill was built by William and his sons Nicholas and

Gerghard, both of whom were papermakers. They had three other partners: Robert Turner, William Penn's land agent; Thomas Tresse, a wealthy merchant and ironmonger; and William Bradford, the first printer in Pennsylvania. William Bradford was also a customer of the paper mill. All of the paper he needed for printing was supplied by the Rittenhouse mill instead of being imported from Europe.

Until 1710, it was the only mill in the United States, supplying paper to printers in Germantown, Pennsylvania, and New York. The Rittenhouse mill was modeled after the European mills at that time. It was destroyed twice—once by flood and once by fire—and was rebuilt bigger and better each time. The mill used waste cotton and linen rags, as well as old paper, as raw materials. They were supplied by neighboring Germantown, which was an emerging textile center.

Fresh water was available from the Monoshone Creek for washing fiber and turning the mill machinery. The Rittenhouse family grew bigger over the next 200 years, spanning eight generations, and added more mills producing paper, textiles, rugs and blankets, and grinding grains. By the mid-19th century, this town became a bustling, self-contained, industrial village containing more than 40 buildings, inhabited by Rittenhouse's extended family and other mill workers.

Papermaking

The paper was made by hand, which remained the case through the end of the next century. The mill used early papermaking techniques: the rags were soaked in freshwater and then pounded into pulp. The pulp was then flattened into sheets and dried into paper. The three major positions in the mill were called vatman, coucher, and layer. The most skilled work was done by the vatman. There were different sizes of rectangular wire screen called the "mold" ranging from 14½-by-¾ to 26½-by-33 inches. The vatman's job was to dip the mold into the liquid pulp and lift out a layer of fibers and hand it to the coucher. The coucher's job was to take the wet paper out of the mold and lay it between felts, building a stack of 144 sheets of wet paper called "post." The post was then pressed to remove excess water and turned to the layman. His job was to peel the paper from the felt, lay the damp paper on top of a fresh dry sheet of felt, cover it with a dry sheet of felt, and repeat the process until all wet felts of the post were replaced by dry sheets of felt. Then the post was placed on the press. This process was repeated three times. After the third time, the paper was hung over the ropes to dry. The vatman was the most skilled position and was paid the most, whereas the layman was the least skilled position and was paid the least.

The paper produced in this manner was still not ready for writing. The paper needed to be treated with sizing and then returned to the post. Finally, each piece of paper was rubbed on either side until the sizing was worked in and the surface of the paper was smooth. The whole process was slow and laborious. In one day, the whole team was able to produce about 1,500 sheets of paper, 22½-by-30½ inches. The distinctive marks produced by placing figures twisted in wires on the surface of the mold were used as "watermarks," which were the identification for the origin of the paper. The Rittenhouse used a few different watermarks. Some of those watermarks had simple designs with initials of the Rittenhouse family members. One of the watermarks had a more-complex design, with the word *Pennsylvania* on it. In 1990, the U.S. papermaking postal card was released by the U.S. Postal Service, celebrating the 300th anniversary of the first U.S. paper mill. It featured the Rittenhouse mill watermark in the lower-left corner of the postal card as a cachet.

Consumption

In the 16th century, paper was used for printing only important books, bibles, and legal documents. All of the paper needed for printing was supplied from England and other European countries until the Rittenhouse mill was founded. Paper consumption grew over time as the printing business flourished. The United States entered into a new era of literature and entertainment through newspapers, magazines, and books at the time of Benjamin Franklin, Andrew Bradford, and other printers and publishers. The rising demand for paper led to the construction of a second mill on Wissahickon Creek in 1710 by Rittenhouse's in-law William DeWees. The Rittenhouse mill used recycled materials for making paper. However, the demand for paper grew fast,

and it became harder to meet the demand for rags until the late 1860s, when wood became the raw materials in making paper.

Conservation

After the U.S. Civil War, the Rittenhouse family started selling its lands, and the city of Philadelphia purchased their land to turn part of it into Fairmount Park. The mill and most of the village structures were destroyed in order to construct Lincoln Drive through the park. However, in 1984, an organization was formed by 30 members and was renamed the Historic Rittenhouse Town, Inc., in 1992. The mission of the organization was to preserve, restore, and historically interpret Rittenhouse Town. The town became a historical landmark as the birthplace of U.S. papermaking in 1992. The five houses in the village of Rittenhouse are Abraham Rittenhouse Home (c. 1720), which serves as the visitor center; Rittenhouse Homestead; Enoch Rittenhouse Home; Jacob Rittenhouse Home; and the Rittenhouse Home. These structures were restored and are maintained by the Historic Rittenhouse Town, Inc. This town receives over 13,000 visitors each year. It offers educational tours on early American history, hands-on papermaking, and German colonial cooking.

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See Also: Biodegradable; Books; History of Consumption and Waste, U.S., Colonial Period; Magazines and Newspapers; Paper and Landfills; Paper Products; Recycling in History.

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Rivers and Harbors Act

The first rivers and harbors bill in the United States was created in 1822 to provide congressional funding for the general upkeep or replacement of lighthouses, buoys, and other tools of navigation that would create hazardous conditions if left unattended. Before 1822, such expenses were funded by individual states. Over time, the growing need for infrastructure to serve both local communities and commercial expansion across state lines created a shift in the rivers and harbors bill. What were originally funds applied to address immediate problems with existing structures, increasingly became funds earmarked for improvements through the creation of new structures. Recognizing this shift is the key to understanding the political turmoil surrounding the evolution of the rivers and harbors bill.

From 1865 to 1882, the Mississippi River flooded four times, cresting over levees that had been damaged during the U.S. Civil War. In 1882, the severity of the flooding led to a rising tide of controversy in Congress over an increase in funding for the annual rivers and harbors bill. Citing pork-barrel legislation concerns, President Chester A. Arthur vetoed the 1882 Rivers and Harbors Bill because he did not think the funding would be distributed fairly among the communities that needed it. Congress managed to override the veto, granting $5.4 million to the Mississippi River Commission under the 1882 Rivers and Harbors Act.

The Mississippi River Commission, established in 1879, was one of the earliest governing agencies

granted jurisdiction over a major domestic waterway, thus superseding the jurisdiction of individual states. The commission's executive body reported directly to the secretary of war and handled concerns regarding navigation, infrastructure, and other matters, in addition to flooding problems.

In 1892, Emory R. Johnson, a noted expert in the field of transportation and commerce, succinctly summarized the history of rivers and harbors bills and the political debate over federal funding. He was probably the first U.S. scholar to document the juxtaposition of the social and commercial concerns affecting the rivers and harbors bills in an academic publication. His essay also demonstrated the need for the United States to learn from the efforts of England and France in these matters.

Rivers and Harbors Act of 1899

From 1870 onward, rivers and harbors bills were created with directly appropriated funding. The Rivers and Harbors Act of 1890 appropriated an unprecedented amount of funds—over $25 million—for works in more than 30 states.

The Rivers and Harbors Appropriation Act of 1899 modified sections 9, 10, and 13 of the Rivers and Harbors Act of 1890 and became the basis for subsequent amendments during the 20th century. As the first act to tackle water pollution and a foundation for the later Clean Water Act, the Rivers and Harbors Appropriation Act of 1899 has remained a recognized piece of legislation into the 21st century. It continues to stand apart from the Clean Water Act in regulating the navigability of interstate waterways and harbors. The Rivers and Harbors Appropriation Act of 1899 prohibits the creation of obstructions and the dumping of waste and refuse into navigable waters without congressional approval. It cites the U.S. Coast Guard as the administrative agency for section 9 and also provides legislative guidelines for the U.S. Army Corps of Engineers to construct, repair, and preserve public works in rivers and harbors.

Aside from the need for flood control along rivers, weighing heavily on the establishment of public works in and across waterways was the growing need to transport domestic and foreign commercial goods. The expanding railroad industry saw itself in direct competition with the shipping industry. Accordingly, the Rivers and Harbors Appropriation Act of 1899 granted the secretary of transportation certain authorities to approve or mitigate the construction of bridges, causeways, and railways in accordance with the navigation of waterways. The end of the 19th century also saw the dawn of the automotive industry, the creation of turnpikes, and an increasing dependency on mining and energy resources.

Endemic to the need for infrastructure is the need to dispose of industrial waste and refuse. One of the incidental, but far-reaching, precedents set forth by the Rivers and Harbors Appropriation Act of 1899 is the paragraph detailing regulations regarding the disposal of refuse from water craft, the shoreline, or industrial buildings along the waterway. Section 13 explicitly describes that no refuse may be deposited into a waterway or along its shores "other than that flowing from streets and sewers and passing therefrom in a liquid state." Readers should note, however, that no attempt was made to provide limits on, or otherwise sanction, the amount—or type—of liquid waste that may be discharged into a given waterway. Section 13 further offers the provision that nonliquid waste may be deposited at the discretion of the secretary of war and chief of engineers when permission is sought in advance. Violations of these and other regulations were enforced by the Department of Justice in collaboration with the secretary of war and the attorney general, and violators were rigorously prosecuted.

The Federal Water Pollution Control Act Amendments of 1972 further modified the Rivers and Harbors Appropriation Act of 1899 by creating legislation for the National Pollutant Discharge Elimination System Permits, which are issued by the Army Corps of Engineers for refuse that is to be discharged into navigable waterways.

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See Also: Clean Water Act; Environmental Protection Agency (EPA); Marine Protection, Research, and Sanctuaries Act; Pollution, Water.

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Rubber

Rubber is a polymer that, when strengthened through the process of vulcanization, becomes a thermoset elastomer characterized by desirable properties, including flexibility, durability, and impact resistance, and which has many industrial uses. Natural rubber is derived from latex, a milky substance produced from several plants but most commonly obtained from the para rubber tree (*Hevea brasiliensis*). Rubber has been known to Western science since the 18th century but commercial exploitation greatly increased in the late 19th century as rubber trees were successfully cultivated in southeast Asia and later Africa. Creating natural rubber involves tapping the trees for latex (containing about 70 percent water), which is then sieved for impurities, blended, coagulated, and dried in smokehouses or in deep-bed dryers.

Michael Faraday described the molecular structure of rubber in 1826, but it was not until the early 20th century that synthetic rubber was created, partly in response to increased demand (and thus higher prices) for natural rubber. Today, over 200 types of synthetic rubber are manufactured, all involving polymerization of one or more monomers, most of the latter being derived from oil. The most common type of synthetic rubber, styrene butadiene rubber (SBR), accounts for about 37 percent of synthetic rubber created in the world. SBR is created from two monomers, styrene and butadiene, which are polymerized in the presence of a catalyst, and the resulting polymer is coagulated, washed, filtered, and dried.

Vehicle Tires

Almost 60 percent of rubber consumed globally is used by the tire manufacturing industry, and the disposal of rubber tires used in automobiles and other vehicles is a serious problem in much of the world. In the United States in 2003, 290 million scrap tires were disposed of, constituting 2 percent of total solid waste. Whole tires are problematic in landfills because of the large amount of empty space contained within a tire, which not only increases the volume of space required but can also trap gases and offers breeding grounds for rodents and (if filled with water) mosquitoes. For this reason, tires are sometimes shredded before being added to landfills. As of 2003, 38 U.S. states banned whole tires from landfills and 11 banned all tires from landfills, while 35 states allowed only shredded tires to be placed in landfills. Aggressive cleanup and scrap tire management programs in many U.S. states have substantially reduced the number of scrap tires in landfills and other stockpiles, from 700–800 million in 1994 to 275 million in 2004.

In many states, tires are classified as either hazardous waste or special waste, in either case requiring a permit to dispose of them. This has led to illegal dumping, which creates many hazards, including ground and water pollution and creation of breeding grounds for pests. Incineration of discarded tires is not practical because when burned, tires break down into hazardous compounds, including oil, heavy metals, and gases: a passenger tire typically produces more than two gallons of oil when burned. This oil may seep into the ground and require environmental cleanup.

Tire fires, although relatively rare, pose significant environmental risk by releasing pollutants such as polycyclic aromatic hydrocarbons, benzene, styrene, phenols, and butadiene into the air. Tire fires can also be quite difficult and expensive to extinguish and may require evacuation of surrounding communities. For instance, a 1983 tire fire in Rhinehart, Virginia, burned for almost nine months, depositing air pollution in three states, polluting water sources with lead and arsenic, and requiring cleanup as a

Superfund site. A 1999 tire fire in Westley, California, required intervention by the Environmental Protection Agency (EPA) and took 30 days to extinguish at a cost of about $3.5 million.

Given the importance of rubber tires to modern transportation, attention has also been given to finding ways to reuse or recycle them. In 2003, the EPA reported that over 80 percent of scrap tires were re-used or recycled, with the most common uses being fuel (44.7 percent), recycling (19.4 percent), ground rubber recycling (7.8 percent), and rubber-modified asphalt. Some tires (about 9 percent) are retreaded and about 3 percent are exported, mainly to be retreaded in other countries.

Sometimes, rubber tires are shredded and the crumbs are used as garden mulch, in artificial turf fields, and to create playground surfaces. This practice has been questioned from a health standpoint, because shredded tires contain many hazardous chemicals and using them in this way means that both children and adults are exposed to potential risks. Among the chemicals often found in tires are benzothiazole, a skin and eye irritant; butylated hydroxyanisole, a carcinogen and neurotoxicant; n-hexadecane, a severe irritant; 4-(t-octyl) phenol, which is corrosive to the mucus membranes; benzene, a carcinogen and reproductive and chemical toxicant; phthalates, an endocrine and reproductive toxicant and suspected developmental toxicant; carbon black, a carcinogen; manganese, a gastrointestinal and liver toxicant; and PAHs (polycyclic aromatic hydrocarbons), which are suspected toxicants of many body systems. Using shredded rubber tires as mulch can also pollute groundwater, plants grown in such mulch may absorb harmful chemicals, and the excessive amount of zinc in the tire mulch can stunt plant growth.

Rubber Manufacturing: Health Risks

The process of manufacturing rubber and rubber products involves hundreds of chemicals, some of them toxic. This is of concern because of the large numbers of individuals employed by the rubber industry: in the United States in 2007, an estimated 147,690 people were employed in the rubber products industry, of whom 103,420 were involved in production. Studies dating back to the 1930s have identified excess cancer deaths among workers in the rubber industry and a British study conducted in the late 1940s found that rubber workers were at increased risk of bladder cancer due to exposure to 1-naphthylamine and 2-napththylamine. Many subsequent studies of workers in the rubber industry have found significantly increased cases of deaths from particular types of cancer, including bladder cancer, lymphatic and hematopoietic cancers, lung cancer, stomach cancer, colon cancer, prostate cancer, liver and biliary cancer, and esophageal cancer.

Studies have also found adverse respiratory effects such as shortness of breath, chest tightness, and reduction in pulmonary function among rubber-products workers. Chronic disabling pulmonary disease and respiratory effects are more common among workers in the curing, processing, finishing, and inspection areas of rubber manufacturing plants. Contact dermatitis has been found among both rubber workers and users of rubber products, although isolating which chemicals are responsible for this effect has proven difficult. In 1991, the incidence rate for skin diseases and disorders, including eczema, contact dermatitis, and rash, was 19 per 10,000 full-time workers in the rubber industries, ninth highest among major Standard Industrial Classification industries. Several studies have investigated risks for spontaneous abortion or other negative pregnancy outcomes among rubber workers but none have been able to establish a clear link.

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See Also: Automobiles; Tires; Toxic Wastes.

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Rubbish Theory

Rubbish theory was introduced in 1979 by British social scientist Michael Thompson. It is a body of thought that addresses how the value of material objects is socially constructed and deconstructed. Ever since, scholars in a variety of academic fields have utilized rubbish theory within their own disciplines. An awareness of rubbish theory is important to the understanding of the sociology of consumption and waste because, while what is and is not considered garbage may seem obvious and natural, the value of objects is based on the perceptions of people. Distinguishing between what is considered valuable versus without value is present in all cultures, and a certain degree of consensus between members of a society as to what is of value is recognized as being an important element for the maintenance of social order.

Tenets

The central tenet of rubbish theory is that objects belong to one of three categories. Two of the categories, called "transients" and "durables," are socially visible. A durable is an object that is, ideally, always increasing in value and has an infinite lifespan; a transient is an object that decreases in value and therefore has a finite lifespan. The classic examples of these categories are the durable 18th-century Queen Anne tall-boy chest and the transient used automobile. What decides whether or not something is a durable or transient is often the perceptions of the powerful members of society, those with a vested interest in owning objects whose value will always increase, while the remainder of society owns objects whose value will eventually decrease to nothing. Between these two categories, however, there exists what Michael Thompson refers to as a "region of flexibility" where actions toward an object can lead to even similar objects being placed in either category. Thompson illustrates this with a comparison of a "secondhand" versus an "antique" vase. Once the value and lifespan of a transient object reach zero, that object enters the third category, that of "rubbish." Rubbish is a covert category because, through unspoken social agreement, it is both valueless and invisible, and it is normally expected to remain so permanently.

The key assertion of rubbish theory is that objects that decline in value and life-span until they enter the rubbish category do not always remain there. Rather, Thompson argues that becoming rubbish can allow what was once a transient to eventually become a durable, a transfer of categories that would otherwise be impossible. This process is illustrated well using an automobile. An automobile is a transient, purchased with the knowledge that its value and lifespan will decrease over time. Eventually, people's perceptions of the automobile will change from "new" to "used" to "worthless," and it will become rubbish. It is possible that after an indeterminate length of time, the automobile will be rediscovered and become "antique," or a "classic." If this happens, the auto enters the category of durable, beginning a new lifespan and increasing in value. This is significant because transients cannot directly transfer into durables.

Implications

Rubbish theory has several important implications for those seeking to better understand the sociology of consumption and waste. There is the need to focus greater attention on waste itself, not just the processes of acquisition and consumption. This is particularly important in both past and contemporary societies stratified by material wealth, since the shift of an object from rubbish to durable bypasses the powerful in societies' control of determining the value of material objects. An interesting concept Thompson introduced was that rubbish theory could also be used when looking at perceptions and relationships between different social groups.

Since its introduction, numerous academic disciplines have utilized rubbish theory in various ways. It is of use for garbologists studying changes in modern society through changes in waste patterns, as well as for archaeologists working with the material remains of past societies. An effort to

develop sociocultural theory from rubbish theory has begun, and economists have also started exploring how rubbish theory could be used to explore consumer-based markets. Michael Fehr has argued that rubbish theory is relevant in considering more than material objects and should also be applied to abstract intellectual and artistic entities. He has used rubbish theory as the basis for his own theorems on the construction and deconstruction of value within Western art.

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See Also: Culture, Values, and Garbage; Definition of Waste; Garbage in Modern Thought; Garbology; Sociology of Waste; Thompson, Michael.

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Ruckelshaus, William

William Ruckelshaus was born in Indianapolis, Indiana, on July 24, 1932. He graduated cum laude from Princeton University and received a law degree from Harvard University. Ruckelshaus came from a family tradition of practicing law and worked at an Indianapolis firm from 1960 to 1968. He then served as assistant attorney general in the Civil Division of the U.S. Department of Justice from 1969 to 1970, a member of the Indiana House of Representatives from 1967 to 1969, and as deputy attorney general of Indiana from 1960 to 1965, where he drafted the Indiana Air Pollution Control Act of 1963.

Environmental Protection Agency

Ruckelshaus was appointed the first director of the Environmental Protection Agency (EPA) by President Richard Nixon in 1970. The mission of the EPA was to treat the environment as a whole, establish and enforce federal environmental regulatory protections, conduct environmental research, provide assistance in combating environmental pollution, and assist in developing new environmental policies. The EPA was created as a strong, independent agency consolidated from several existing environmental programs into an overarching umbrella. It coincided with the first Earth Day and increasing concern worldwide about the environment and human health. Nixon's State of the Union Address outlined 37 environmental goals, including clean water, improved national air quality, and cleaning up contaminated land (or "brownfields") among other proposed initiatives.

While Nixon's administration established the mission, Ruckelshaus set the tone for the agency. He emphasized the need for transparency, communication, enforcement, and a firm, fair hand within the agency organization and with the outside world. Many of his decisions regarded the significant but often unnoticed regulations that make up everyday environmental policy. Others were more controversial and changed the way environmental policy is conducted, such as banning of the general use of the pesticide DDT and the establishment of the Clean Air Act (CAA) of 1970, which required the EPA to establish national air quality standards as well as national standards for significant new pollution sources and for all facilities emitting hazardous substances. It forced states, cities, corporations, and even government to address long-standing air and water pollution problems that impacted human health and the environment. Ruckleshaus's willingness to confront compliance failures on their practices and to find workable solutions has come to define federal–state environmental relations.

Ruckelshaus was appointed as the director of the EPA for 1983–85, following the resignation of the then EPA administrator because of conflicts of

interest. President Ronald Reagan wanted to restore confidence in the agency, which had lost some of its transparency. Ruckelshaus would initiate the "Tacoma Process" for participatory democracy, which was at the time highly controversial to many environmental groups and government officials but is standard practice in the early 21st century for many environmental issues. At the time, Tacoma, Washington, housed the only copper smelter in the nation to use ore with high arsenic content, which accounted for 25 percent of inorganic arsenic emissions nationwide. However, the community itself was polarized over the need for environmental compliance and the need for jobs. Ruckelshaus saw it as being representative of the type of issues that the EPA was going to face in the future. He felt that to effectively manage environmental risk, the people impacted by the issue involved must be part of the decision-making process or vested in a meaningful way. The EPA held public workshops so that stakeholders could deliberate about acceptable risk and to ask the public to contribute to the decision of what pollution control technologies the EPA should require. While critics said that it was the job of the EPA to protect public health and not to require the public to make difficult decisions that gambled with their health and safety, Ruckelshaus believed that it would be arrogant of himself or any other Washington elite to tell citizens what was an acceptable risk.

Later Years

Following his work as the first EPA director, Ruckelshaus became involved with industry. First, he was the senior vice president for law and corporate affairs at Weyerhaeuser Company, one of the largest pulp and paper companies in the world from 1976 to 1983. Later, he was the CEO/chairman of Browning-Ferris Industries, one of the largest North American waste management companies. Browning Ferris Industries was later bought out by Allied Waste in 1999. In addition to being on the Weyerhaeuser board of directors, he serves on the board of numerous companies, such as Coinstar, Nordstrom, Monsanto, and several others.

From 1983 to 1987, Ruckelshaus was the U.S. representative to the United Nations World Commission on Environment and Development (Brundtland Commission). The commission's 1987 report on sustainable development, *Our Common Future*, precipitated the 1992 Earth Summit, which was at the time one of the largest gatherings of world leaders. In the late 1990s, Ruckelshaus became known for his environmental activism against water pollution, most notably the Puget Sound cleanup and salmon recovery for endangered salmon species in the region.

He was President William Clinton's U.S. envoy for the Pacific Salmon Treaty from July 1997 to July 1998, the chairman of the Washington State Salmon Recovery Funding Board in 1999, and later the chairman of the Leadership Council of the Puget Sound Partnership. President George W. Bush appointed him a member of the Commission on Ocean Policy, which in 2004 recommended to the president and Congress a coordinated and comprehensive national ocean policy.

Ruckelshaus is chairman of the William D. Ruckelshaus Center at the University of Washington's Daniel J. Evans School of Public Affairs and at Washington State University's WSU Extension. Its mission is to assist community leaders in their efforts to build consensus and resolve conflicts around difficult public policy issues. He chairs or has chaired numerous boards, including former chairman of the World Resources Institute board of directors, chairman emeritus of the University of Wyoming Ruckelshaus Institute for Environment and Natural Resources, chairman of the Meridian Institute, board of the Energy Foundation, Seattle Aquarium, Center for Global Development, founding director of the Initiative for Global Development; he also serves on the board of several other nonprofit organizations and conservative economic or social policy think tanks.

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See Also: Earth Day; Environmental Protection Agency (EPA); Environmentalism; History of Consumption and Waste, U.S., 1950–Present; Mining Law.

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Russia

Russia is a country located on the continent of Eurasia with an area of 10.6 million square miles and a population of 142 million. Russia is the largest country by territory and the ninth by population size. Since the collapse of the Soviet Union in 1991 and the start of ongoing political, economic, and social reforms, the level of mass consumption has increased and was still growing as of 2012. Correspondingly, the quantity of municipal waste is increasing. Regardless of the fact that the sheer size of the country makes municipal waste less noticeable, the garbage management problem is one of the most topical in Russia. No efficient system of municipal solid waste (MSW) management had been created in Russia as of 2010, and more than 90 percent of municipal waste is stored at dumps, which affects the environment and health of the population. The need for garbage management modernization is increasingly evident. However, modernization is hindered by many problems linked to imperfections of state policy and by cultural norms and social habits of the population.

Reverse vending machine in Moscow, Russia. 300 machines first appeared in 2004; by 2008, there were 2,600. The wastes providing for maximum profit, such as plastic bottles, are involved in economic turnover to the greatest extent in the country.

Consumption

Municipal waste quantity depends on consumption: the more people consume, the more waste is created. The level of consumption depends on the affluence of the country. In the Soviet Union, people consumed much fewer commodities than in market economies. This was connected to the fact that the Soviet government considered military industry to be of high priority, and the closed, state-planned economy caused a permanent deficit of consumer products. After the collapse of the Soviet Union, the closed state-planned economy in Russia was changed to an open market economy. The 21st-century Russian economy is developing predominantly at the expense of primary production (such as oil, coal, gas extraction, and wood harvesting). However, the level of home production has decreased radically from 1991, and the level of mass consumption has increased through the number of imported products. According to the United Nations, in terms of living standard, Russia was 71st among 182 countries in 2009 and gradually rising. Correspondingly, mass consumption is also increasing. Per capita income also increased from $102 per month in 2001 to $530 per month in 2009, while consumption expenditures on commodities and services increased from $55 to $271 per month during this period. The portion of expenditures on foodstuffs in the overall expenditures structure is an important indicator of the population's living standard: the higher the welfare of a

person or a family, the smaller the share of expenditures spent on purchase of food, and vice versa. In 1992, Russians spent 72.6 percent of their income on food, compared to 45 percent in 2008. At the same time, consumption of durable products (e.g., household appliances, computers, and automobiles) is increasing. In 2008, Russians purchased three times as many durable consumption products compared to the 1992 level. In connection to significant growth of expenditures on consumption of products and services, many researchers argue of a consumer boom in Russia and agree that the Russians have a high desire for consumption.

The spread of such phenomena typical for consumer societies is further evidence of a consumer boom. Increases have occurred in many areas, including consumer loans; number of malls, supermarkets, hypermarkets, cinemas, cafés, and restaurants, especially in major cities. In 2003, merely 16 percent of Russians purchased some products on credit, while in 2009, more than 30 percent did. Spending time in malls is becoming one of the most popular forms of leisure, especially for younger people. Moscow is a leader in terms of the number of malls. In 2009, 900,000 square meters of shopping centers were constructed in Moscow, while general procurement of the population with shopping spaces amounts to 326 square meters per 1,000 muscovites. Conspicuous consumption is a widespread form of consumer behavior among social groups with different incomes. Increase in garbage quantity is a consequence of the rise in mass consumption—one of the most important problems of 21st-century Russia. Regardless of the fact that Russia produces a smaller quantity of wastes compared to affluent societies, garbage management is one of the most topical problems because there is no theoretical and practical municipal waste management system on the state level.

Waste Management

In the Soviet Union, quantities of municipal waste were much less significant compared to developed countries of the West because of deficits of consumer goods and services. Municipal garbage was not collected separately, and the main means of disposal was the use of special landfills. At the same time, there was a state program for collection and reprocessing of secondary raw materials that were the most valuable for industry of that period: metal, paper, glass, and textiles. About 59 percent of paper and 50 percent of textiles were reprocessed. The population, including schoolchildren, were actively involved in collection and transfer of these raw materials to special reception centers. Municipal waste was recorded only partially, and statistics were scarce. After the collapse of the Soviet Union and the start of reforms, the state secondary raw materials system was abolished, while the level of garbage reprocessing decreased radically.

The municipal waste management system in 21st-century Russia is essentially based upon the Soviet system in terms of unavailability of separate garbage collection and predominant location of municipal wastes at dumps. At the same time, increases in the number of consumer wastes require modernization of the garbage management system. Garbage management depends on a number of factors. Such factors are federal and regional state policy, legislation, reliable statistics of wastes, accessibility and level of resources and technologies, and social habits. In Russia, there are problems in virtually each of these fields that call for early solutions.

Responsibility for garbage management in Russia is imposed on municipal districts. However, their budgets are small, and they have little means to build garbage processing plants, which are quite expensive, or to properly maintain dumps. The result is disposition of garbage to legal and illegal dumps, which pollute the environment. Over half of the companies operating in the field of garbage management are state companies. To attract private investment to garbage management, state guarantees are necessary, but municipalities are unable to provide them because of inadequate state financing. At state-level policy, there are other factors hindering efficient garbage management: (1) lack of complex state planning in the field of garbage management; (2) cumbersome bureaucratic apparatus and lack of a single state authority responsible for protection of the environment and garbage management; (3) insufficient financing of the garbage management sector (merely 11 percent of the total environmental costs are constituted by garbage management expenditures—$1.3 billion in 2008); (4) inefficient, outdated laws and lax con-

trol over execution of existing laws; and (5) lack of economic incentives for promotion of new waste collection and reprocessing technologies.

Efficient control of garbage is impossible without reliable statistics. Each constituent entity of the Russian Federation must calculate garbage originating in its territory and provide this information to central authorities; however, they do not always comply with this regulation. There is no separate collection of information on household garbage. Statistics are only provided regarding production and consumption wastes as well as information on municipal solid waste quantity evacuated from cities where municipal solid wastes was represented by waste of households, organizations (such as schools, stores, or restaurants), streets, and parks, among others. Statistics on garbage are virtually unavailable.

There are no checks of statistical authenticity, while the official government information on consumption wastes contain disparities that are officially not explained. According to available statistics, in the territory of Russia, about 90 billion tons of production and consumption solid waste had been accumulated by 2008 and located at dumps with a total area of 621 square miles.

One peculiarity of Russia lies in the fact that about 90 percent of all waste nationwide is formed due to mining operations, while consumption wastes amount to 3 to 5 percent of the total quantity. In 2005, Russian production and consumption wastes amounted to 3 billion tons, while in 2009 they increased to 3.5 billion tons, of which 3.1 billion tons are waste from the mining industry.

The quantity of garbage emerging in the territories of the Russian cities is increasing every year. Most of municipal solid waste is created in Moscow; for instance, in 2008, the quantity of evacuated garbage amounted to approximately 4 million tons. In 2000, municipal solid waste removed from all the Russian cities amounted to 152 million cubic meters. In 2008, it increased to 218 million cubic meters, which works out to 617 pounds of waste per capita in 2000 and about 925 pounds per capita in 2008. Of this quantity, about 12 percent was removed to garbage processing plants in 2008. In 2008, the quantity of municipal wastes in Russia amounted to approximately 130 million tons. According to various data, household garbage in Russia consisted of 30–60 percent packaging and paper, 25–30 percent food wastes, 11–30 percent plastic products, and 4–10 percent glass. The composition of domestic garbage is close to that in the Western countries because of an increase of packaging materials in the waste structure. In sum, according to various estimates, about 30 percent of production waste and from 3–12 percent of consumption wastes are processed in Russia. The residual wastes are evacuated predominantly to open dumps, which constitute a serious threat for environment and health. This state of affairs gives evidence of the low development of technologies necessary for garbage management.

Garbage Technology

New technologies necessary for modernization of garbage management in Russia are virtually nonexistent, although both the government and public are aware of the necessity of such innovations. Separate constituent entities of the Russian Federation and private companies have tried to implement their own garbage management modernization programs.

The wastes providing for maximum profit—metal, glass, waste paper, and plastic bottles—are involved in economic turnover to the greatest extent. In large cities, several waste reception units are operating. However, in general, in Russia, use of waste as secondary raw material and energy supply is very low, and the reprocessed raw materials market was not developed as of 2010.

In 2008, five combustion plants and nine garbage-reprocessing plants were operating in Russia, but their capacities were inadequate for the quantity of garbage in the country. Virtually nowhere, including at these plants, are technologies for ecologically clean waste management available. Omnipresent selective waste collection, evacuation, and reprocessing systems are unavailable. Manual sorting of garbage and distribution at dumps are the principal applied technologies. In cities, residents of multistory houses discharge unsorted garbage in plastic packages to garbage chutes or to garbage containers in yards. Every morning, garbage out of containers is taken to garbage sorting plants or, more frequently, to the dumps. In certain districts

of large cities, there are containers for selective collection of garbage, although this was a very rare phenomenon for Russia as of 2010. In villages, garbage containers are also available, although garbage is sometimes not evacuated for several weeks. Frequently, villages take garbage to informal dumps not far from their homes.

Pollution

In Russia, garbage is evacuated to 11,000 sanitary landfills, of which only 5 percent are in satisfactory condition, while the remaining pollute the environment and are a danger. There are also 15,000 legal dumps and as many illegal dumps. The number of landfills for industrial waste is insufficient, which is why nonhazardous industrial waste is stored at dumps together with municipal wastes. In Moscow, in 2008, illegal dumps occupied 0.4 percent of the city area. Generally in Russia, depending on the region, up to 70 percent of wastes are allocated in the environment illegally.

This gives rise to many problems for the environment and for human health, because garbage at the dumps pollutes soil, water, and air (dumps are often on fire). Such dumps violate landscape and natural systems in the large surrounding territory. Ecological monitoring is carried out at very few dumps. It often indicates excesses of admissible concentrations of many hazardous substances, regardless of the fact that allocation of toxic and radioactive wastes is prohibited at the sanitary landfills. Fines for infringement of laws on waste are not high and do not affect improvement of the situation.

Culture

In Russia, garbage and its negative effects on the environment are unfairly distributed. This is connected to the fact that most garbage is produced in richer cities and is evacuated and stored in poorer suburbs, exerting negative effects on the living quality of rural residents. The Russian government is more effective in cleaning the Russian cities of garbage than in cleaning the countryside. The obstacles to effective garbage management exist not only on the level of state policy. Cultural norms and social habits of the Russians also need modernizing.

The 21st-century Russian cultural norms accept a negligent attitude toward garbage and nature. For instance, in 2008, more than 100,000 cubic meters of garbage thrown out of automobiles was collected in the territory bordering highways. After spending time in nature, people frequently leave garbage in forests and on riverbanks. When garbage accumulates in popular places of leisure, this becomes a serious problem. However, such behavior is not typical for everyone. Ecologically conscious Russians frequently remove garbage together with their families or organize a group of volunteers.

The need for modernizing the waste management system is one of the important problems in Russia. Without reforming the waste management system and boosting the level of ecological consciousness, environmental pollution will increase. International cooperation is needed with countries with vast successful experience in the sphere of garbage management.

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See Also: Capitalism; Developing Countries; Industrial Waste; Landfills, Modern; Open Dump; Politics of Waste; Shopping; Sociology of Waste; Sustainable Waste Management.

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Safe Drinking Water Act

Access to clean drinking water is one of the most basic human needs. According to the World Health Organization (WHO), 1.6 million people die each year from diarrheal diseases contracted from microorganisms present in drinking water. The vast majority of these people are young children in developing countries. Often, the microorganisms stem from human and animal waste that contaminates drinking water. Agricultural runoff and industrial waste that discharges into water sources are also serious forms of contamination. There is a clear need for everyone to have access to clean, potable drinking water. In the United States, the Safe Drinking Water Act (SDWA) is the prime federal law that allows the Environmental Protection Agency (EPA) to set and enforce standards for drinking water for every public water system in the country, ranging from those in large cities that serve hundreds of thousands of people each day to small facilities serving approximately 25 people for only two months of the year.

The SDWA was first introduced in the U.S. Senate by Warren Magnuson, a Democratic senator from Washington, in January 1973, and was signed into law by President Gerald Ford in December 1974. It was later amended in 1986 and 1996. Related laws enacted in the 1970s include the Water Pollution Control Act (1965, amended in 1972) and the Clean Water Act of 1977, which governs pollution of rivers and lakes. Together, these laws provided a solid foundation for monitoring and enforcing water quality standards and signaled a significant shift in the environmental movement.

Standards and Measurement

Prior to the 1974 Safe Drinking Water Act, water quality was monitored solely at the state level, and few legal requirements for water quality existed. The 1970s witnessed improvements to the accuracy of water quality testing, allowing small concentrations of contaminants to be detected. In the early 21st century, the EPA sets standards for and regulates both naturally occurring and human-made contaminants, including microorganisms, disinfectants, disinfection by-products, organic chemicals (which are often linked with kidney and liver problems), inorganic chemicals (such as lead and nitrates), and radioactive contaminants. Employing scientific research, the EPA first establishes which contaminants exist in water supplies at concentrations high enough to pose a health risk and then determines which ones to include in the National Primary Drinking Water Regulations. The EPA establishes unenforceable

Maximum Contaminant Level Goals (MCLG) for each contaminant. These goals are entirely health based and take into account the risk of exposure to vulnerable populations, such as pregnant women, young children, the elderly, and those with immune deficiencies. Once MCLGs have been established, enforceable standards or Maximum Contaminant Levels (MCLs) are set, considering the known health risks as well as the economical and technical feasibility of complying with the set limit. Efforts are made to ensure that the MCLs are as close to the MCLGs as possible. In some instances, it is not possible to accurately measure the levels of certain contaminants and, instead, the EPA outlines specific methods of water treatment. While the EPA oversees compliance with the SDWA, individual states and Native American tribes can obtain the authority to implement the regulations themselves, as long as they can prove that they will uphold the water quality standards set by the EPA. In the early 21st century, all states, with the exception of the District of Columbia and Wyoming, have received this authority or "primacy."

Amendments and Updates

The 1986 amendments to the SDWA allowed for a wider range of water sources to be protected and required the EPA to set safe limits for additional contaminants in drinking water, including lead. In the early 21st century, lead is minimized by the use of lead-free pipes combined with a treatment technique designed to reduce the corrosiveness of water. The 1996 amendments also required that all water system authorities provide annual reports to the public, outlining any contaminants found, along with the health risks they may pose. These authorities are also required to notify consumers immediately following an emergency that contaminates a drinking water supply. Information on water quality is freely available through each public water system or drinking water databases maintained by the EPA. Maintaining the standards set by the SDWA can be expensive, so the EPA conducts a cost-benefit analysis for each new standard set. The Drinking Water State Revolving Fund created following the 1996 amendment provides financial assistance to states to help enhance their infrastructure or protect source water. While the EPA maintains the legal authority for ensuring that the standards set by the Safe Water Drinking Act are maintained, it stresses that the protection of drinking water lies in everyone's hands and it encourages community involvement in ensuring that clean, healthy drinking water continues to be available in the future.

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See Also: Clean Water Act; Pollution, Water; Public Water Systems; Water Consumption; Water Treatment.

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Salvation Army

The Salvation Army (SA) is one of the world's largest charitable institutions, distinctive for its quasi-military structure of soldiers and officers. The religious organization emerged in Victorian England, promising active adherents worldly salvation and offering assistance to the poor and needy. The first places to adopt the SA ideology were Anglophone satellite countries such as Australia and the United States. By 2010, the SA was active in 121 countries where it offers a range of charity and social services, such as emergency relief, refugee and youth services, provision for the homeless and unemployed, and an extensive network of secondhand retail stores. It receives significant government and philanthropic financial support in the form of donations, tax exemptions, and public subsidies, raising some public debate and criticism about the appropriateness of religious organizations as service providers in secular contexts. In many English-speaking countries, the SA enjoys public recognition for

its community work, particularly the traditional "Red Shield appeals," door-knock fund-raising, or goods donations. The red-colored shield is familiar in popular imagination and culture.

Analysis of the SA has typically focused on the role Christian principles played in shaping its charity-based social work. However, ideas about consumption practices and waste reduction have also characterized much SA thinking and action throughout its history. In the 21st century, discourses on waste and ethical consumption, especially around textiles and clothing, have become prominent in the United Kingdom and, increasingly, in Australia, though perhaps less so in the United States. Therefore, the SA can be read through a social innovation paradigm, with the organization as a generator of social, cultural, and public value based on an innovative model of human development and material recycling, rather than framed only as a religious institution with a social conscience.

History

At first sight, a history of the Salvation Army appears well documented. There are formal accounts of the movement's early days, including the SA champions' biographies, manifestos, or theological debates—William Booth's 1890 book *In Darkest England and the Way Out* is one example. Both the development of the SA's recycling services and the management and organization of SA trading in secondhand goods globally are, however, much more nebulous. Systematic archival work has often been undertaken only sporadically, and the hard-to-capture, invisible nature of secondhand and nonmonetary exchanges and transactions are frequently unrecorded in the archives. This lack of formal historical and current documentation presents researchers with challenges, but it also points to gaps and alternatives (such as anecdotal evidence) in the sources used to construct the understanding of the SA and its role in social history.

The Salvation Army was founded in 1865 by Booth, an English lay preacher and former pawnbroker. Inspired by the teachings of John Wesley, the movement quickly spread worldwide. Its core philosophy underscored the moral value of a productive life and human agency to generate self and social transformation: no one was considered useless, and everyone was capable of enacting their own salvation with hard work and discipline. The role of the SA was to actively assist salvation, extending a helping hand to the "undesirables" of society. These philosophies were applied in the establishment of innovative social welfare services. Of particular importance is the historical, industrial model of recycling pioneered by the SA in the 1880s as a creative solution to both material and human waste. The Prison Gate Brigade program offered food and shelter to recently released prisoners in exchange for paper-recycling work. Moral discourses about the values of labor and participation converged around ideas of socially worthy production and consumption of commodities, linking thrift, consumption, human, and social care. The SA soon began "jumble sales," providing used clothing, and later household items, to the poor, collected by Salvage Departments—predecessors of the popular contemporary charity (thrift, opportunity, or "op") shops. The legacy of the SA's founding values have stretched into its social services in the 21st century, which include assistance for the homeless, migrants, refugees, and vulnerable youth.

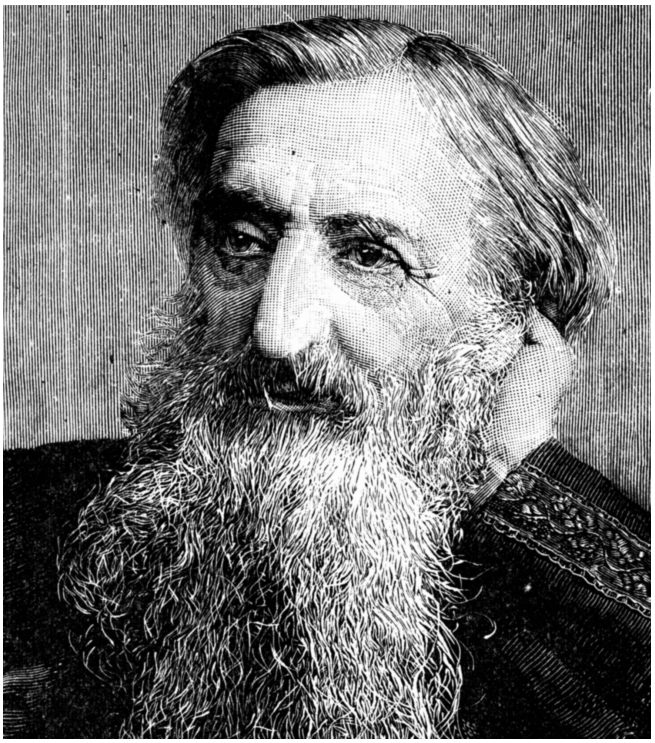
Operations

The SA has grown from a small-scale social experiment to an enterprise comprising secondhand collection; recycling and retail outlets; a strong brand; ongoing government tax subsidies; and inflows of donated cash, goods, and labor from the community. Commercially operated SA stores trade in secondhand clothing, bric-a-brac, accessories, books, shoes, and household linens and encourage a culture of ethical consumption and recycling. Excess donations and unsold clothing are exported to developing countries for reuse as rags or fillings, but little is known about the exact structure, intermediaries, and contribution of this segment of SA's activity. Profits from trading are directed to local social funds supporting community work. The majority of goods donated are reused, with approximately 25 percent recycled to make mattress fillings, industrial wipes, or car soundproofing. Only 5 percent are never used again.

The SA ethos of human development and material recycling is seen in the employment of people referred through community service corrections programs in stores, instead of serving a prison sentence.

Intermediary employment pathways, such as voluntary or paid jobs in the stores or in recycling/repackaging services (such as removing labels from new donated clothes), are also extended to ex-prisoners and disabled people. Nonmonetary support such as in-store voucher systems for clothes or goods is also available; for example, the provision of clothes from SA stores so that prisoners can make a "respectable" court appearance.

The stores are a place to volunteer, provide a social "drop in" venue, and be a center for distribution of assistance. Sociologists of consumption and informal markets frame the role of charity shops as important enablers of reuse and redistribution of material goods and as a viable alternative to mainstream consumer practices. Cultural studies of social production stress the importance of networks and individual creativity to cultural and economic life in the digital era, with new technologies enhancing possibilities for giving, swapping, secondhand consumption, trading, and exchange.



The Salvation Army was founded in 1865 by William Booth, an English lay preacher and former pawnbroker. Inspired by the teachings of John Wesley, the movement quickly spread worldwide, and is now one of the world's largest charitable institutions.

Innovations

In the context of increased competition in charity retail and faced with debates about environmental sustainability, the SA has responded by expanding its customer base to include the environmentally minded and so-called fashionistas, whose secondhand consumption is motivated by choice rather than necessity. The SA's shift to professionalization or corporatization of its retail structure, including sophisticated pricing system and display, has been criticized for alienating its traditional low-income demographic, but the organization insists that its social agenda remains unchanged.

The SA maintains both a real-world and a virtual presence via local stores and "op-shoppers," blogs, and Websites. Despite recurring criticisms over professionalization, conservative religious ideology (for example, policies regarding non-heterosexual volunteers), or lack of transparency, the SA has been valued for promoting the value of inclusive social participation. Its overarching Christian philosophy has proven adaptable to contemporary social trends, although terminology has evolved and applications have taken different forms. The moral discourse of productive work behind the industrial Prison Gate Brigade model has morphed into individualized ethical consumption, but the idea of developing responsible, nonwasteful individual and collective citizenship continues, enabled by flexible organizational structure and strong community links.

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See Also: Consumption Patterns; Goodwill Industries; Industrial Revolution; Recycling Behaviors; Shopping.

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Sanitation Engineering

Sanitation (or "sanitary") engineering emerged in the 19th century as a specialized form of civil engineering. Drinking water treatment and distribution, wastewater treatment and distribution, and solid and hazardous waste management are the principal traditional disciplines. Sanitation engineering is dedicated to the remediation of waste streams generated by human activity in an effort to preserve both environmental and public health. Public health has been defined as "community action to avoid disease and other threats to health and welfare to individuals and the community at large." Environmental health is the extension of this concept beyond human settlements and into the larger natural world. The two concepts are inextricably linked.

Human wastes may be generated from municipal, commercial, and industrial sources. Sanitation engineering becomes increasingly important proportional to the density and activity of these sectors. Waste is traditionally defined as "a system by-product without inherent value," but it is better described as a spent or displaced resource. Waste may be gaseous, liquid, solid, or even thermal in form. Accumulation of wastes can aggravate and distress ecosystems through the disruption of natural environmental equilibriums. This happens once a natural ecosystem's capacity to handle wastes is overloaded or incidentally diminished. Urbanization, industrial intensification, and agricultural expansion can be disruptive to both the immediate and global environment. The consequence if waste accumulation is left unchecked is disease, which may be derived either chemically (poisoning) or biologically (pathogenic microorganisms). The aim of sanitation is to return wastes back to the environment in a natural, harmless state. The more ambitious objective is to manipulate or transform a spent resource back into a desirable and useful commodity. A few examples are scrap-metal recycling and energy-from-waste programs (anaerobic digesters).

A waste stream must be treated from within the greater context of a complete system. A sanitation engineer must address a waste stream from its point of origin until final release and account for each intermediary step before it may be rendered "harmless." In this respect, sanitation engineers must become masters of process engineering lifecycle analysis. The physical, chemical, and biological components of waste may change over time. Decomposition, degradation, or a change in the pattern of consumption can all influence the behavior of waste. For example, relatively harmless dissolved proteins in water contain proteins that can be reduced by bacteria to create toxic and corrosive hydrogen sulfide, which is potentially a safety concern at waste management facilities. Asbestos is only dangerous as a friable, airborne particulate. Water conservation programs may result in less volume of wastewater but yield a proportional increase in concentrations of contaminants.

Background

Wastewater sanitation is one of the largest medical advancements of the 20th century. Dr. John Snow discovered that contaminated drinking water was responsible for England's cholera outbreak in 1848, claiming 52,000 lives. However, this method of transmission was not universally accepted at the time. Modern environmental engineering began by accident in the mid-19th century with Joseph Bazalgette. He proposed to construct an enclosed sewer network that would discharge raw sewage downstream of the Thames to control odor—foul air being the assumed vector of transmission. The result was significantly fewer instances of dysentery, which is now recognized as a common symptom of many diseases from waterborne pathogens. In the United States, Colonel George Waring became a leading sanitary engineer after the Civil War, developing sewage and drainage systems and later street-cleaning and solid waste management systems for several municipalities. Wastewater treatment facilities to remediate the wastewater before discharge into the river were not built until after World War I. Sanitation engineering also encompassed other activities, including food inspection and street cleaning, but these have since evolved and been refined into separate disciplines.

The work of a sanitation engineer is grounded within environmental legislation and optimized with the application of the best-available science. The "harmless" or maximum allowable concentration (MAC) of chemicals and materials discharged into the environment is objectively based. Targets set by the local governing authority are based on toxicity

data commonly reported in lifetime average daily dose (LADD) and the available treatment technology. Targets are occasionally set higher than human toxicity concentrations. Common reasons are that either the toxicity data or treatment technology does not exist, or the jurisdiction is financially restrained in respect to adequate cleanup. The allowable concentration of arsenic in drinking water is a good example. Toxicity data suggest that the concentration of arsenic in drinking water should be less than 0.03 $\mu g_{As}/L$ for a zero cancer risk. However, the World Health Organization standard is 10 $\mu g_{As}/L$, and in Bangladesh it is 50 $\mu g_{As}/L$. This is because the analytical technology in the laboratory is not yet that precise, and monitoring, testing and treatment must be affordable. In this respect, legislation will continue to evolve as new knowledge, technology, and resources are discovered.

The social infrastructure around sanitation is still evolving. The May 2000 *E. coli* outbreak in Walkerton, Ontario, caused 2,500 people to become ill and at least seven deaths. This was attributed to the infiltration of agricultural runoff into the drinking water aquifer, which resulted in fecal matter contamination. Inadequate water treatment (chlorination in this instance) on behalf of the operator allowed the *E. coli* pathogens to enter the local drinking water distribution system. This occurrence led to the passage of the Safe Drinking Water Act of 2002, which prescribes that only licensed, qualified persons (i.e., a sanitary engineer) may operate drinking water treatment facilities. Sanitation engineers must be competent and accountable for their actions as they have a direct impact on public safety.

Traditionally, solid wastes were disposed of by burying them in an unlined pit. Not until the 1960s were the problems associated with this practice understood. Heavy metals and toxic and carcinogenic chemicals can leach into groundwater supplies. There is also a peculiar and devastating secondary effect. The uncontrolled migration of volatile landfill gases through soils may cause explosions in neighboring residences long after a landfill is closed. Landfill gases were responsible for blowing up the same house twice in Kitchener, Ontario. The same sort of phenomena have been reported all across North America, the United Kingdom, and India. The decomposition of waste by anaerobic bacteria creates methane (natural gas), which is also a greenhouse gas. This gas travels through porous soils, may enter sewers, and may even permeate concrete to pool and collect in a basement until something as simple as the pilot light of a furnace triggers an explosion. These same gases can be collected in methane collection systems to produce heat and electricity.

Skills

Professional engineering demands a diverse skill set that draws from academia, politics, social aptitude, and creative thinking. From an academic perspective, sanitary engineering requires a little bit of every engineering discipline to provide a background for waste management. Mathematics is a staple for every engineer; however, its application is especially diverse for the sanitary engineer. Practical knowledge in physics, chemistry, microbiology, fluid mechanics, soil engineering, heat and mass transfer, mechanical design, meteorology, and economics is also required.

Analytical ability is necessary for two key reasons. The first is in formulation of a complete problem definition that includes criteria and constraints to objectively guide the development of a solution. Constraints define what a design must accomplish, while criteria indicate how to increase design performance. Analytical ability also assists in the reduction of a complex problem into smaller, manageable components that are easier to solve.

Effective communication skills are required to clearly convey ideas. Verbal, written, and graphical communication is important because engineers usually rely on a second party to execute their work. Sanitation engineers often need to account for uncertainty in design, especially when dealing with the future. Wastewater treatment plants and waste management facilities are designed to accommodate future demands. Risk assessment, probability, and statistics are often used to anticipate population growth and dynamics to predict trends in waste production, generally on a per capita basis.

Qualifications

Sanitation engineering, as with all of engineering, is a regional, internally regulated professional discipline. Each country has its own requirements to be able to practice as a professional engineer that may

or may not be recognized by other jurisdictions. For example, in Ontario, Canada, to gain professional engineer (P.Eng) status under the Professional Engineers, Ontario (PEO), an individual must (1) have graduated from an accredited engineering program at a recognized postsecondary institution, (2) passed a formal law and ethics examination, and (3) have worked several years (generally four) in the field under the supervision of a professional engineer as an engineer-in-training (EIT).

There are additional avenues to gain accreditation. Sanitation engineers may work in the private sector as consultants, or in the public sector in policy development and management positions. Consultants earn a living by submitting numerous project proposals to several clients to secure a given project. Project bidding is competitive and often subject to the rule of law to ensure an equal playing ground. Engineers are held to the highest ethical standard. All work performed must abide by the rule of due diligence—performing every reasonable action that any professional in their field would endeavor—and hold public safety in the highest regard. In terms of an engineer's allegiance, public interest comes first, followed by the client, then the employer, then oneself. If a practicing engineer is found in violation of any of the codes of conduct of the governing authority, they may be called before a tribunal for trial where they may face criminal charges and have their license revoked.

Address the Source

Sanitation engineers must be socially conscious of waste generation. This is common sense, as waste is the direct result of human activity. Municipal wastes are heterogeneous and variable in nature, which makes them a difficult media to work with. To reduce the complexity of a problem, it is best to address the source. There are several source management strategies that can help make waste management strategies more successful. The 3Rs axiom "reduce, reuse, recycle" is the best place to start.

Waste reduction may be subdivided into waste prevention and waste mitigation. Prevention is the most important. Avoid waste generation and dealing with that waste is no longer an issue. Prevention is often accomplished by replacing an old, outdated process with an improved one that may accomplish the same task with less resource expenditure. The green energy movement is a great example in which the demand for fossil fuels as energy sources is slowly being replaced by cleaner, more sustainable energy options. The second strategy is waste mitigation and resource preservation, which basically means to use less. This can be accomplished by introducing programs that reduce demand and encourage or persuade a population to buy products with less packaging or by financing water conservation programs, for example.

Reuse is simple. Use the same resource to perform a task over and over again. Beer bottles, fabric grocery bags, and graywater systems are good examples of reuse that cuts down on waste generation.

Recycling is the least efficient of the 3Rs because it requires energy expenditure to refine a waste back into a usable resource. Most recycling programs operate at a net loss in revenue. Recycled materials are generally of a lower quality and purity than newly processed materials, and this has a negative influence on market demand. New technologies may improve the scales of economy for recycling programs. Successful recycling programs directly depend on informed source separation on behalf of the consumer and on securing a good market for the recycled goods. The degree of source separation of recycled materials affects the operating costs of the recycling facility. It can enable them to produce higher-quality recycled material. Recycling education workshops are a great way to show the public how to recycle correctly.

Source separation extends beyond recycling in the solid waste stream. In wastewater applications, there has been a progression from combined sewers to separate sanitary and storm sewers. Combined sewers funnel rainwater into municipal sewage, which increases volume and treatment costs. Stormwater runoff and infiltration unnecessarily increases the volume of wastewater treated by a wastewater treatment plant.

Wastewater Treatment

Wastewater treatment uses an array of interdependent physical, chemical, and biological processes to restore soiled water to a state where it is suitable for safe release to the environment. Wastewater treatment is also one of the most power-

intensive operations conducted by a municipality. Aeration basins are the best-known method for the biological removal of dissolved organics in wastewater; they may consume up to a third of a city's total power needs. Drinking water treatment further improves the quality of source water for safe human consumption.

Large debris, solids, and particulate matter may be removed through (1) coarse screening such as bars to remove large debris; (2) sedimentation, which is the removal of suspended solid materials in water under laminar flow conditions due to gravity (may be assisted by coagulation and flocculation, a chemical addition, usually aluminium sulfide or ferric chloride, which causes suspended material to bind together in larger particles or "flocs" that are easier to remove); and (3) membrane, vacuum and multimedia filtration, which selectively allow materials of a given size to pass through a porous structure while rejecting the rest.

The solid material that is removed from wastewater is termed *sludge*. Wastewater treatment plants are generally equipped with sludge management facilities. Sludge is generally stabilized and reduced in vessels called "digesters." Digesters are biological units that are maintained at ideal environmental conditions to support virile populations of bacteria that readily decompose the solid organic material. The stabilized sludge is then dewatered to further reduce its volume. The proper disposal of sludge is an important issue to sanitation engineers that currently has no universal answer. Most sludge contains trace contaminants, such as heavy metals, pathogenic microorganisms, and/or harmful organic compounds such as pesticides. This sludge is either landfilled or incinerated, both of which are expensive operations. However, contaminant-free sludge is useful as a great soil amendment and may be applied to land. The problem is that sludge quality is dynamic because it is dependent upon what is discharged into sewers from day to day. The larger the area and volume serviced, and the types of service discharges accepted (e.g., from industries and hospitals), the greater the variability in sludge quality.

Dissolved nutrients such as carbohydrates, proteins, nitrogen, and phosphorous cause eutrophication if they enter surface water in high-enough concentrations. Eutrophication occurs where the metabolism of aquatic microorganism populations, such as algae, depletes dissolved oxygen concentrations in water to the point where higher-order organisms, such as fish, can no longer survive; they effectively suffocate. This phenomenon is sometimes referred to as "algae blooms," or "fish kills." Microorganisms grow exponentially in ideal conditions. On average, two-thirds of a microorganism's energy is invested in reproduction, whereas only one-third is utilized to maintain cell functionality and homeostasis. Carbohydrates and proteins are food sources for aquatic microorganisms. Nitrogen and phosphorous are both growth-limiting micronutrients for microorganisms. The metabolism of nutrients by microorganisms depletes dissolved oxygen in the water. As such, wastewater treatment applications are designed to control and remove each one of these constituents.

Nutrients are most effectively removed by engineered biological processes that may use carbon-reducing aerobic/anaerobic bacteria, nitrifying/denitrifying bacteria, and phosphorous-accumulating organisms in controlled environments. The most common biological processes are (1) activated sludge: free-floating microorganisms in aerated lagoons; (2) biofilms: adhere to a solid surface, use less energy, and have a higher resistance to environmental fluctuations, such as pH and temperature; (3) granular activated sludge: the hydrodynamics in a vessel are such that bacterial cultures begin to aggregate into tiny balls or granules; (4) biolytics; (5) facultative lagoons; and (6) manufactured wetlands and wastewater gardens.

Water Resources Management

Water resources management becomes even more important in arid regions. The quality standards of reclaimed water discharged from wastewater treatment plants becomes increasingly stringent, as it may directly enter the head works of drinking water treatment facilities. The wastewater treatment industry is undergoing a transformation whereby the technology and knowledge is sufficient to consider these plants resource recovery plants, rather than wastewater treatment plants. Water reclamation from these plants for nonpotable use is already being implemented in arid portions of the United States and energy recovery from the biologi-

cal treatment plants can, in some circumstances, be sufficient to power these plants.

A future challenge in wastewater treatment is in the management of emerging contaminants, such as pharmaceuticals and endocrine disruptors. These chemicals enter the water through medications that pass through our bodies and have not been effectively addressed by regulating authorities. Better source separation of wastewater streams could help.

Solid and Hazardous Waste Management

To begin solid and hazardous waste management, a sanitation engineer must have a good understanding of the nature and character of the waste. The composition of municipal wastes generally varies from region to region. An extensive survey is usually conducted to sort solid waste into several manageable categories. A typical solid waste characterization is paper, plastics, metals, organics, and styrofoam. Developed countries generally have less organic municipal wastes (food wastes) than developing countries. Source separation is generally regarded as the best option to minimize the quantity of waste. The public sort their waste into nonrecyclables, recyclables, and compostables for separate curbside collection. Questions that need to be asked include is the population density high enough to make curbside pickup an affordable option? How will the population pay for this service? By volume or weight, bag tags, taxes, or by the load for drop-offs?

Solid and hazardous waste management also deals with the design and operation of landfills, transfer stations, recycling centers, composting facilities, and incinerators. Site-selection methodologies are especially important in this field.

The discipline of engineering continues to evolve, refine, and further specialize with the advancement of knowledge and technology. The names of accredited engineering programs may change over time with this progression. Sanitation engineering may one day grow to incorporate solutions and management strategies for maintaining open resources, such as our oceans and air, where the control of how waste enters these systems is not easily regulated.

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See Also: Biodegradable; Hazardous Materials Transportation Act; Pollution, Water; Waring, George.

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São Paulo, Brazil

São Paulo, located in the southeast region of Brazil, is the most populous city in Brazil and one of several megacities (with a population of 10 million or more) growing around the world. Although it has a long history, rapid urbanization in the late 20th century exacerbated waste management problems. In the early 21st century, the city has responded with some of the most proactive responses to waste management of any large city on Earth.

History

Fathers Manuel da Nóbrega and José de Anchieta, Jesuit missionaries, founded the village of São Paulo dos Campos de Piratininga on January 25, 1554, when they established the Colégio São Paulo de Piratininga's mission to convert to the Catholic faith the Tupi-Guarani local populations. Because of its excellent location—just beyond the Serra do Mar mountains, above Santos (a coastal city with an important port), and close to the Tietê River—the new settlement became the main entrance from the coast to explore and to colonize the fertile plateau areas that would become the richest Brazilian state. In 1711, this village officially became the city of São Paulo.

São Paulo is considered the most ethnically diverse city in Brazil. Much of this diversity is because of the fact that in 1850, with the end of the traffic

of African slaves in Brazil, the state of São Paulo started to replace the slave manpower in its coffee plantations with voluntary European immigrants, most of them from Italy, Portugal, and Spain. The waves of immigrants from the mid-1800s continued until the end of the century.

In 1888, after the complete abolition of slavery in Brazil, São Paulo continued to receive increasingly large numbers of immigrants. By the end of 19th century, the city's population was comprised of significant numbers of Italians, Portuguese, Spaniards, Lebanese, and Syrians.

In the first half of the 20th century, many Japanese immigrants arrived, followed in the 1960s by Chinese and Koreans. During the same time and through the 1970s, great numbers of migrants from the impoverished northeast region of Brazil migrated to São Paulo, helping to build the city's wealth and producing a multiethnic society. It is estimated that people of about 100 different ethnicities call São Paulo their home.

Statistics and Characteristics

By 2010, São Paulo, with a population of about 11 million people living in an area of 588 square miles, was the largest city in Brazil, the world's sixth-largest city, and seventh-largest metropolitan area. It is also the capital of the state of São Paulo, the most populous Brazilian state, and is considered an Alpha world city, the center of the heavily urbanized São Paulo metropolitan area, with about 20 million inhabitants distributed among 39 municipalities in 3,067 square miles.

São Paulo occupied, in 2008, the 10th place among the top 30 urban agglomerations by estimated gross domestic product (GDP) according to United Nations data and is expected to be the sixth in 2025 based on projections using the same data. According to the Brazilian Institute of Geography and Statistics (IBGE), the city's GDP in 2007 was about $173.7 billion, equivalent to approximately 14.9 percent of the Brazilian GDP. If it were an independent country, its economy would be among the 50 greatest in the world, greater than countries like Egypt and Kuwait.

However, the city's economy is undergoing a profound transformation in the early 21st century, losing its strong industrial character and increasingly becoming a services and business center, the base for the largest number of foreign corporations located in Brazil. Despite being the most important Brazilian financial center of the country, São Paulo presents a high degree of informality in its economy, and its categorization as an important global city can be seriously criticized considering its severe social exclusion and spatial segregation issues.

Regarding culture and lifestyle, São Paulo is one of the liveliest cities in the world, with 70 museums and more than 200 cinemas and 50 theaters. It is also an important global gastronomy center, where more than 40 different world cuisines are represented by about 12,000 restaurants.

Waste Management

The 11 million residents of the area generate about 15,000 tons of garbage each day. Waste collection is managed by private companies (including Loga and EcoUrbis) through contracts with the municipal government to collect wastes from dwellings, hospitals, and street sweepings.

Primary waste disposal is in landfills, including two of the largest landfills on Earth. The Bandeirantes landfill opened in 1979 about 16 miles northwest of the city and closed in 2007. The São Joao landfill opened in 1992 in the eastern section of São Mateus and received almost 28 million tons of garbage before closing in 2009. The city owns both the Bandeirantes landfill and the São Joao landfill. Active landfills include the privately owned Pedreira waste layout center located in Guarulhos and the privately owned Caieiras waste layout center located 21.7 miles outside of the city.

When both the Bandeirantes and São Joao landfills were approaching their capacity in 2004, the city began developing a landfill emissions control program in order to reduce the threat of greenhouse gas emissions from decaying waste (the source of 25 percent of the city's greenhouse gas emissions in 2005). Working with the Biogas Company, a consortium of Brazilian and Danish businesses, the city began developing infrastructure to capture and use the methane produced for energy. Estimates when the project began indicated that the landfills could capture and burn enough methane to generate 175,000 megawatts per year, or

about 7 percent of the electricity consumed in São Paulo. Under the agreement with Biogas, all of the energy produced by the plants belongs to the consortium to sell.

Since 2006, the Bandeirantes landfill has had a thermoelectric power plant running on biogas. This landfill project was approved as a United Nations Clean Development Mechanism (CDM) project, making São Paulo one of the only cities (rather than nations) to benefit from the carbon finance concept. Under the agreement with Biogas, the city and consortium evenly split the carbon credits. São Paulo began selling carbon credits based on this energy in 2007, and a similar plant was approved for development in the São Joao landfill in May 2010.

Plans for the project include efforts to alleviate the substantial social inequities existing in the megacity. The city's revenue is intended to support the socioeconomic development of communities around the landfills. The region of Perus (by the Bandeirantes landfill) received funds from carbon credit auctions in 2007 and 2008. Among funded projects were the development of public parks and playgrounds in the region.

São Paulo approved its Municipal Act on Climate Change in 2009, which (among other provisions) directs the transition of municipal buses to run entirely on renewable energy sources by 2018. The city estimates a reduction of 30 percent in its 2005 greenhouse gas emissions by the end of 2012.

Between the projects at the two massive landfills, São Paulo's program to capitalize on the city's waste represents an important chapter in international waste management approaches. While the megacity continues to have significant waste management and social equity challenges, the efforts to capture methane may serve as a model for future waste management practices of megacities.

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See Also: Archaeology of Garbage; Archaeology of Modern Landfills; Brazil; Developing Countries; Incinerators; Rio de Janeiro, Brazil; Waste Management, Inc.

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Saudi Arabia

An Islamic absolute monarchy, Saudi Arabia is the largest Arab country in the Middle East and the world's largest oil exporter, with the largest oil reserves. Oil accounts for 75 percent of the government's revenue and more than 90 percent of the country's exports, resulting in a welfare-state government, which—though normally prosperous—is sometimes difficult to fund because of the volatility of oil prices. It is also the largest donor nation per capita, contributing significant amounts of foreign aid since the 1980s.

One of the world's largest energy producers, Saudi Arabia produces almost 11 million barrels of petroleum per day, most of which is exported. It also possesses the fourth-largest natural gas reserves. The state-run oil industry accounts for 45 percent of the country's gross domestic product (GDP); by comparison, the entirety of the private sector is 40 percent of the country's GDP. Saudi oil interests are controlled by Saudi Aramco, a company formed in 1980 when the Saudi government purchased nearly all the stock of the Aramco oil company.

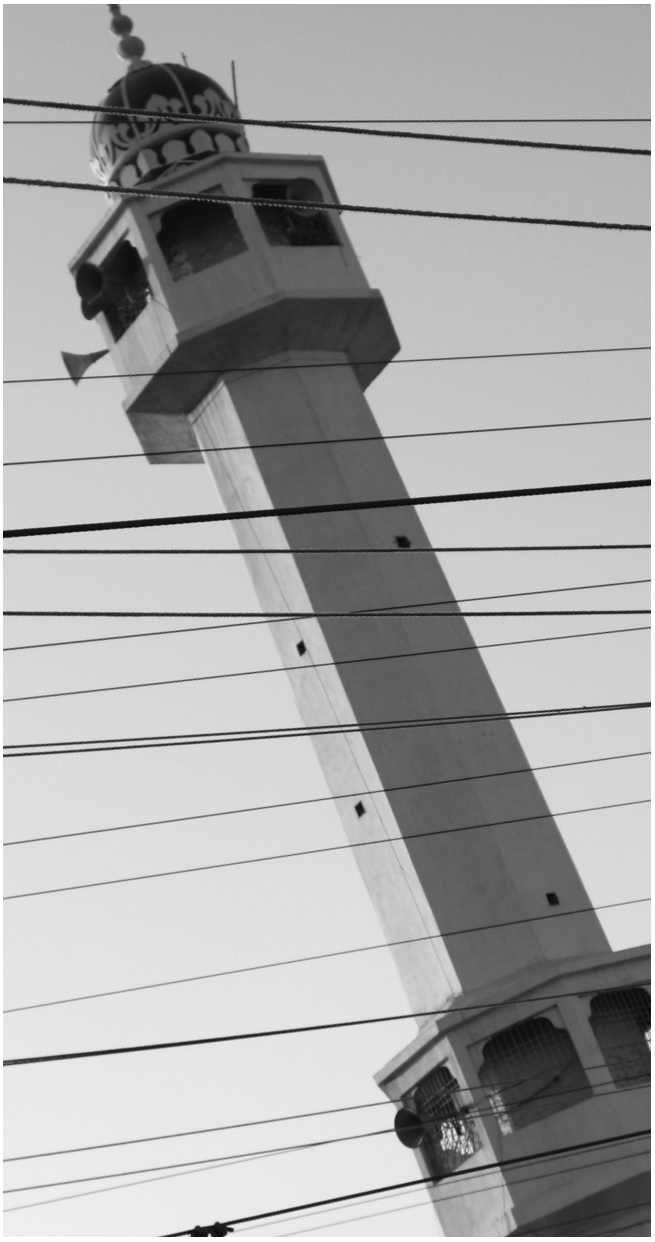
The country is also the fastest-growing consumer of energy in the Middle East and is one of the 20 greatest energy consumers in the world, thanks principally to its use of transportation fuels. About 65 percent of electricity generation comes from oil-burning plants, 27 percent from natural gas plants, and the rest from steam plants.

The energy sector is overseen by the Ministry of Oil and the Ministry of Water and Electricity.

Energy Demand

The minister of water and electricity has been responsible for electricity in Saudi Arabia and has been since 2003. All the electricity providers operating in the kingdom were consolidated in 1998 into the publicly traded Saudi Electric Company. Rapid economic development at the end of the 20th century and into the 21st century led to sharp increases in electricity consumption, with peak loads reaching 25 times their 1975 level at the beginning of the 21st century. Much of this increased demand is due to the delay in fully electrifying the country: the number of electricity customers grew from 216,000 in 1970 to 3,035,000 in 1996, not because of population increases but simply because of increased access to electricity, which had previously been unavailable in much of the country's rural areas. Despite the plenitude of oil, consumption has increased so drastically that the government began to stress energy conservation in order to avoid what seems to be an inevitable energy shortage. A facility has been approved to turn waste into electricity, which, if successful and efficient, will be the prototype for more such facilities throughout the kingdom.

At the end of the 1990s, the government responded to the consumption increase by restructuring the electricity sector in order to move toward sustainability. Demand is still increasing much faster than capacity, and inefficient energy use is a countrywide problem. Further, the electricity sector has adopted no time-of-use rate adjustments, and the government has not been willing to seriously commit to the significant capital investments necessary to expand the country's electricity-generation capacity. Inefficient usage is believed to be widespread enough that simply changing habits—in many of the same ways promoted in the United States in the 1970s, like turning off lights that are not in use—could reduce demand by as much as 10 percent, a $3 billion savings over 20 years. In hot, arid Saudi Arabia, air-conditioning usage is a considerable source of demand, and the government has been promoting more-efficient air conditioner designs and moderate usage. Because of the lack of time-of-use rates and other controls, the "buffer" between the energy demand on the Saudi grid at peak and the total generation capacity—the difference between the total used and the total available—is quite slim—slim enough to make critical outages a real possibility, particularly if climate change continues to drive demand for air-conditioning.



Power lines cross in front of a minaret in Saudi Arabia, where air-conditioning comprises a large portion of the electricity demand. The country is the fastest-growing energy consumer in the Middle East and one of the 20 greatest energy consumers worldwide.

Regulation and Policy

Because of the importance of oil and natural gas to the economy, energy law forms a significant part of Saudi Arabia's body of law. Under the Basic Law of Saudi Arabia—a constitution-like charter—all oil and gas wealth within the borders or in its territorial waters belongs to the government. The law, the document states, "defines means of exploiting, protecting, and developing such wealth in the interests of the state, its security, and economy." Taxes and fees on energy consumption are permitted by law "on a basis of justice and only when the need for them arises." In addition to governing electricity, the Ministry of Water and Electricity is tasked with maintaining the nation's water and sewage networks as well as with formulating regulations to preserve water and properly manage the country's wastewater.

Renewable Energy

A mark of 21st-century Saudi energy policy has been emphasizing conservation, rather than the 20th-century tendency to simply increase production. Efforts at efficiency are still in their infancy. In 2009, Saudi Arabia announced a new program of energy-efficiency labeling requirements for high-consumption appliances, including washing machines, refrigerators, freezers, and air conditioners. The program required energy performance tests based on product type, with a rating of one to six stars in increasing order of efficiency. Of course, Saudi Arabia is in a problematic position when it comes to energy. While much of the developed world has begun to turn to alternate sources of energy, the Saudi minister of oil, Ali Naimi, in 2009 referred to renewable energy as "a nightmare scenario," warning that estimates of "alternative energy supplies'" capacities could be overly optimistic, leading to a worldwide energy shortage if investment in alternative energy were coupled with scaled-back investment in fossil fuels. Regardless of the veracity of this, politically, Saudi Arabia is in a position of needing to promote oil as the primary source of the country's prosperity, even while it stands to suffer from dependence on oil even more than its customers.

At the same time, Saudi Aramco has stated a desire to become the world's largest provider of solar energy. The kingdom is largely desert, with ample empty land available for solar farms and little inclement weather to reduce solar energy collection. The country's ambition to become the leading exporter of clean energy is realizable, if the capital for development is made available, whether through the government or Western corporate partners.

In April 2010, Saudi Arabia took an even more significant step toward renewable energy when King Abdullah issued a decree ordering the creation of the King Abdullah City for Atomic and Renewable Energy (KACARE), a "city" within the nation's capital of Riyadh that will serve as a renewable energy technology and policy research center. A specific timeline had not been announced as of 2010, but the city indicates a sense of awareness that fossil fuel reserves are not infinite. The similar King Abdullah University of Science and Technology (KAUST) had been announced only a few months earlier, in late 2009, funded with billions of dollars and tasked with energy and the environment as its core research focuses. Between KAUST and KACARE, Abdullah has made a serious commitment to developing renewable energy technologies. KACARE will be responsible for drafting the country's policies on nuclear power and the resulting waste and will represent the country at the International Atomic Energy Agency. Though in extremely early stages, these efforts still stand in stark contrast to the oil minister's comments and to the general attitude of the Organization of the Petroleum Exporting Countries (OPEC) toward new energy sources. The nation's wealth and command economy may, if commitment remains strong, allow it to develop these technologies faster than is currently being done in the Western world and China.

Pollution and Waste

While energy issues receive the bulk of the attention because of their entanglement in the country's economy, the rapid industrialization and urbanization of Saudi Arabia has also led to increased levels of pollution, solid waste, and wastewater, and the government has acted to attempt to address these concerns. Annual budgets in the 21st century have allocated significantly more money to the municipal services sector and have developed water drainage,

waste disposal, sanitation services, and desalination plants in order to deal with waste disposal needs and the coming global water crisis. The government has also promoted the business opportunities available to foreign companies in these sectors, as well as electronic waste, medical waste, and other specialized subsectors. Concerns over water have led Saudi Arabia to become one of the world's leading producers of desalinated water—about 18 percent of the total volume as of 2010—and to announce radical plans to end wheat production around 2016, rather than pit agriculture and other water demands in competition with each other.

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See Also: Africa, North; Cairo, Egypt; Consumption Patterns; Developing Countries; India; Iran; Middle East.

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Scandinavia

Scandinavia is a northern European region consisting of three countries: Denmark, Norway, and Sweden. United by very similar languages, the Scandinavian countries have historically been culturally and politically close. All the countries are constitutional monarchies with a parliamentary system. Denmark and Sweden are members of the European Union (EU); Norway has twice voted against joining (in 1972 and 1994). Each country has its own currency called *kroner*.

Of the three countries, Sweden is the largest with approximately 9.3 million inhabitants, followed by Denmark with 5.5 million, and Norway with 4.8 million. Denmark is by far the smallest and most densely populated country of the three, with a size of 26,777 square miles. Sweden is 279,595 square miles, and Norway is 201,200 square miles, giving these countries a much more spread-out population pattern, though the density is much higher in the south. The largest cities in each country are Stockholm (829,000 people), Copenhagen (1,181,000 people), and Oslo (590,000 people).

Each of the Scandinavian countries has gone through periods of rapid industrialization and urbanization, particularly after World War II. The Scandinavian countries saw rapid economic growth in the postwar years, partly aided by the Marshall Plan. In the early 21st century, many associate Scandinavia with public healthcare, relatively high trust in government, high standards of living, and high levels of social cohesion, though this image is increasingly coming under pressure.

Brief History of Consumption and Waste

While 21st-century Scandinavia is one of the most affluent regions in the world, with high standards of living, many faced poverty and poor living conditions in the cities in the 19th and early 20th centuries. In the latter half of the 1800s, most large Scandinavian cities established city sanitation departments, mainly for public health purposes, such as preventing cholera. Recycling of waste became a way to make scarce resources last longer. Many cities practiced food recycling through mandatory source separation of waste, feeding food leftovers to pigs, up until World War II. Due to resource scarcity during the war, recycling of all types of materials became commonplace. Rationing cards indirectly encouraged recycling by controlling and limiting consumption. During the 1970s, the Scandinavian countries all implemented official waste disposal policies tied to the creation of a Ministry of Environment. In the early 21st century, few recycle because of individual resource scarcity; rather, consumer recycling has become a practical and ideological statement about the relationship between consumer habits and waste generation.

After World War II, consumption levels rose dramatically. Scandinavians eagerly discarded old recycling habits in favor of disposables and unused products. At the same time, Scandinavians gained more leisure time and vacation days, which was linked

with more private car ownership and increased mobility. By 2009, Norway had the fifth-highest per capita income in the world (PPP adjusted) at $57,600, while Sweden was 29th with $37,000, and Denmark was 31st with $35,900. Since the 1970s, oil and gas have become Norway's main source of income, though fisheries and forestry have retained their historically important role. Sweden has an extensive, knowledge-based industrial manufacturing sector and also has a large resource export industry for timber, hydropower, and iron ore. In Denmark, the service industry plays an important role in the economy, though industry, fisheries, and forestry also contribute to the country's economy.

Waste Management

Because of high affluence and consumption levels, municipal waste generation is generally high in Scandinavia. According to the Eurostat statistical database, the European Union (EU) average municipal waste generation was 522 kilos per person in 2001 and 524 kilos in 2008. Denmark produced far more waste than these averages, with 658 kilos in 2001 and 802 kilos in 2008, giving Denmark the highest municipal waste production per person in Europe. Sweden was significantly below the average in 2001, with 442 kilos, but increased to 515 kilos in 2008. Norway generated 362 kilos per person in 2001, but increased considerably by 2008 to 490 kilos per person.

Nearly half of Scandinavia's consumer waste is incinerated, while less than 10 percent is landfilled. The incinerator systems are almost all energy recovery facilities, which convert the burned waste into energy for heating water. Denmark has a particularly dense heating network tied to its municipal incinerators. Landfilling is infrequently used in Scandinavia and is, in fact, banned for most organic, compostable wastes. In 2008, Norway landfilled 88 kilos of waste per capita, Sweden 15 kilos, and Denmark 35 kilos. The average for the EU as of 2008 was dramatically higher, at 207 kilos per person in 2008.

Recycling

The remainder of the municipal waste is recycled in various ways. Scandinavian post-consumer recycling rates are some of the highest in the world; for example, Sweden recycles 35 percent of its municipal wastes and composts 13 percent, and Denmark recycles 24 percent and composts 18 percent. Packaging materials are specifically targeted for recycling in all the countries, including paper and cardboard packaging, glass bottles, plastic cartons, and metal containers. Composting and biogas are common for organic wastes, including garden waste as well as food wastes. Electronic waste has a separate recycling system in Scandinavia, which has resulted in some of the highest recycling rates in Europe, with Norway and Sweden recycling, respectively, 43.5 percent and 54.1 percent of these special wastes.

Source separation plays a key role in the ability to recycle wastes, although the design of the system varies greatly across the region. Municipalities often decide how many waste streams will be separated and which treatment options each will undergo. Most often, consumers are asked to either use distinct waste disposal containers or separate bags for various streams.

The Scandinavian countries all have state-mandated beverage container recycling systems, with mandatory deposits on most beverage containers. These systems were previously organized by bottlers and brewers but became required by law starting in the early 1970s as disposable containers became increasingly common. Some containers, primarily glass beer bottles and some plastic soda bottles, are washed and reused, though most containers are recycled as plastic or aluminum waste. This setup keeps much packaging waste from being landfilled or ending up as litter. The Scandinavian countries have the highest beverage container recycling rates in the world, with 98 percent of glass bottles, 92 percent of aluminum cans, and 90 percent of PET plastic bottles recycled in Norway in 2009. Swedish figures are very close to the Norwegians, and the Danish are only a few percent behind.

Voluntary recycling of other materials is also strong. Nongovernmental organizations (NGOs) like Keep Sweden Clean (founded in 1983), Keep Norway Clean (founded in 2005), and Keep Denmark Clean (founded in 2008) attempt to influence values and organize cleanups. Other cleanup systems are organized by state or by NGOs set up by business to fill government requirements, following the polluter pays principle. In such systems, the producer is made responsible for ensuring the cleanup of its

products after use. The beverage container recycling system is one example, but there are similar systems in place for milk and juice cartons, glass, metal, and electronic waste.

The high affluence level that began after World War II has led to high waste generation rates. Scandinavians have generally offset this trend by recycling and reusing many waste streams, relying on active consumer source separation techniques.

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See Also: Consumerism; European Union; Incinerators; Packaging and Product Containers; Recycling.

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Scrubbers

Communities worldwide often have complicated relationships with coal-fired power plants and manufacturing. While they can bring jobs, tax revenue, and energy to a community, many times they may carry serious public health and environmental issues or concerns due to smokestack emissions. Normally, smokestack emissions are the primary visible way the public is able to distinguish heavy manufacturing from other types of industry and business structures in an area, thus providing a public vocal point for concern. Flue gas desulfurization units, or "scrubbers," are a technology that has specifically been created to address some of these concerns. As such, they have become increasingly prevalent in modern plant design.

Scrubbers are used in industrial processes to separate unwanted residual solids or particulate matter from emissions or effluent before being released into the air or water. Despite what their name seems to imply, scrubbers do not actually physically scrub away emissions like a chimney sweep cleaning the inside of a chimney. Most scrubbers consist of a material such as limestone that traps emissions as a wet or dry substance in order to prevent the emissions from being released. They traditionally control the emissions of acids (e.g., sulfur dioxide, hydrogen chloride, and sulfuric acid) that cause acid rain, smog, and other types of pollution. Some scrubber technologies claim to reduce unwanted emissions by upward of 80 percent.

Before the use of scrubbers, manufacturers and coal-fired power plants had limited ways to reduce harmful particulate emissions. Over time, this particulate soot changed the color of buildings in industrial cities such as Pittsburgh, Pennsylvania, and London, a physical indication of the air quality, or lack thereof, at the time. The image of a smog-filled Victorian era is due to the increased manufacturing production of the Industrial Age without any way to control emissions and other pollution. The resultant impacts ranged from the cosmetic staining of the local architecture to increased public health dangers. Particulate emissions continue to be a problem in today's society, especially due to increased energy needs.

In the United States, burning coal to produce electricity produces 93 percent of the sulfur dioxide created from manufacturing processes. Much of it can be removed with scrubbers. The first scrubbers were invented in Britain in the 1930s; however, they were not widely used. Early scrubbers are considered to have been first implemented in the late 1960s in order to turn trapped sulfur into solid waste and dispose of it in landfills. This practice led some environmental scientists to argue that scrubbers were turning air pollution or emissions into land pollution or a solid waste sludge, thus swapping one

problem for another one. Disposing of solid waste sludge from scrubbers became more difficult as regulation of landfills and landfill locations became more stringent in the mid-1980s and onward. The resulting regulations led to the development of new scrubber technology that could reuse scrubber waste. The new process allowed manufacturers to meet environmental, public health, and manufacturing needs. In this process, more than 35 percent of sulfur waste is turned into a dry powder that can be converted into synthetic gypsum and reused to make drywall and other industrial materials.

Besides industry, scrubbers are used in waste-to-energy incinerators, including municipal solid waste, medical waste, and hazardous waste incinerators. Scrubber technology produces the least amount of waste of current available strategies and is increasingly handling greater quantities and types of emissions waste as time goes by. There are several types of scrubbers, the primary two being wet or dry. In general, wet scrubbers work by using limestone powder or another solution that is mixed with water. As the hot gases go through the substance, the sulfur dioxide remains trapped, while the water is released as steam. Dry scrubbers work with little or no moisture and in its place use solid alkaline powders that absorb the particles without producing emissions. Dry scrubbers are often used in susceptible areas to reduce the possibility of water pollution.

However, scrubber technology is still not 100 percent successful and the American Lung Association contends that coal-fired power plants are still major sources of hazardous pollutants. These pollutants are linked to aggravated asthma and allergies and lead to air pollution linked to greater health problems later in life. However, unlike during the beginning of the Industrial Age, scrubbers are a technology that is available to address these issues along with better practices and regulation throughout the manufacturing life cycle. The benefits of using scrubbers go beyond public health and safety. Scrubbers have evolved to remove or mask possible strong odors associated with manufacturing and power production, which often causes complaints and concern by residents near facilities or plants. According to the Environmental Protection Agency (EPA), scrubbers have been found to reduce equipment breakdowns, and in the long run might increase efficiency. For many facilities, scrubber technology is often considered a costly but necessary part of designing and building a new facility. Scrubber installation creates short-term jobs and is a growing part of the international energy market.

Scrubbers and Environmental Regulation

In the 1980s, the U.S. public became increasingly concerned about the public health and environmental impact of power plants producing sulfur dioxide air pollution. Power plant and industrial emissions were linked to increased incidents of asthma, cancer, and environmental degradation of forests and water sources. More pragmatically, the public was concerned with reduced property values if a power plant facility were to be sited in their neighborhood. These concerns were given the name Not in My Backyard (NIMBY) to indicate the opposition of residents to facilities that produced potentially hazardous emissions. However, despite its negative-sounding connotation, these concerns put pressure on the U.S. government to control toxic emissions. The method used by the EPA was primarily to bring legal action against companies found guilty of polluting. However, this was not seen as effective by itself. This led to the concept of "cap and trade."

Cap and trade is the adoption of the principle that environmental impact is an externality to economic production; thus, its associated costs can be quantified. Emissions can be set to a maximum allowable social cost per firm, or "capped." This cap can be slowly reduced at a regular rate to reduce the total industrial emissions produced. However, regulators recognized that different greenhouse gas producers will have different costs to meet their cap. Efficient firms that could reduce their production would be able to trade their surpluses to comparatively inefficient firms, thus providing an economic incentive to reduce greenhouse gas emissions.

Many people in the government did not believe it would work, or thought that it gave businesses a license to pollute. In 1970, when the U.S. Clean Air Act was first drafted, coal-fired power plant sulfur dioxide emissions were not addressed because it was assumed that they were going to be

phased out with the advent of new power sources. When the issue was revisited in 1977, new coal-fired power plants were required to install scrubbers, but older power plants, which were intended to be phased out, were still exempted unless they planned to expand. However, the use of scrubbers and emissions trading became part of the Clean Air Act Amendments of 1990. Emissions trading or "cap and trade" reduced acid rain emissions by 3 million tons nationwide the year it was implemented. In 2011, the EPA proposed national emission standards for hazardous air pollutants (NESHAP) from coal-fired power plants under the Clean Air Act.

Today, emissions control is more important than ever, as the increasing need for energy competes with the need to promote a sustainable environment. The growing environmental movement means that the NIMBYs of the United States have now become a global concern of Not on Planet Earth, or "NOPE." Luckily, new technological innovations mean that scrubbers have become increasingly more sophisticated as industrial facilities and power plants become more efficient at green practices and government concern for environmental issues has increased regulations. This means that, while emissions still release harmful particulates, they have improved greatly from the 1980s. New facilities today are required to be built with efficient scrubbers, unlike power plants and facilities in the past.

Around the world, scrubbers are becoming increasingly important in meeting competing global economic needs such as tourism, housing, and manufacturing. For example, Beijing, China, put pressure on local industries surrounding the region to control emissions before the Olympics, a major source of tourism revenue.

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See Also: Acid Rain; Emissions; Fuel; Pollution, Air.

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Seasonal Products

Seasonal holidays come with a significant cost in terms of additional consumption and waste. With each party comes more food and packaging waste such as disposable cups, of which the average American worker uses approximately 500 per year. With each wrapped gift comes literally tons of post-consumer waste added to local landfills. Some of the more popular, and thus waste-producing, seasonal holidays in Western culture include Easter, Halloween, and Christmas.

Easter

Easter is celebrated by many in Western cultures, whether religiously or secularly, as a joyous spring holiday spent with family and friends. The United Kingdom estimates that such festivities bring an extra 8,000 tons of waste from the 10 million cards sent and egg cartons used to create Easter eggs.

While Easter is the second-biggest chocolate-consuming holiday (after Christmas), producers such as Cadbury UK and Nestlé UK are making efforts to reduce packaging waste by more than 25 percent, thereby reducing landfill waste by 200–700 tons per year, respectively. Ecoconscious celebrants recommend sending e-cards over paper cards. Also, dyed eggs should be consumed, not just disposed of, and eggshells composted. When purchasing eggs, celebrants should opt for recyclable cardboard egg crates, rather than landfill-bound Styrofoam.

Halloween

Halloween is an increasingly popular holiday in the United States, with over 60 percent of Americans celebrating annually. Across the United States,

consumption of disposable products increases as temporary (pop-up) Halloween stores such as Spirit Halloween Stores and Halloween Express offer seasonal products. The National Retail Federation reports that Halloween purchases in 2009 exceeded $4 billion, which is down from previous years. Halloween sales tend to include many products purchased for a single use and then discarded. Items range from single-use costume makeup and colored hairsprays to disposable party ware. Estimates suggest that 13,000 tons of Halloween costumes are sent to landfills each year.

Costume swaps, where children swap old costumes for different costumes, could reduce the holiday impact on landfills substantially. Ecoconscious party revelers also recommend using natural, festive adornments such as old clothes for stuffed scarecrows and repainted paper lanterns over nonrecyclable plastic pumpkins and plastic bags. Further, rather than discarding pumpkins, make use of the inside (pumpkin seeds and pulp for pies) and compost the outer shells.

Winter Holidays

According to the Clean Air Council, one-third of the waste generated in the United States is packaging, with an additional 5 million tons of waste generated during the holidays. An extra 1 million tons of waste is generated each week between Thanksgiving and New Year's Day.

Four million tons of the additional generated waste is wrapping paper and shopping bags. In addition, consumers send and dispose of an estimated 2.6 billion holiday cards and 38,000 miles of ribbon each year. Estimates suggest that for every pound of wrapping paper, there is an additional five pounds of cardboard and other packaging, whether from product packaging itself (cardboard and bubble wrap) or from shipping protection (additional cardboard, plastic wrap, and crating).

Further, approximately 40 percent of all battery sales occur during the winter holiday season. When improperly disposed of, the metals and chemicals in batteries, such as lead and mercury, can leach into the ground, affecting soil and groundwater. Fortunately, battery recycling is gaining momentum. North America's only free battery and cell phone collection program, Call2Recycle, collected 6.7 million pounds of rechargeable batteries in 2010. This represented a 10.1 percent increase in the United States and an 81 percent increase in Canada from their 2009 collection rates.

Christmas Trees

There is an ongoing debate about which option is most environmentally friendly: natural, or artificial Christmas trees. Artificial Christmas trees originated in Germany in the 1800s and were comprised of a metal frame covered in feathers, often dyed green to resemble actual trees. Plastic Christmas trees as they are known today were originally developed from a toilet brush in the 1930s by the Addis Brush Company. The usable life span of an artificial tree is generally 10–15 seasons, with over 11 million artificial trees purchased annually. Artificial trees, comprised of petroleum-based plastic and metal, are not recyclable.

Eighty-five percent of artificial trees are imported from China. Approximately 25 percent of artificial trees were found to emit high levels of lead, prompting the state of California to enact Proposition 65, requiring trees to carry a label warning of lead poisoning. Additionally, trees originating from China with a wooden center pole were quarantined in 2004 by the U.S. Department of Agriculture because of the detection of a harmful beetle.

An artificial tree would need to be used for 20 years to make it more environmentally friendly than a real tree; real trees are grown, replenished, and recycled very well. Many cities make money by picking up and recycling discarded, real Christmas trees from the curb. Conversely, most artificial trees end up in landfills.

Cut (natural) Christmas trees have a life span of a single season but are recyclable (known as treecycling) and are turned into mulch for consumer use. Of the over 30 million live trees sold each year, approximately 93 percent are treecycled through local recycling initiatives. Experts agree that the most environmentally friendly option is to use a live, potted tree that can be planted after the holiday season. This option may not, however, be viable for all consumers, such as apartment dwellers, who may not have ample space to plant trees after use.

Conclusion

While seasonal holidays are wonderful opportunities to make memories with loved ones, often more than memories are created. As consumers become increasingly eco-aware, sustainability practices such as reduced packaging and increased use of recycled/recyclable materials is likely to escalate. In addition to being a positive experience for family and friends, use of environmentally friendly holiday practices can yield a more positive result for the planet.

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See Also: Candy; Consumerism; Food Waste Behavior; Marketing, Consumer Behavior, and Garbage; Paper Products; Post-Consumer Waste; Sociology of Waste.

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Seóul, South Korea

The capital of South Korea, Seóul is one of the largest cities in the world and the second-largest metropolitan area, with 24.5 million people living in the surrounding area. The history of the city extends back more than 2,000 years, and it is 21st-century South Korea's political, economic, and cultural center, as well as the home to major conglomerates like Samsung and Hyundai-Kia. The city is known for its advanced infrastructure, including the wireless, high-speed mobile Internet; an ultrafast fiber-optic broadband network; the third-largest subway system in the world; and a 217-mile-per-hour bullet train, the KTX. Its size has also led to unique waste management challenges.

Seóul has the highest per capita energy consumption in Asia, and it has increased sharply since the 1970s because of the rapid economic growth of South Korea as a whole, propelled by heavy industry. There is a significant dependence on imported electricity. Most of the electricity in Seóul is generated by nuclear power or coal (about 40 percent each), with natural gas, oil, and hydroelectric power making up the remainder.

Urban Renewal and Green Policies

The majority of the city's air pollution comes from the exhaust of buses and trucks; converting many public buses to natural gas has helped with this issue, though there continues to be a problem in the early 21st century with air pollution blowing in from China. In October 2005, the first segment of a massive 25-neighborhood urban renewal project was opened: the Cheonggye Stream Project, which restored a paved-over streambed and lined it with walking paths. The project was criticized for worsening traffic and demolishing the beloved Cheonggye Market neighborhood, but it was intended to provide better access to many of Seóul's green-space parks and to moderate the city's radiant heat.

In 2010, South Korea announced its commitment to climate friendliness and energy efficiency by designating Seóul its first Climate Friendly City or Green Growth City, according to a Master Plan For Low Carbon Green Growth, which sets out a number of goals for the subsequent 20 years. In that time, greenhouse gases will be reduced by 40

percent and new or renewable energy supply will be increased by 20 percent. One million new green jobs will be created by promoting a number of green technologies appropriate for Seóul, notably the hydrogen fuel cell. The master plan is aggressive and ambitious, and it is meant to constitute a new paradigm in urban planning and environmental policy. It calls for the redesign not only of buildings, the urban area, and transportation systems but also for a "human-oriented city," with many more green jobs and higher salaries. A total of $45 billion is expected to be invested.

Because only a fraction of Seóul's energy is generated in the city—less than half of 1 percent—part of the master plan involves new energy sources generated in the city itself, including solar power and hydrogen fuel cells. Energy efficiency is also a major concern, and 10,000 buildings larger than 2,000 square meters are intended to be converted into green buildings (as will all new construction). All public transportation will be made green, and the plan calls for a goal of increasing the ridership rate to 70 percent, presumably by adding bus lines and reducing fares. Bike ridership should be increased to 10 percent through the creation of bike-only lanes along all major roads. The redesign of the city will take into account climate impacts like heat waves, diseases, and water shortages and will design the waste management systems accordingly. Shortly after the master plan was announced, South Korea further announced an intention to build 14 new nuclear reactors by 2024 in order to cut its dependence on fossil fuels and increase nuclear power's contribution to the nation's electricity to nearly 50 percent, with a major reduction in imports.

Perhaps the most paradigm-changing part of the Seóul declaration is that the city intends to profit from these changes and to demonstrate that a nation's wealth can be founded on sustainable growth. The creation of green jobs will dovetail with the city's excellence in advanced technologies, including biotechnology and nanotechology, and will focus on the 10 green technologies chosen by the local Seóul government: hydrogen fuel cells, solar cells, IT electricity, green buildings, LED lighting, green IT, green cars, urban environment recovery, recovering waste into resource, and climate change adaptation technology. In 2010, most of the city's taxis were converted to gas-electric hybrids, further reducing greenhouse gas emissions—particularly because taxis spend so much time idling.

Waste Management

An early step in this greener direction came in 1995 when the city's basic waste management taxation system was changed to a volume-based garbage collection fee (VGCF) system. This VGCF system is based on two theoretical principles: first, a principle of cooperative production between citizen and city government, or citizen volunteerism; and second, a pay-as-you-throw (PAYT) procedure for assessing waste fees. Previously, the fee charged to households or small businesses for their solid waste

Part of Seóul's master plan for green growth involved new energy sources generated in the city itself, including solar power and hydrogen fuel cells. Other goals include increasing bus and bike ridership, conversion of buildings to green buildings, and green jobs.

was a proportion of their property tax. As of 1995, in order to encourage the reduction of waste, the fee is closer to the real cost and is charged according to the weight of waste discharged. Of course, some forms of waste are more harmful or avoidable than others but this system treats all waste the same. This further encourages recycling, since failing to recycle will have a direct economic effect on the household or business.

Even five years after the new system, a significant amount of Seóul's municipal solid waste was material that could have been recycled: paper (27 percent) constituted the greatest share in 2000, plastics (7 percent), glass bottles (5 percent), and cans (1 percent). The direct landfill of food waste has been forbidden since 2005 in order to overcome South Korea's landfill problems; instead, after separation from the rest of the municipal solid waste, food waste (some 23 percent of the total waste in Seóul) is recycled into compost and animal feed. Some food waste is brought to an anaerobic digestion facility, where it is screened, crushed, and stored in an anaerobic digester, which puts out methane gas as a by-product and powers a generator. It is then converted into liquid fertilizer and solid compost. Some of the facilities also process livestock manure the same way.

Early results of the VGCF system were promising but also produced surprising problems. At the end of the first year of operation, the amount of domestic waste collected in Seóul was reduced by 8.4 percent to a daily average of 14,102 tons. Of this amount, 4,137 tons were recycled, a rate of 30.9 percent. While desirable in terms of diverting materials from landfills and incinerators, the increase in recyclables collected led to an unanticipated glut of secondary materials on the local market. Prices of paper, iron, and aluminum dropped and remained low for two years. Many stocks of recyclables accumulated in scrap yards, as brokers were either unwilling or unable to sell them at depressed prices, and politicians began to criticize the VGCF system as economically unsound.

At the end of 1997, the Korean won collapsed, losing more than half its value against the U.S. dollar. This produced an economic crisis in the nation but ended the recycling crisis in Seóul, as the value of secondary commodities suddenly doubled. The markets stabilized, and the VGCF system continued. Ten years into its operation, the system had reduced per capita waste generation from 1.42 kilograms per person per day in 1994 to 1.13 kilograms per person per day in 2004, while at the same time it increased the amount of recycled materials from 0.3 kilograms per person per day in 1994 to 0.62 kilograms per person per day in 2004.

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See Also: Consumption Patterns; Recycling; South Korea; Sustainable Development.

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September 11 Attacks (Aftermath)

The terrorist attacks that took place in the United States on September 11, 2001, represent one of the defining events of the early 21st century. Their aftermath reveals the significance of the transience and durability of material remains in the contested remembering and forgetting of historical events. On the one hand, the site of the attacks has been the subject of dispute concerning the symbolic and public health implications of its cleanup and the memorialization and reconstruction of Ground Zero. On the other hand, the circulation of human and nonhuman remains from the World Trade Center and surrounding buildings—their sifting at Fresh Kills Landfill and material conversion, sacralization, and commodification in the form of scrap metal,

military equipment, and commemorative objects—illustrates the politics of waste and recycling and their relationship to the delicate materiality of history and memory.

On September 11, 2001, members of the militant Islamist organization al-Qaeda conspired to hijack four passenger airplanes in the United States and deliberately crash them into planned targets, including the World Trade Center in New York City and the Pentagon building in Virginia. All 246 passengers aboard the planes were killed, including 19 hijackers, along with 2,606 civilians and emergency service workers in and around the World Trade Center, and 125 at the Pentagon. The political aftermath that followed included the transformation of domestic homeland security through the Patriot Act and the War on Terror of the Bush and Obama administrations, most notably the overthrow of the Taliban in Afghanistan and Saddam Hussein's regime in Iraq by U.S.-led forces.

The term *9/11* has since come to stand for the event as a whole, understood as a dramatic turning point in recent history, and has acquired a central place in geopolitical discourse as well as in American national memory and political culture. Moreover, the continual reconciliation of 9/11 the material event with "9/11" the ever-changing and politically evocative symbol has been expressed, more than anywhere else, in the contested preservation and transformation of the remains found at Ground Zero at the site of the former World Trade Center.

Recovery

The recovery operation at Ground Zero consisted, initially, of searching for criminal evidence, survivors, and remains of the dead. Waste from the destruction of the buildings was intermingled with human remains, creating a traumatic scene that continues to affect the health and happiness of those who contributed to the cleanup. The once-impressive buildings were transformed into debris and dust, which continue to haunt minds and bodies long after the attacks concluded. Hundreds of cleanup workers at the Ground Zero site, along with local residents and first responders, unknowingly inhaled the remains of the buildings without warning or proper protection. In so doing, they were exposed to a toxic combination of asbestos, pulverized glass and concrete, and heavy metals. Significant numbers experienced respiratory difficulties as a result, locally known as "World Trade Center cough," often presenting to doctors with forms of psychological distress.

Environmental action groups have pressed officials for a more comprehensive review of the deleterious effects of hazardous working conditions on the health of those exposed during the cleanup, and numerous class action lawsuits were brought against cleanup employers, the city, and the Enviromental Protection Agency for downplaying the risks of breathing the air around the site.

Cleanup

The cleanup of Ground Zero was one of the largest of its kind in world history. Over 1.8 million tons of materials were removed from the Ground Zero site in Lower Manhattan and transported to the nearby Fresh Kills Landfill in Staten Island, which was reopened so that the materials could be carefully sorted and sifted through by thousands of detectives, agents, and forensic evidence specialists. As a result of the initial sifting process, which lasted 10 months, thousands of dollars, personal photographs, IDs, and vehicles were discovered, along with nearly 20,000 human remains, which were sent away for identification and eventual return to next of kin.

On different occasions, additional human remains were discovered that had initially been overlooked, exposing city officials to criticism that they favored a quick cleanup over a careful one, and leading to two more searches for remains in the years that followed. To date, identifiable remains are still missing for hundreds of victims of the attacks, and a number of families of those who remain unidentified object that a landfill is substituting for a more appropriate burial. Their concerns led to a grassroots political campaign and a lawsuit against the city of New York, through which some of these families allege that more efforts should be made to find additional remains and that nearly 15 percent of recovered materials from the ruins of Ground Zero have not yet been properly sifted. The suit was eventually heard by the Supreme Court in the fall of 2010 and dismissed.

Memorials

If the difficulty of recovering human remains made Fresh Kills an unlikely and unpopular graveyard, it is also partially responsible for having transformed Ground Zero into a sacred site, now akin to other American national monuments, such as Gettysburg, to which it is frequently compared. There are considerable efforts at memorializing Ground Zero, which have led to considerable disputes surrounding what to do with the space. With the release of each new proposal, there are new debates about the relationship between architectural aesthetics and political narratives and about how best to honor those who have died, a question often collapsed with the preservation of the former towers. As with all efforts at memorialization, preserving the sanctity of the site means expressing the right nationalist messages. This was demonstrated, most recently, in the intense public debate over plans to erect a Muslim cultural center in the vicinity of Ground Zero. Such disputes reveal a tension between preserving signs of the former buildings and rebuilding the site into something new.

Similar issues arise when the focus becomes the way the remains of Ground Zero travel as objects more or less associated with the remembering of 9/11. The conversion of remains can be understood in terms of their relative commodification and sacralization, depending on their successful representation of 9/11 and the confluence of meanings attached to it.

One telling example is the last object removed from Ground Zero during cleanup, a 36-foot-tall steel shaft—known as "the last column"—which rescue workers used to post photos of the missing along with letters from their family members, rosary beads, and other commemorative objects. When the cleanup was complete, the column traveled the globe, a fragment of Ground Zero and a sign of the resilience and survival of New York City in the wake of tragedy, until it was returned to Ground Zero in 2009 to serve as the centerpiece of the new memorialization effort.

A less successful example is the commemorative coin released by the National Collector's Mint and sold on the fifth anniversary of 9/11. According to advertisements, which have not been substantiated, the coins are composed of valuable gold and silver recovered from the vaults beneath the wreckage. The coins came under criticism from members of the public and politicians. The U.S. Mint warned that the coins were not legal tender and the sale of the coin was temporarily stopped by the attorney general, but it was reported that a 10th anniversary coin would also be introduced. The problem was not solely the commodification of the metals recovered, because another successful commodity—a billion-dollar U.S. Navy assault ship called the USS *New York*—was also constituted in part from steel claimed from the ruins of Ground Zero. Rather than seen as an object or measure of value in its own right, the ship is imagined as a positive and practical outcome of the attack, not so subtly embodied in a killing machine engaged in the global war on terror.

Scrap Metal

Perhaps the least remarked upon and controversial destination for the remains of 9/11 was also the most common, which is as recycled steel in the global scrap metal market, typically to be sold in China and India. Scrap yards sell scrap metal by the pound to be smelted into raw material for construction. All connection to the original object is lost as it is broken down into its basic material constituents and recommodified for trade. This pathway for material remains represents the other end of the spectrum from celebrating a particular object for its specific biography, as a beam that survived destruction of the World Trade Center.

As scrap metal from Ground Zero is dissolved into a mass substance with no unique identity, revalued per pound, and remade into something new (e.g., the Olympic Stadium in Beijing), it loses the capacity to represent the past as memory or as evidence. Perhaps the only controversy surrounding this scrapping process has been raised by members of the 9/11 Truth Movement, some of whom claim that rapidly selling off the material ruins of the World Trade Center destroys the only remaining evidence of a possible conspiracy. For the most part, however, this process of material conversion has not generated the same public debate and controversy as others associated with Ground Zero. Unlike the controversial commemorative coin, the conversion of World Trade Center metal into

Chinese and Indian cities is rendered morally and politically inert, which perhaps explains why it has attracted little public interest, even as the fate of other human and nonhuman remains of the 9/11 terrorist attack live on in the public imagination.

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See Also: Construction and Demolition Waste; Environmental Justice; Fresh Kills Landfill; Funerals/Corpses; Landfills, Modern; New York; New York City; Politics of Waste; Steel; Trash as History/Memory.

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Septic System

The septic system was invented around 1860 in France by Jean Mouras, who developed a one-chamber anaerobic waste digestion system. The technology was adopted throughout Europe and the United States, as well as in colonial Africa through French colonial administrations. While the system worked remarkably well, it soon became overwhelmed when more than one person's waste was added.

Imhoff System

The Imhoff two-chamber septic system, named for German engineer Karl Imhoff, was developed about 20 years later. The Imhoff system is the same basic design of systems used in the early 21st century. Wastewater is pumped into a tank. The solids, which are heavier, fall to the bottom of the tank. What is left is wastewater that includes gases, grease, and other waste products. The gases in the wastewater naturally break down the solids and other materials in the wastewater and purify it as it goes through the system. Through the two-chamber system, this process happens more efficiently, allowing more clarified water to move through the system and not be continually mixed with new blackwater. Water is released after receiving this primary treatment to filter into leach fields, where it is treated through natural processes of filtration through the soil. The Imhoff system functions optimally with a flow-through of about 1,000–2,000 gallons per day. This means that the system works adequately for a modern U.S. household of two to three people. Various amendments have been made to the Imhoff system, in part to increase capacity, but the basic design elements remain the same.

Use

Septic systems are among the most important systems for treating waste at the individual household or cluster household level. According to the Environmental Protection Agency (EPA), the 2007 U.S. Census Housing Survey estimates that approximately 20 percent of U.S. households use septic systems for wastewater treatment. In addition, some 22 percent of newly constructed houses had septic systems. Septic systems have been applied around the world in places where centralized wastewater is not available. As smaller communities have struggled with the cost of bringing centralized wastewater treatment online, there has been increased attention to decentralized wastewater treatment options. Because of technology's reliability and widespread usage, septic systems are frequently included in decentralized management plans.

Criticisms

While many consider septic systems among the most efficient systems for water-based sanitation, there are also critics of this technology as a means of treating human waste. These critics include those who are concerned about the inappropriateness of the technology for particular environmental conditions, potential mismanagement of systems, and the cost of proper installation and management, along with those who propose technologies that better incorporate human waste into the ecological system (called "biosanitatation," such as composting toilets or wetland treatment systems). Septic systems

may be incorporated into some alternative wastewater management programs.

Concerns about the appropriateness of the technology for particular environmental conditions vary. Septic system technology is dependent on having the correct soil type for filtration of wastewater once it is released from the tanks into the leach field. Soils that have too much clay may be insufficiently permeable, leaving wastewater bubbling to the surface, creating a health hazard both through potential direct contact or runoff into adjacent surface water.

Soils that have too much sand may be too permeable, and wastewater may seep into the groundwater table before being sufficiently filtered. In areas with a high groundwater table, there is also a risk of contamination through contact between insufficiently treated wastewater and groundwater. Proper assessment of the soil type and depth to groundwater, along with landscape variables such as slope, are essential to proper septic system design and installation.

Particular system designs exist to mitigate some of these potential hazards. For instance, in places with high groundwater tables, septic systems are frequently designed with a mounded leach field to mitigate the potential of minimally treated wastewater contaminating the groundwater—usually the source of potable well water in the area. In areas with sandy soils, the leach field is frequently designed to slow filtration of wastewater to prevent contamination of groundwater.

Mismanagement of systems is also an issue of increasing concern. Septic systems are sometimes installed with insufficient attention to the environmental and landscape variables. This may then be compounded as homes and businesses change hands, and those managing the system have less memory of the issues mentioned as the system was installed (presuming the issues were mentioned). Additionally, septic system functionality may decrease if the system is inundated with wastewater. When owners lapse in pumping schedules or add volume through numbers of people in the household or establishment sending water into the system, this may severely impact the system. Additionally, poorer people may lack the resources to repair old septic systems that no longer function well.

The EPA Decentralized Wastewater Management Program devotes significant attention to developing the institutional frameworks for improved local management. Among the suggestions are the establishment of local inspection systems, training for home and business owners, education campaigns, and utilizing existing services such as wastewater pumpers and haulers to provide system oversight.

Cost of proper installation and maintenance of systems continues to be a major concern. Depending on the environmental conditions, the cost of septic system installation may be significant: $15,000 or more. In most cases, because septic systems are on private property, it is difficult to raise grant or subsidized loan money for this purpose. Cost of repairs may also be prohibitive. It is also often the case that the households with systems most in need of repair are precisely the households that lack the ability to make those repairs.

Alternatives

Alternatives to septic systems come in many forms. Constructed wetlands and other bioengineered wastewater treatment systems are often cited as a less expensive system that allows natural processes to biodegrade and purify wastewater. Management of these systems, however, requires diligence and expertise in ecological system function. The same is true of composting toilets, which in practice are hard to maintain consistently. Separation of graywater (wastewater from sinks, baths, and appliances) and blackwater (from toilets) is seen as the best practice in water management and has been applied in some areas. The separation of gray- and blackwater may improve the functionality of existing septic systems.

Septic system technology has a long history in on-site waste management. The system is easy to understand, sanitary when it is working, and provides clear signals when it is not working. While good septics are sometimes expensive to install, they can operate with minimal expense once in place—given that the correct provisions were made for local landscape and environmental functions. For these reasons, while state regulatory bodies are becoming more tolerant of alternative systems, water quality regulators are more likely to permit

septic systems for wastewater treatment in areas not served by municipal wastewater treatment plants.

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See Also: Human Waste; Pollution, Water; Sewage; Sewage Treatment.

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Sewage

Sewage comprises the wastewaters deliberately contained, collected, and evacuated by a community, including both household and industrial wastes as well as surface runoff. There are many ways to dispose of or utilize human excreta, but in a real sense, human waste does not become "sewage" until collected by some type of sanitary technology such as a latrine or sewer, however simple. The long and complex history of sewage is strongly related to the growth of human settlements and the problems of disease and disorder arising from the spatial concentration of human wastes. Access to technologies for the safe, efficient collection and disposal or reuse of sewage varies widely around the globe, and sewage remains a major source of environmental pollution and public health threats in many parts of the world. From a social perspective, sewage is best understood as an amalgam of cultural ideas, nonhuman constituents, and technoscientific discourses and practices surrounding human sanitary waste production and disposal. The material flow of sewage connects bodies, environments, technologies, and cultural systems through space and time.

Composition

Technical literature on sewage almost exclusively uses the term *wastewater* to describe liquid domestic wastes, reflecting the dominance of water-carriage technologies for sewage disposal in the developed world. The precise material composition of sewage, however, reflects the social and cultural practices of the society producing it and the methods of collection and disposal employed. Domestic sewage contents are highly variable, ranging from a nearly solid product composed mainly of composted human feces (or urine) to a complex flow of wastes greater than 95 percent water.

A community's sewage may include human feces and urine; bodily cleaning materials and other solids added deliberately or incidentally; industrial and commercial inputs; and water, including flushing water, graywater from household uses, rainwater, groundwater infiltration, and street, yard, and roof runoff. From a biochemical perspective, sewage may contain large quantities of decaying organic matter; nitrogen, phosphorous, and other nutrients; bacteria and other pathogenic microorganisms; toxins, including dioxins, pesticides, and other chemicals, heavy metals, oils, and phenols; gases, including hydrogen sulfide produced by decomposition; and suspended solids, such as dirt, fibers, and other particles. These constituents present challenges for the safe treatment, disposal, and potential use or reuse of sewage and wastewaters.

Environmental Effects

As part of what has been described as the "urban metabolism," sewage connects the proximate space of human settlements with distant places and environments. Whether carted, trucked, piped, or percolated, sewage flows into aquatic, soil, and biotic systems, altering, enriching, and often degrading them. Sewage inputs promote the enrichment of biological systems, as with its deliberate reuse as an organic input for agriculture or through the incidental addition of nutrients to natural streams (which may promote fish growth and reproduction). More often, however, uncontrolled sewage disposal creates potentially severe environmental degradation.

Excessive enrichment of natural waterways may result in cultural eutrophication, a process whereby algae and bacteria feeding on sewage or other nutrients rapidly reproduce, or "bloom," reducing oxygen availability for other aquatic life forms. In the 1960s, widespread use of phosphate detergents contributed to fears that Lake Erie would be rendered lifeless due to eutrophication. The particulate matter and toxins in untreated sewage also degrade the aquatic environment, while pathogenic bacteria may threaten organisms and people that come into contact with untreated wastes. Sewage also fouls the environment from an aesthetic perspective, altering the appearance, taste, and smell of receiving media.

Disposal Methods

For millennia, humans have exploited natural systems as "sinks" for the deliberate disposal and neutralization of harmful wastes (in addition to or instead of technological treatment). Water flushing systems for the evacuation of human wastes date back to the ancient Indus Valley and Mesopotamian civilizations, and the Romans built an extensive network of sewers, or *cloaca*, for their capital. Many societies have collected human excreta for application as manure, a practice still common in rural Asia; the reuse of post-treatment wastewater and "biosolids" (composted sewage sludge) still finds many advocates. Other "dry conservancy" methods for human waste containment, such as cesspools and privy vaults, relied on householders or specially designated collectors (known in England and North America as "night soil men") to clean out their contents periodically. With the advent of piped urban water supplies and sanitary appliances in the 19th century, these in-home systems often overflowed, polluting homes, streams, and groundwaters and prompting the development of subterranean sewerage networks. Many early sewer systems merely transported and discharged sewage to the nearest water body, resulting in environmental degradation, the contamination of community water supplies (or those of communities downstream), and the spread of waterborne diseases such as typhoid, dysentery, and cholera.

Evolving sewage treatment and disposal practices in the modern era have been guided by changing technoscientific discourses about waste and environment. For instance, sewage—understood as the content of sewers—has not always included human excreta. Hausmann's plans for the sewerage of Paris in the 19th century sought to exclude fecal matter from the city's drainage system. Even once sewers accepted *tout à l'égout* (everything down the drain), the scientific understanding of sewage contents, their health, and environmental effects, as well as how to address them, has changed considerably. Until the bacteriological revolution in the late 19th century, public health advocates believed that foul smells, or miasmas, were the main cause of epidemic disease, a belief that shaped water quality and waste disposal debates. By the early 20th century, the broad acceptance of germ theory led to the identification of fecal contamination of water supplies as a major public health problem, but debate continued among sanitary engineers over whether the technical solution should be water supply purification or sewage treatment. Sewage disposal solutions ranged from ideas about the "self-purifying abilities" and waste-assimilative capacity of flowing waters to the scientific delineation of appropriate receiving waters, mixing zones, and treatment and disposal technologies based on environmental conditions.

Cultural Conceptions

Sewage disposal practices are also shaped significantly by cultural attitudes toward waste and the environment. Historians, anthropologists, and other observers highlight how ideas about filth, pollution, and purity—both bodily and social—influence individual and collective reactions to sewage. Encounters with sewage elicit emotional reactions such as disgust, abjection, and fear of contamination; the sight and smell of human excreta offends the aesthetic sensibilities of many cultures. Those in society associated with waste spaces or occupations are often stigmatized by their association with sewage. Waste collection and disposal practices reveal culturally distinct attitudes toward the management of the natural and built environment. European colonial authorities, for instance, imposed their own conceptions of public health, sanitation, and social order in proposing urban waste disposal solutions for colonized populations.

Urbanism

The organized and collective effort to accumulate and dispose of human waste via sewers is strongly associated with urbanism and the state as spatial orderings of society. The management of the social spaces of the city is deeply entwined with the management of waste in that space. Sewage collection practices contributed to the reconfiguration of social spaces of defecation and hygiene (indoor and private) and therefore of the physical spaces of the home and city, from early "houses of office" to modern toilets and from street-level disposal practices to subterranean sewer systems.

The networked spaces and sanitary preoccupations of what geographer Matthew Gandy calls the modern "bacteriological city" in the 19th century emerged in tandem with the increasing role of expertise, centralized, bureaucratic management, and the state in public life. Trends toward the privatization and decentralization of sewage, water, and other urban infrastructural services are indicative of the rise of neoliberal models of urban governance.

Conclusion

Sewage remains a significant environmental and public health challenge, particularly in the developing world. An estimated 2.6 billion people lack access to basic sanitation, resulting in widespread illness and death from diseases such as dysentery. The 2002 establishment of a United Nations' Millennium Development Goal to halve this figure by 2015 has struggled to reach its targets, in spite of the United Nations declaration of 2008 as an International Year of Sanitation. Where sewage disposal systems exist, they are often inadequate, and more than 80 percent of the developing world's sewage is discharged untreated. As the world's population continues its rapid pace of urbanization, sewage disposal will likely remain a critical environmental and development challenge for decades to come.

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See Also: Germ Theory of Disease; Human Waste; Miasma Theory of Disease; Sanitation Engineering; Sewage Treatment; Sewers.

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Sewage Collection System

Archaeologists provide valuable information about the design of ancient cities. The city of Rome was not the first to construct buildings and structures for urban sanitation. The excavations of ancient cities have revealed equipment destined to manage waste and wastewater, with fully integrated sewage collection systems. The site of Chatal Hüyük (Çatalhöyük), in the Konian plain of Anatolia (in Turkey) had public dump sites covered in oven ash to neutralize odors (6th millennium B.C.E.). The Sumerians (4th millennium B.C.E.) created a system of irrigation and wastewater disposal. This huge sewer ran through the cities of Lower Mesopotamia. Around 2500 B.C.E., cities of the Indus Valley civilization, especially Mohenjo-Daro and Harappa, boasted a sewer system that drained into the Indus. A similar system can be found in Knossos, Crete, draining into the Kairatos. Houses in the Indus Valley were equipped with bathrooms and wash houses, floors were made of tilted slabs for drainage, and a gutter ran along a sealed wall leading to the street sewer.

Far before Rome and its empire, different systems of water as a means of evacuation and purging

existed. Sewage networks of the 21st century are variants of this universal principle. The Egyptians, for example, opted for the transport of fecal material in clay amphorae, which was then collected regularly and used as fertilizer.

In Jerusalem, the Kidron Valley served as a dumping ground for garbage from the holy city. Raw sewage was reserved for composting, while solid waste was incinerated in a perpetually lit hearth.

Athens was an exception to this urbanization norm, with its unpaved streets that quickly becoming muddy and dusty. The capital of Attica did not adopt a garbage disposal system until the 5th century B.C.E. It was not until the 4th century B.C.E. that Aristotle mentioned the work of the Astynoms, official employees who managed the road and waterways networks and were responsible for preventing dumping into street gutters and ensured garbage removal. Pergamum, the ancient city of Mysia, capital of the kingdom of Attalides from 282 to 133 B.C.E., was an active center of Hellenistic civilization before being bequeathed to the Romans by Attalus III. Here, the rules of urban road management, water fountains, water mains, and sewers were strict and under the responsibility of the Astynoms.

Rome

Rome built its famous sewer in 300 B.C.E., nearly 400 years after its legendary founding by Romulus. The Cloaca Maxima was a network of open-air pipes leading to a main collector before flowing into the Tiber. Built under Tarquin the Proud, Etruscan king of Rome (616–579 B.C.E.), the canal system was cleaned regularly by opening aqueduct valves to flush out wastewater. A connection to the network was very expensive. The city's wealthier classes stored their waste in various amphorae called *vasa obscoena* that were either emptied by slaves (called the *lasanophorus*, from the Roman word *lasanum*, which means "chamber pot carriers") into public sewers or collected by private companies that then delivered the waste to farmers.

In 500 years (200 B.C.E.–300 C.E.), Rome's population grew from 130,000 to 1.2 million, and its Cloaca Maxima spread in keeping with the urban expansion. Expansion, though, had its limits, and eventually superintendence could not keep up. For lack of sufficient maintenance, waste was often discarded through windows or other openings. Roman courts frequently punished violators of urban civic responsibility. Accumulations around the city mingled human and animal corpses with other organic materials, forming a frontier between the urban and the nonurban world. In a single day, several hundred men could die in the arena, along with roughly 5,000 animals. All were thrown into the pits according to the archaeologist Rodolfo Lanciani, based on his excavations. These deposits were petri dishes for germs and diseases such as typhoid, cholera, or malaria. This remained the case until the late 19th century in the countryside surrounding Rome.

Since antiquity, urban sanitation, whether in Babylon, Nineveh, Syracuse, or Rome, was based on channeling water as the main vector to rid the site of sewage, feces, and other wastes. The history of urban expansion demonstrates the spread of sewers, both above and below ground.

Medieval European Cities

The fall of the Roman Empire triggered a general decline in urban municipal administration. The air was so polluted in 590 that St. Gregory the Great (540–604) called it "bestial," and declared it the cause of the plague, which was raging. In 165 C.E., an epidemic would have caused havoc. What Rome experienced would cross the English Channel.

London in the 12th century was a typical medieval town, split in two by the Fleet (London's former river). The river concentrated many of the city's industries and a large portion of its population. The activity and dense population eventually clogged the river with filth in the 14th century, rendering it unnavigable. Following the fire of 1666, when the capital was reduced to ashes, a renovation of almost the entire city was undertaken. Architects devised a system of garbage disposal at each street corner. The Fleet collector was rendered navigable once more but continued to exhale its miasma through some of the most densely populated areas of the city. Between 1830 and 1840, the riverbed was finally transformed into a covered sewer.

The water flowed by gravity in most tunnels, but it was necessary to pump in some places. Four pumping stations were equipped with eight steam engines of 140 horsepower each, which, in turn, powered

two double-acting piston pumps. Londoners drew most of their freshwater from the highly contaminated Thames. Serious epidemics of cholera in 1849 and 1853 killed nearly 20,000 people. Sir Joseph William Bazalgette (1819–1891), member of the Royal Commission on Public Health Works, presented a report on the sanitary conditions of the working population of Great Britain in anticipation of a population of three to four million inhabitants. In 1856, he advocated the development of a vast network of sewers parallel to the Thames to be built over 20 years. The sewage collection system would be routed 12 miles downstream from London Bridge before being scattered into the Thames. Over 93 miles of tunnels were built, and Bazalgette's grandiose project became a reality in 1875. Edwin Chadwick envisioned the city as a body of irrigated water circulating and purifying the city. It was a Pastorian century, and Chadwick had already announced the extension of this model across Europe and the Western world.

In Paris, the first above-ground sewer was built in 1374; they were open-air sewers identical to those of medieval towns. These rudimentary sewer and water supply systems quickly became useless as soon as garbage was dumped inside them, a practice that was strictly forbidden by countless by-laws in the Middle Ages. In the 14th century, Parisian regulations forced the residents to clean the streets at their doorstep and carry the filth and sludge to the fields surrounding the city at their expense. The first real public cleaning service was inaugurated in 1506. A decree prohibited throwing dead animals, garbage, or dyes into the river. It was also forbidden to wash skins for tanning or one's linens in the river.

In the mid-17th century, the Parisian sewer network that was 10.5 miles long was destined to serve about 500,000 inhabitants, increasing to 550,000 in 1800 (12.5 miles of sewers), then 800,000 in 1830 (25 miles of sewers). Work to extend the network began in 1833 and employed some of the most brilliant French engineers. With more than 1 million inhabitants in 1850 and 1.7 million in 1860, the city should have had a network of 217 miles of pipelines. Forecasts had predicted the needs for 2.5 million inhabitants; but in 1951, the city already had 2.8 million inhabitants.

Modern Sewers

The model of city planning deployed by Western countries uses large "collector" systems that converge into outlets. Sewers are the most illustrious of these achievements. It must be noted that the Far East and Latin America have developed alternative models to "all waterborne sewerage." In China, farmers build elegant latrines to attract the traveler and his excreta. They also construct digesters to transform the waste into either compost or energy in the form of biogas. The global urbanization trend of megacities makes it almost mandatory in the 21st century to build sewers of mammoth proportions to collect and deliver the quantities of excreta produced by urbanites.

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See Also: Archaeology of Garbage; Cloaca Maxima; History of Consumption and Waste, Ancient World; Human Waste; Sanitation Engineering; Sewers; Waste Management, Inc.

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Sewage Treatment

Sewage treatment results in two end products: treated wastewater and sewage sludge. The intended product of wastewater treatment is clean water. The sludge captures materials that are water repellent (hydrophobic) and insoluble. The partitioning of hydrophobic substances and their subsequent removal as sewage sludge is an integral step in the treatment process, decreasing the level of pollutants discharged into receiving waters. In the United States, approximately 16,500 wastewater treatment plants (WWTPs) discharge 12 trillion gallons of wastewater and 9 million dry tons of sewage sludge each year (many more times than this if not dried or digested).

Wastewater is characterized in terms of its physical, chemical, and biological components. It brings to the sewage treatment plant all the wastes sent into the sewers from drains and toilets: industrial, hospital, commercial, and human waste; road and stormwater runoff; and every other kind of hazardous, toxic, and biological waste material produced in a municipality and carried away from its source via the sewer. Not all sewers discharge treated wastewater, but the vast majority in industrialized countries do, using regulatory policy to establish effluent limitations.

Pollutants

Sewage treatment is focused on reducing in-wastewater discharges, so-called conventional pollutants: oil, grease, organics like nitrogen and phosphorous, total suspended solids, and settleable matter. Most chemical removal is incidental and is dictated by volatility, solubility, and hydrophobic properties, rather than by treatment processes.

Elements commonly found in wastewater, such as nitrogen and phosphates, reduce the available oxygen in water and become organic pollutants in the receiving waters. Organic pollutants can profoundly alter aquatic ecosystems to the point of eventually making them unable to support aquatic life.

Measurement

The principal metric used to measure the quality of treated wastewater is its biological oxygen demand (BOD). BOD measures the oxygen used by microorganisms to decompose organic waste. The higher the BOD, the more polluted the water and—when measured in wastewater—the less effective the wastewater treatment.

Since BOD can be uniformly measured regardless of the heterogeneous and complex nature of wastewater, it has been the preferred benchmark for wastewater quality. Inorganic pollutants, such as synthetic organic chemicals and other chemicals of concern, are much more difficult to measure and their impact on aquatic and terrestrial life is more difficult to gauge.

Regulation

The Environmental Protection Agency (EPA) regulates toxic chemicals in sewage if three conditions are met: (1) the pollutant is present in high amounts, (2) technology for its control is available, and (3) the implementation of that technology is economically feasible.

Pollution control is implemented by end-of-pipe limitations, meaning by effluent limitations on specific constituents in the discharge. These are based on current available technologies (what the treatment plant is actually capable of doing).

To address indirect discharges from industries to WWTPs, the EPA established the National Pretreatment Program as a component of the National Pollutant Discharge Elimination System (NPDES) Permit Program. The Pretreatment Program is plagued with permit backlogs, gaps in program coverage, huge amounts of nonregulated pollutants, lack of monitoring, inadequacy of regulatory compliance, lack of WWTP incentives for implementation and enforcement, and the fundamental fact that it is cheaper to dump hazardous wastes in the publicly owned and financed sewer than to properly dispose of them.

Brief History

Sewage systems were not of great interest to mid-century engineers, but the technology fast became their domain, contested primarily by physicians. Between 1850 and 1880, when the first sewers were built in the United States and England, the number of engineers grew from 512 to 8,261. In 1867, the American Society of Civil Engineers, the first national professional engineering society, was estab-

lished. In 1900, the number of engineers grew to 45,000, second only to teaching as a profession; by 1930, there were 230,000 engineers in the United States. Engineers became members of the technocratic elite through their positions in city government and professional networks and organizations.

As urban populations doubled and tripled in the late 1890s, untreated wastewater poured into waterways, while illness and death from typhoid, cholera, and other infectious diseases soared. Sewers improved the health of upper riparian communities and devastated the health of downstream populations. Debate among engineers, doctors, and politicians ensued as to whether to treat the sewage before discharge or to treat polluted water before delivering it to households. The engineers' arguments for not treating sewage, based on economic concerns, prevailed and so treating polluted drinking water for disease-causing organisms became the norm.

Treatment

The general levels of wastewater treatment are preliminary, primary, secondary, and tertiary. In preliminary treatment, floating and settleable materials—like rags, sticks, and grit—are removed and carried to landfills, usually by truck. Primary treatment, the next level of treatment, uses sedimentation to remove some suspended solids and organic matter. In secondary treatment, biological and chemical processes use anaerobic or aerobic bacteria to further reduce suspended solids, BOD, and nutrients like phosphorus and nitrogen. These nutrients are called "limiting factors." When they are present in water, they cause an explosive growth of algae, which, in turn, causes lakes to die of eutrophication as the decaying algae rob the water of its oxygen. Tertiary treatment is the most advanced level of treatment for wastewater and utilizes screens, filters, and chemicals. Its goal is the reduction of nutrients, dissolved solids, and suspended solids that remain after secondary treatment. Disinfection of the wastewater, often with sodium hypochlorite (chlorine bleach), is common. Fecal coliform counts are the measure of success or failure for this process.

Hazards and Disposal

Besides what is deposited into the sewer by roadways, households, industry, hospitals, and every other legal and illegal source imaginable, what comes out the outfall pipe is sometimes generated by the chemistry happening in the confines of the wastewater treatment plant. What the engineering and public health community call "disinfection by-products" is a good example. Two unintended, highly-toxic by-products of the chlorination of wastewater are trihalomethanes (THMs) and N-nitrosodimethylamine (NDMA). NDMA is a nitrosamine and is among the most powerful carcinogens known.

What is not removed by treatment or partitioned into the wastewater is found in sewage sludge. Sewage sludge is a heterogeneous mix of hazardous materials. The EPA's 2009 National Targeted Sewage Sludge Survey detected "high concentrations of toxic contaminants in sewage sludge," specifically of the following:

> . . . toxic contaminants with heavy metals, steroids and pharmaceuticals, including the antibacterials, triclocarban and triclosan . . . antibiotics, disinfectants, antimicrobials, steroids, endocrine disrupting chemicals and other anthropogenic drugs.

The Clean Water Act and the Ocean Dumping Ban Act of 1988 eliminated all but land-based options for the beneficial use or disposal of sewage sludge. A decade earlier, the Clean Water Act mandated that thousands of communities upgrade their sewage treatment plants to secondary treatment—a process that more than doubles the amount of sludge produced at wastewater treatment plants. Sewage sludge is also referred to as biosolids. The word *biosolids* has no scientific or legal basis. However, this word has been adopted by the waste industry and can be found in place of the term *sewage sludge* throughout its marketing materials and literature.

In 1991, the Water Environment Federation (an association of sewage treatment plant operators, municipal sewage authorities, and corporate sludge haulers) established a Name Change Task Force to develop a more appealing name for sewage sludge. In June of that year, the task force came up with a brand new word: *biosolids*. The federation also established the Biosolids Public Acceptance Task Force, which received administrative and financial

support from the EPA, with the purpose of overcoming the growing opposition to the disposal of sewage sludge on land.

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See Also: Human Waste; Pollution, Water; Sewage; Sewage Collection System; Sewers.

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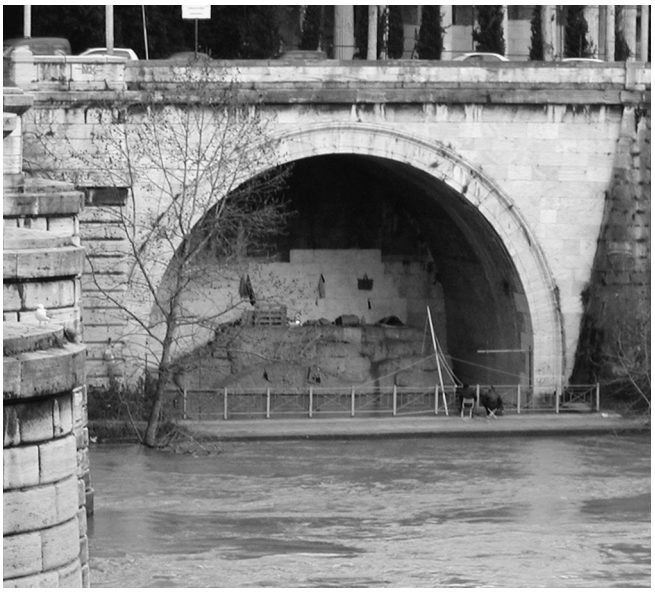
Sewers

Sewers are underground systems of pipes that use water to carry stormwater, domestic waste, and industrial waste for disposal into waterways. The combination of water and waste, commonly referred to as "sewage," moves through the pipeline by gravity or under pressure (in which case, the flow is dependent on a pump station). Since people decided to use water-carriage systems for waste disposal, governments have been trying to deal with the unexpected and negative impacts of the technology with regulatory policy.



The mouth of the Cloaca Maxima, the earliest sewer in Rome. Built in the 6th century B.C.E., it was designed to carry stormwater and effluent to the River Tiber. The flush toilet developed later was the luxury of the privileged few in the city.

Early History

The orthodox view is that sewers were invented by the Romans with the construction of the Cloaca Maxima, which discharged into the Tiber River. Rome's first sewers were built in the 6th century B.C.E. They were originally open channels, constructed by lining existing streambeds with stone. The channels were enclosed beginning in the 3rd century B.C.E. The sewers' primary function was to carry off stormwater, though like in all cities with stormwater drains, they were eventually used to carry human and other waste products to receiving waters.

The flush toilet greatly facilitated the introduction of human excreta into sewers. This pivotal technology was known to the privileged at the height of the Roman era and since the 18th century in parts of Europe. By the middle of the 19th century, diseases like cholera and typhoid—carried to wells, spigots, and waterways by feces-laden wastewater—gave rise to a demand for the construction of sewers that would carry sewage not only out of and away from the home but also away from the city.

English sanitarian Edwin Chadwick, in his 1842 report on the sanitary conditions of England's poor, advocated sewers as a way to improve the health of the urban poor. At the time, it was thought that poisonous vapors from putrefying materials caused disease. This was called the miasma theory of disease (the term *miasma* means "bad air").

Early Sewers

The first sewers were constructed in England and the United States in 1850, trailing the construction of waterworks by 5–50 years in most cities. The effort to move human and industrial wastes away from city centers was driven by access to piped water in urban areas and also by the work of sanitarians like Chadwick. This entailed the evolution of the ditch-type stormwater sewer into the closed-pipe water-carriage system of sewerage. The wastewater was the medium of transportation, so a large and regular supply of water was a requirement to keep the wastes moving in the pipes.

In the United States, Philadelphia built the first waterworks in 1802; by 1860, the nation's 16 largest cities had waterworks. By 1880, the number increased to 598. After sewers were built on the heels of waterworks, conveniently carrying wastes with water, urban populations were regularly drinking effluent from sewers. With polluted water everywhere, waterborne epidemics like typhus and cholera ferociously swept through metropolitan areas such as Chicago, New York, and Pittsburgh, taking thousands of lives and giving new authority to sanitary reformers and, paradoxically, life to sewers.

Construction in Chicago

Building sewers was a monumental task. The Chicago Sanitary District, established in 1889, the first regional wastewater authority in the nation, managed to reverse the flow of the Chicago River in 1900 when it built a canal to accommodate the city's sewage. The Sanitary and Ship Canal was larger than the Suez Canal and established the Chicago School of Earth Moving, which would later be employed in the construction of the Panama Canal. Instead of carrying Chicago's sewage to Lake Michigan, the reversal of the Chicago River and the subsequent construction of the 387-mile Sanitary Ship Canal moved the city's wastewater to the Mississippi River. In order to install sewer lines in Chicago, every street was raised six to 10 feet. Existing buildings were lifted to the new street level. By 1908, the city's typhoid deaths dropped 91 percent, but downstream communities in Missouri experienced an increase in disease.

Problems, Hazards, and Limitations

The water-carriage system of sewerage introduced a new set of problems and, about these problems, a new set of debates among sanitary engineers in Europe and the United States. One of the debates that divided engineers was between those who believed in the value of human excreta to agriculture and those who did not. The believers argued in favor of "sewage farming," the practice of irrigating neighboring farms with municipal sewage. The second group claimed that "running water purifies itself," arguing for piping sewage into lakes, rivers, and oceans. In the United States, the engineers who argued for direct disposal into water had, by the turn of the 20th century, won this debate. By 1909, untold miles of rivers had been turned functionally into open sewers, and 25,000 miles of sewer pipes had been laid to take the sewage to receiving waters.

In the 1940s, U.S. wartime production of synthetic organic chemicals and a subsequent push by government and the chemical industry to get these chemicals into commercial use resulted in the exponential increase of synthesized organic compounds in the environment. Estimates are that 10,000 new chemicals are added to production in the United States each year. Sewage treatment is not designed to reduce or eliminate synthetic chemicals, instead addressing only a handful of parameters, including biodegradable organics like proteins, carbohydrates, and fats from food and excreta; pathogens; and suspended solids. Though the United States has invested more than $250 billion in sewerage since the 1970s, discharges from sewage treatment plants remain the primary cause of pollution in receiving waters.

In the developing world, where most communities remain unsewered and (where sewered) the sewage remains untreated, sewerage gets the bulk of expenditures by governments, donor nations, and international lenders for improved sanitation, signaling a strong preference for the technology by decision makers. But because sewers are expensive

to build and maintain and require large quantities of freshwater to function, they have had little impact on addressing the lack of access to sanitation for nearly half the people in the world. Still, sewerage is the preferred choice for the disposal of human and industrial wastes by governments, engineers, public health professionals, and many environmentalists. There is ongoing contestation over regulations and treatment at the end of the pipe, but little or no contestation about the pipe being there in the first place.

Until there exists a criticism of conventional sanitation that encompasses not only the technologies but also the systems—political, technological, economic, and managerial—that drive the technologies, there will continue to be exhortations to "fix the problem," but with no approach that actually can.

The needed critique will take into account on-site technologies versus central collection, and source separation versus mixing-then-fixing technologies. The choice of developing sanitation systems that are culturally appropriate, ecologically responsible, and functionally sustainable is a fundamental challenge of the 21st century.

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See Also: Cloaca Maxima; Human Waste; Miasma Theory of Disease; Pollution, Water; Sewage; Sewage Collection System; Sewage Treatment.

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Shanghai, China

With a population of over 19 million, Shanghai is the most populous city in the People's Republic of China (PRC). As both a symbol of the Chinese economy and a megacity (with a population of 10 million or more), Shanghai is an important representative of waste production and management patterns in the 21st century.

Economic Development

The PRC is a compelling site for considering both the relationship of consumption and waste production to economic development and the cultural specificities of refuse in social life. As a general rule, wealth per capita is positively correlated with the volume of refuse generated by each person in a country. This has been clearly evidenced in the PRC, where modernizing urban centers like Shanghai have increasingly produced more household waste and environmental pollutants per capita as individual real income has rapidly increased since the 1970s. However, with economic development has come the challenge of increased trash generation, with China producing about one-third of the world's garbage by 2010. Like many other leading urban locales in the PRC, Shanghai has struggled with how to manage the growing amounts of waste materials produced by its populace. Infrastructure and public-sector resources, ranging from landfill capacities to sanitation workers, are strained by the unwanted by-products of economic growth and consumption. In Shanghai, there exists a simultaneous dilemma of how to judge and intervene in the social norms of behavior that lie behind the culturally particular conditions of waste. From a heightened consumerism to nascent efforts at privatizing waste processing, the issues raised regarding refuse in China's economic capital are grounded in historically embedded practices.

Consider the economic explosion of Shanghai since the 1970s and its correlation with garbage

produced in this mostly urban zone. Since 1978, the PRC has undergone "reform and opening up" (*gaige kaifang*) measures that have led to historically unprecedented levels of growth in personal disposable wealth (though with a widening income gap). Led by state efforts at privatizing select sectors of the economy, attracting foreign direct investment, and allowing an expanded personal employment market, not only has gross domestic product (GDP) per capita increased steadily in Shanghai, but a domestic consumer market has also taken hold. In the early 21st century, Shanghai and Beijing have constantly switched positions in rankings of cities with the greatest per capita income—and the greatest volume of waste generated—in China. And as the center of the Yangtze River Delta, which produces close to 20 percent of China's exports, Shanghai has attracted a population influx from rural areas searching for work in urban industries. These factors have directly contributed to the explosion in waste production within Shanghai.

Shanghai during the republican era of the early 20th century was the undisputed center of Chinese consumer culture, with China's first department stores and a landscape abundant with popular advertising. By the 1970s, however, after years of exposure to Maoist norms, this was gone. Shanghai was barely a site of modern urban forms of consumption and consumer waste generation. A strictly limited range of choices in household products was available to the general public, while imported foreign goods were almost impossible to find. Sites of middle-class food consumption, ranging from independent restaurants to global brand-name supermarkets, were nonexistent. Moreover, throughout the Maoist era before 1978, modern consumer values were not characteristic of the aspirations and dispositions of the citizenry of Shanghai. Social norms and state ideology focused more on fostering a production-based economy and advocated the significance of basic necessities, not consumer products characteristic of much-maligned Western capitalist cultures.

Shanghai in the early 21st century exemplifies transformations brought about through economic expansion and rapidly changing consumer preferences. Shopping malls abound in the urban landscape as increasing wealth is spent on a wide array of retail products. Transnational big box companies with familiar names, such as Home Depot and Walmart, supply an increasing range of products to a burgeoning middle class aiming to cultivate a lifestyle of consistent consumption. Consumer marketing, an almost nonexistent feature of the economy under Maoism, is in ascendancy as Shanghai's citizens encounter billboards, print advertisements, social media, and television commercials on a regular basis.

Waste Production

Household consumer waste in the early 21st century is produced at a volume that strains processing and collection capacities. From the increasing turnover in consumer product ownership to the meant-for-disposal packaging of household goods, mass consumption brings with it new forms of refuse generation. While coal ash from households was the primary component of landfill waste in the 1970s, its place was taken by consumer packaging after 2000 in Shanghai. Simultaneously, the private-sector food market, a minimal dimension of the economy in the 1970s, has led to the by-products associated with processed, heavily packaged, and consumer-oriented food products. These seemingly insignificant empirical measurements indicate qualitative transformations in the lifestyles of Shanghai's residents. Shifts in consumptive practices can be discerned through the very makeup of what is tossed away as waste materials.

Direct consumption is not the only producer of waste; Shanghai is also the shipping and commercial center of the Yangtze River delta, one of China's great regions of production for export to foreign markets. To sustain these economic changes, Shanghai has seen one of the largest urban development and industrial booms in China during the reform era, efforts that have resulted in high levels of waste, with over 15,000 tons of debris generated every day from industries. These forms of refuse, usually ending up in landfills, are the hidden cost of Shanghai's spatial boom and economic growth. Indeed, at Laogang, Shanghai has the world's fifth-biggest landfill site and China's largest, at over 2.5-square-miles. The combination of increased disposable income, the availability of a wide scope of goods, a nascent cultural orientation toward consumptive practices,

and booming regional factories have changed the scope of refuse in China's economic center.

Waste Management

Like other major Chinese cities, Shanghai relies on the easily exhausted capacity of landfills, burying over 70 percent of its garbage in 2004. Compare this to Japanese cities, considered to have some of the most sustainable refuse disposal infrastructures in the world, which use landfills for less than 10 percent of their waste. With already-existing landfills nearing capacity, the Shanghai government faces problems specific to this region, as property there is among China's most expensive and the high population density leads to frequent opposition to landfill construction near residential neighborhoods. As Shanghai attempts to develop new landfills in marginal village areas located in the outskirts of the city, local citizens have staged a number of prominent protests. Though the state has attempted to respond to popular demands by constructing more-sustainable processing centers, such as trash incinerators, these have also met with popular refusal by nearby residents. While trash generation at the household level is closely tied to the new economic individualism associated with Shanghai's consumer culture, the common dilemma of waste disposal at the scale of the city remains a contentious site of public politics.

With Shanghai's landfills nearing maximum capacity in the early 21st century and further construction facing popular hurdles, the local government has led the way in experimenting with state-sponsored privatization of garbage processing at the city level. This should not come as a surprise because Shanghai was an early—and perhaps the most successful—site where the party-state economic liberalization efforts were tested during the 1980s and 1990s. The central government strives to hold Shanghai as a "model city" for other urban locales in China interested in implementing sustainable sanitation technologies developed by industry. Shanghai's political leaders are also relatively more open to commercialization and often draw from the knowledge offered by globalized, private-sector firms.

As of 2010, Shanghai had undertaken a number of state-directed initiatives in privatizing select segments of urban waste processing and disposal, for example, the Sino-French cooperation on utilizing solid waste as a resource for generating electricity. Hoping to move away from an exclusive dependency on landfills, Shanghai has, since 2002, launched two major waste-to-energy incinerators in joint ventures with the French environmental services company Veolia. As state officials argue, these refuse-processing projects cooperated with the private sector to draw from the expertise and infrastructure technology of foreign firms.

Moreover, striving to achieve compliance with European Union (EU) limits on toxic emissions from trash incineration, Shanghai has hoped to learn from industries with a longer history of meeting stringent health and regulatory standards. And this is not the only case of a public–private venture in solid waste management. From garbage biotreatment plants to the implementation of high-tech landfills using liners and methane recovery, Shanghai has frequently worked in conjunction with international enterprises.

Privatization extends beyond the scale of the state's contracting with the private sector for technology and service provision in waste management; it has also penetrated the scale of household and individual behavior. Whereas Shanghai had, until the beginning of the 21st century, always provided free garbage disposal as a state social service to private households, there has been an effort—if nonuniform—to develop a fee-for-disposal system. For households, fees are supposed to be assessed on the basis of the volume of garbage collected. Likewise, industrial waste is judged according to a fee-collection schedule that takes into account the volume and type of refuse. Since 2006, shoppers in Shanghai must pay a small fee for plastic bags at retail points. While education campaigns on sorting waste for recycling and environmental responsibility marketing have become prominent, they have been pursued by the municipality in conjunction with new economic incentives in refuse practices. Culturally, these initiatives have been designed to develop rational actors who make decisions regarding waste with an eye toward economic costs—a trend that is more evident in an increasingly privatized PRC.

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See Also: Beijing, China; China; Consumerism; Developing Countries; Household Consumption Patterns; Politics of Waste.

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Shopping

Shopping involves the examination of goods or services from retailers by customers with a goal to purchase them. It is an activity of selection and purchase; it may be considered both a leisure as well as an economic activity.

Emerging Foundation of U.S. Culture

Shopping was an important part of the expansion of the post–World War II economy in the United States. Shopping centers and malls became the new centers of community life in the expanding suburbs. During the cold war, Americans (including Vice President Richard Nixon in his 1959 Kitchen Debate with Soviet Premier Nikita Khrushchev) extolled shopping as a symbol of the consumer's personal freedom. Choice in shopping allowed consumers to purchase homes, cars, appliances, clothes, food, and other needs and wants. In turn, this expanded the economy after a decade and a half of Depression-era thrift and wartime rationing into a dynamic mass consumption economy.

Much of this spending was fueled by an increase in credit in the form of credit cards (expanded in the 1950s through the Diner's Club card and American Express, joined over the next 20 years by Visa and Mastercard) and home mortgages. Americans enjoyed both increases in material prosperity and debt. Consumption continued even through recessions in the 1970s and 1980s, and after the September 11, 2001, terrorist attacks, U.S. President George W. Bush told the nation to go shopping as a response, indicative of how central consumption had become to national identity.

Effects of an Early-21st-Century Recession

The recession that began in 2008 reduced consumer spending. A new pro-savings, anticonsumption mind-set dramatically transformed the retail industry. Other concerns include a high level of debt, high healthcare costs, and depressed conditions in the housing market leading to low home equities and limits on consumers to sell their homes. From the late 1990s to 2006, consumers in the United States increased the balance on their mortgages, taking advantage of rapidly rising home values, which enhanced their borrowing power. This enabled them to spend the cash windfall freely, driving up retail sales in many categories, which then began slowing down in 2006.

In 2010, a continued depressed housing market, a high level of home mortgage foreclosures, high unemployment levels, lower consumer confidence, and tightened lending standards forced consumers to save more and spend less. Over time, a higher percentage of the spending focused on high-value items with longer lives, low impact on the environment, and low energy consumption, as well as on products that promoted a healthy lifestyle.

In the meantime, competition among retailers continued to intensify. Physical retail stores battled each other for competitive advantage, while direct marketers (including online e-commerce and catalogues) took away market share from them. Several major retailers, including Circuit City, Sharper Image, Linen 'n Things, Bombay Company, and others have either declared or operated out of bankruptcy. In the United States, malls and shopping centers continue to experience higher vacancy rates, and very few major chains have expanded their operations. Direct marketing sales across all categories fell from an all-time high of $1.95 trillion in 2008 to $1.74 trillion in 2009.

Growth in e-commerce has been driven by two major factors. First, the number of fast Internet connections in U.S. homes and businesses, which are critical for making buying online faster and more interactive, grew to about 150 million by the end of 2009. Second, astute marketing of online giants like Amazon.com (sales of $14.8 billion and $19.1 billion in 2008 and 2009, respectively) and eBay combined with the e-commerce efforts of traditional retailers such as Walmart and Home Depot. Analysts predict a growth of 9.8 percent in online sales to $146.1 billion in 2010, after growing 19.8 percent and 4.6 percent in 2007 and 2008, respectively, and then falling by 0.4 percent to $133.1 billion in 2009. Early-21st-century trends point to a continued cutback of shopping for U.S. consumers. Revenues and profits are expected to be low through 2010, particularly for cars and luxury items. Among the rare exceptions are Walmart, Target, and Costco, where consumers have found low prices on high-quality merchandise.

Shopping and Waste Management

Retailers are beginning to take proactive actions in reducing the waste generated by grocery consumption. The United Kingdom (UK)–backed Waste and Resource Action Program (WRAP) is encouraging retailers, manufacturers, packaging designers, and all involved in the supply chain to encourage environmentally friendly packaging design to come up with ways of reducing the amount of waste. WRAP has estimated that more than 40 percent of the 30 million tons of household waste in the UK that ends up in landfills comes from the products of supermarkets and convenience stores and includes cardboard, plastic, and metal used in packaged goods. Retailers such as Tesco, Asda, and Argos have supported this $15-million government innovation that increases in-store efficiency by reducing the amount of space products take up on the shelf and by reducing packaging, production, storage, and transportation costs. Furthermore, it also adds to a company's corporate social responsibility credentials.

Studies in the United States have shown that half of consumers waste 25–75 percent of their fresh food because of spoilage. Shoppers valued fresh food and made an average of two visits weekly to supermarkets and grocery stores. When asked to rank the top factors used in primary store selection, they ranked "high-quality fruits and vegetables," and "high-quality meats," numbers 2 and 3, respectively after a "clean, neat store." They have strayed from traditional outlets and visited two to five stores every week in order to buy the freshest and healthiest products. However, based on wasted food, they have not been able to consume all their purchases.

Research has also concluded that shoppers have a poor understanding of carbon footprinting and its related consequences. For example, the Department for Environment, Food and Rural Affairs (DEFRA) in the UK found that although consumers were concerned about the environment, they were unlikely to change a diet that influenced sustainable food consumption. Consumers assumed that if a product is on sale, it must have overcome the green hurdle. They understood the basics of recycling but not long-term impacts, such as how food affects climate change.

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See Also: Appliances, Kitchen; Automobiles; Beverages; Consumerism; Consumption Patterns; Economics of Consumption, U.S.; Food Consumption; Grocery Stores; Home Shopping; Household Consumption Patterns; Malls; Materialist Values; Overconsumption; Supermarkets.

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Shopping Bags

Shopping bags are receptacles produced for the purpose of transporting consumer goods from a store or place of consumption to a consumer's home or other location. There are four main types of shopping bags: paper, plastic, reusable, and designer.

Paper Bags

Paper bags (introduced in U.S. stores in 1883) are seen by some environmentalists and consumers as a more-sustainable choice for shopping. Given the right conditions in a landfill, paper bags can break down more quickly than plastic bags. An average paper bag can hold about four times the amount of items compared to smaller, plastic bags. One drawback, according to the Environmental Protection Agency (EPA), is their production costs. It takes approximately 40 percent more energy to produce paper bags than plastic ones, it requires more energy to deliver them due to their higher weight than plastic, and paper bags take up more space in landfills.

Plastic Bags

Plastic bags were first introduced in U.S. stores in 1977. They make up 90 percent of all bags used by consumers in grocery stores. They have been the subject of environmental scrutiny because of their ubiquity and associated environmental impacts. Over 100 billion plastic bags end up in U.S. landfills every year, with an estimated one trillion plastic bags used worldwide annually. In the United Kingdom, the biodegradable shopping bag has become an option for retailers. This bag is composed of oxo-degradable plastics or bioplastics, which means that it can decompose in three years, compared to a traditional plastic bag, which can take 100 or more years to decompose. The bags do have their critics, including those who worry that the bags need optimal environmental conditions to degrade effectively and those who argue that the bags will expose the environment to potentially harmful by-products, including certain metals.

Reusable Bags

An emerging form of shopping bag in the early 21st century is the reusable one. The reusable bag is made from a variety of materials, including cloth, canvas, nylon, and woven polypropylene, and it is designed to be reused hundreds, perhaps thousands, of times. Reusable bags have less environmental impact because once they are adopted by the consumer, they pose no new use of resources and no impact in terms of disposal. Many stores offer customers a discount for using a reusable bag.

Designer Bags

An emerging variety of the reusable shopping bag is the designer bag. Retailers including Saks Fifth Avenue, Macy's, Juicy Couture, Abercrombie & Fitch, and Lord & Taylor have invested millions of dollars in producing more durable forms of the traditional shopping bag. Plastic-coated paper and durable fabric cord handles are some of the enhancements being made to the traditional shopping bag. In some cases, these bags are provided free to consumers; in others, there in a nominal charge. The designer shopping bag, while part of a move to reduce the number of disposable bags, can also be attributed to the status associated with the brands associated with the bags. For some consumers, these bags,

while intended for shopping, have become alternative purses or day bags. The Smithsonian's Cooper-Hewitt Museum in New York City keeps a collection of nearly 1,000 such bags.

Impacts

There are numerous impacts associated with shopping bags. Plastic bags have been the subject of the most ridicule. In terms of their production, plastic bags require the use of petroleum. Aesthetics and quality of life are a concern with bag use. Plastic bags litter many nations, including South Africa, whose citizens have dubbed the bag the "national flower." Marine life are particularly affected by plastic bags. They often mistake bags for food and, after ingestion, die from intestinal blockage. Plastic bags have a long life cycle and may take 20–1,000 years to biodegrade. Plastic bags are sometimes culprits in the blockage of water drains. They were attributed as part of the cause of severe flooding damage in the 1988 and 1998 floods in Bangladesh, a country that later banned them in 2002. Bags are also expensive in terms of the cleanup that is needed to deal with them.

Solutions

One solution to plastic bag use is to make them more durable and encourage their reuse, but this strategy depends on the consumer's efforts to truly reuse them. A 2002 Australian study of the impacts of shopping bags, for example, pointed to the production-level issues of the manufacture and distribution of plastic bags and, perhaps more importantly, the consumption level and the desire of consumers to curb their use of them. Both plastic and paper bags are recyclable. Recycling paper bags is easier than recycling plastic ones, though the cost is higher. A number of large chain stores, including Walmart, offer recycling drop boxes for plastic bags. Still, only 5.2 percent of plastic bags were recycled in 2005, while 21 percent of paper bags and sacks were recycled in the same year. According to the Progressive Bag Affiliates, many Americans reuse their plastic bags as lunch bags, for throwing out trash, and for picking up pet waste. In Burkina Faso, a common practice is to crochet plastic bags into more valuable products, including handbags.

In 2009, more than 100 U.S. cities engaged in debates and considered potential legislation related to banning shopping bags. Some cities, including San Francisco, have banned plastic bags entirely. Other cities have discussed requirements that stores will have to stock reusable bags only, while others considered measures that would impose a charge on plastic bags offered to customers. One of the most successful shopping bag reduction programs took place in Ireland. A $0.15-per-plastic-bag tax has resulted in an overall use reduction of 90 percent. Like many aspects of consumption, shopping bags illustrate a choice between their convenience and cheap product costs and the more long-term costs associated with their environmental impacts.

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See Also: Overconsumption; Packaging and Product Containers; Paper Products; Recycling; Shopping; Styrofoam.

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Sierra Club

The Sierra Club is a pioneering grassroots environmental association. Founded in 1892 by conservationist and preservationist John Muir and others, in San Francisco, California, the organization had over 650,000 members as of 2010 and chapters in all 50 states and Washington, D.C., in the United

The Sierra Club's initial goals included establishing Glacier and Mount Rainier national parks, convincing the California legislature to give Yosemite Valley (entrance to the park shown here) to the U.S. federal government, and saving California's coastal redwoods. Today, the organization has expanded its scope to 17 conservation-related issues ranging from land-related concerns such as agriculture and forest and wilderness management to political activist causes such as environmental justice, military issues, nuclear issues, and land-use policies.

States. It is also affiliated with Sierra Club, Canada, which has been active since 1963.

History of the Organization

The organization was founded by John Muir, Warren Olney (an attorney), and a group of professors from the University of California at Berkeley and Stanford University in May 1892. It was modeled after the eastern Appalachian Mountain Club, and their initial goals included establishing Glacier and Mount Rainier national parks, convincing the California legislature to give Yosemite Valley to the U.S. federal government, and saving California's coastal redwoods.

In the early part of the 20th century, the Sierra Club focused mostly on social and recreational activities by organizing outings and improving trails in the west. In the mid-1950s, the Sierra Club gained in national reputation in preventing the Echo Park dam construction in Dinosaur National Monument in Utah. Primarily because of this effort, it saw its membership swell from 10,000 in 1956 to 15,000 in 1960. In the 1960s, the organization continued campaigning against building dams that would flood portions of the Grand Canyon.

In 1966, full-page ads were placed in major newspapers such as the *New York Times* and the *Washington Post*, prompting the Internal Revenue Service (IRS) to suspend the club's 501(c) (3) status, pending an investigation. Hence, the organization noticed steep loss of revenue from contributions, but the memberships continued to increase steadily to about 75,000 members in 1969.

In the 1970s, the club focused on preserving Alaskan lands and eastern wilderness areas as well as supporting various environmental legislation, including the 1976 Toxic Substances Control Act, the Clean Air Act amendments, and the 1977 Surface Mining Control and Reclamation Act. The Sierra Club made its first U.S. presidential endorsement for Walter Mondale in 1984 and has since then continued to support mostly Democrats. In the 2008 presidential election, it endorsed Barack Obama for

"his strong record of support for clean air, wetlands protection, and clean energy."

Environmental Policies

The Sierra Club focuses primarily on 17 conservation-related issues: agriculture, biotechnology, energy, environmental justice, forest and wilderness management, global issues, government and political issues, land management, military issues, nuclear issues, oceans, pollution and waste management, precautionary principle, transportation, urban and land use policies, water resources, and wildlife conservation.

The club has been active in the protection of national forest and other federally owned public lands. It opposed the building of new nuclear reactors (both fission and fusion) until safety risks have been mitigated. It has argued for alternative energy sources to coal, given that coal accounts for over 40 percent of the nation's carbon dioxide emissions, which are a leading cause of respiratory illness. The organization has advocated investment in alternative energy resources, such as wind, solar, and other renewable resources, and favored restructuring energy markets to facilitate innovation, creation of green jobs, and efficient energy use.

In 2006, the Sierra Club formed a Blue-Green Alliance with United Steelworkers, the largest industrial union in North America, to pursue a joint public policy agenda in balancing workers' needs for good jobs with societal needs for a cleaner environment and a safer world. It has also taken an active role in controlling immigration in the United States, arguing that population growth contributes to environmental degradation.

As waste-to-energy projects have developed in the early 21st century, the Sierra Club has developed a strong position against classifying waste-to-energy as a renewable resource. Sierra Club campaigns include asking members to contact state legislators to remove waste-to-energy from renewable energy standards, petitions against incentives for developing incinerators, and related campaigns with the message "waste-to-energy is a waste *of* energy." The organization adopted a policy on zero waste at its board meeting in Atlanta, Georgia, on February 23, 2008, and embraced cradle-to-cradle efforts to prevent waste by design rather than managing waste after the fact. The Sierra Club has a Zero Waste Committee to coordinate campaigns, joining Greenpeace and several nongovernmental oganizations to advocate zero waste policies.

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See Also: Acid Rain; Environmental Defense Fund; Environmental Justice; Environmental Protection Agency (EPA); Greenpeace; Population Growth; Recycling; Toxic Substances Control Act; Zero Waste.

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Singapore

Singapore is a small, island country immediately south of the Malay Peninsula and north of Indonesia's Riau Islands. The population lives in urban conditions, almost entirely on the largest island. With fewer than 5 million people, including noncitizens, it has become one of the most prosperous countries in the world since the 1980s. An aspect of this economic transformation has been the hard-won association between Singapore and public cleanliness, despite its limited territory for disposing

of waste. While Singapore's economy and its residents' lifestyles depend greatly on heavily polluting activities, the Singaporean government has policies and plans to reduce both waste and consumption in many sectors.

Cleanliness Policies

Singapore is famous internationally for its government's strong measures against individual acts of public uncleanliness. One joking slogan is "Singapore is a fine city," in reference to the sanctions against, among other activities, urinating in elevators, chewing gum, not flushing public toilets, spitting, and feeding birds.

Defenders of the government's policies point out that the government only instituted them because some Singaporeans had, for example, disabled public transit with chewing gum or commonly urinated in elevators. The most high-profile case internationally went beyond fines when a U.S. teenager living in Singapore was caned for vandalism in 1994. Some affronts to public order can result in jail time after multiple offenses.

The general acceptance of—or acquiescence to—these regulations suggests that many Singaporeans look to the government to beneficently control their excesses. Discussions of these laws often focus either on Singaporeans' desires and on those of tourists. Many believe that, notwithstanding the shock or amusement expressed in other countries, Singapore's public neatness helps its tourism industry.

Consumption

Perhaps less considered are the environmental effects of Singaporeans' consumption. The country's gross domestic product (GDP) per capita, adjusted for purchasing power parity (PPP), ranks in the top 10 in the world. A materialistic orientation that motivates many Singaporeans to spend this income has also developed. Singaporeans commonly refer to the "5 Cs" to which most aspire: cash, car, condominium, credit card, and country club. Critics who would amend or replace this formula with more-intangible or communitarian goals recognize materialism's ascendancy. Thus, Singaporeans contribute indirectly to waste from industry and transportation in other places for the many products and materials that they import to achieve their consumptive goals.

Singapore's industries also contribute to the city-state's consumption footprint. Mostly export oriented, they include electronics, oil refining, financial services, and pharmaceuticals. Businesses account for 75 percent of all electricity use. Many of the country's imports are used in industrial production, such as crude oil for refining, steel, machinery, and chemicals. The lists of its major suppliers and markets are similar, featuring Malaysia, the United States, and China at the top of both.

Singapore is the site for activities that arguably belong more fully on others' account for consumption. For example, Singapore is a major transportation center for people and, especially, products that neither originate nor end their journeys there. A center for transshipment in southeast Asia, Singapore has one of the world's busiest ports for containerized shipping. Oil is a prominent example. With no oil reserves, in 2007, Singapore was the world's 17th-largest exporter of oil, thanks to its massive oil-refining industry. Similarly, Singapore plans to become a center for transporting liquefied natural gas by 2013.

Singapore also is a popular destination for tourists from around the world. Some tourists choose Singapore for shopping, a quintessentially consumptive activity. In addition, the famously clean island has developed into an international center for medical tourism, entailing not only waste from travel but also the burden of increased medical waste.

Waste Management

Singapore's status as a small country with a comparatively large industrial output and consumption of resources, regardless of their provenance, shapes its disposal of garbage and wastewater. Singapore has limited ability to place its solid waste in landfills. While Singapore has limited programs to reduce the production of garbage, the trash generated is either recycled, incinerated, or landfilled, in that order of preference.

As of 2007, Singapore recycled 54 percent of its waste, not far from its goal of 60 percent by 2012. Over 60 percent of stores and homes participate in a voluntary program in which recyclables are placed in separate bins from trash. Different

programs include composting organic waste and recycling wood into particle board.

Combustible trash that is not initially recycled, including any food waste that is not composted, is incinerated. This process yields scrap metal and a small, but significant, percentage of the island's electricity. Burning reduces the volume of waste by about 80 percent, which is important given Singapore's limited space for landfills.

Singapore had only one landfill in use by 2010, at Semakau Island. The government created it, after the local population was relocated, by reclaiming land in order to join two islands south of the main island. A barge carries incinerated waste that is not recycled and noncombustible, including many materials from construction and demolition, to this location.

The price set for landfilling waste directly has provided an incentive for the construction industry to reduce waste overall. Because of reductions in waste reaching the landfill, its estimated use has been extended from 20–25 years to 35–40 years. In the meantime, the area otherwise serves as a conservation area for coral and mangroves as well as a burgeoning point for wildlife recreation.

Water Distribution

Water presents a special case. By 2010, Singapore imported about 40 percent of its water via pipelines from Malaysia. The agreements governing this transaction expire in 2011 and 2061. Rather than pay higher costs via a new agreement while remaining vulnerable to disruptions for political purposes, Singapore is attempting to partially replace and reduce the demand for the Malaysian supply with the ultimate goal of self-sufficiency. Through mandatory labeling requirements, education campaigns, and the availability of more-efficient fixtures, water consumption per capita decreased from 172 liters per day in 1995 to 155 in 2009.

Local supplies of water come from three main sources: catchment of rainfall, desalination, and reclamation of wastewater. Together with importation, these constitute the Four National Taps strategy. Singapore is completing reservoirs that will increase catchment to 67 percent of its land area. In 2005, the country's first, massive desalination plant opened, supplying about 30 million gallons per day. Recycled sewage water, branded as NEWater, supplied about 30 percent of Singapore's demand in 2010, up from 15 percent in previous years. All of these sources are said to meet the World Health Organization's standards, and all of Singapore is served by modern sewage systems.

Air Pollution and Green Policies

Singapore also has programs regulating air pollution, but its policies related to greenhouse gases are less stringent than those in some other wealthy countries. Singapore joined the Kyoto Protocol in 2006. However, despite its high GDP, it is not an Annex 1 country—meaning its emissions are not subject to a cap—and Annex 1 countries can locate offset projects in Singapore. Singapore's official goals regarding carbon emissions are to reduce its carbon intensity (carbon dioxide produced per dollar of GDP) rather than to set an absolute target for carbon emissions. By switching from oil to natural gas and increasing energy efficiency, Singapore reduced its carbon intensity by 39 percent from 1990 to 2007. Such gains do not preclude an increase in absolute carbon emissions. Only 2 percent of its electricity comes from renewable sources.

Singaporeans and others debate the extent to which this island country is green. Singapore's Green Plan 2012 sets goals related to sustainability, and the government points to considerable success in meeting them. Some international environmental rankings produce a different impression, as some position Singapore as anywhere from the most destructive country to middling, depending on the focus and methodology. For example, without including bunker fuel (for international transport), Singapore ranked ninth in the world for carbon emissions per capita, at almost three times the world average. Government officials criticize such rankings, pointing out that much of environmental destruction results from Singapore being a city with limited hinterland and that much of the greenhouse gas emissions result from export-oriented activities.

Missing from this debate is a consideration of the displaced emissions resulting from Singapore's reliance on imported goods. Its wealth relies greatly on transshipments of products and on transforma-

tions of imported materials into finished products for export. Singaporeans use that wealth to import goods, including water, food, and luxury items.

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See Also: Culture, Values, and Garbage; Emissions; Materialist Values; Producer Responsibility; Recycling; Water Treatment.

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Slow Food

The "slow food" movement started in Italy in 1986 in opposition to the expansion of McDonald's. A group of food writers and chefs first established it in Bra, a small town near Turin in the Piedmont region. Since 1986, the movement has been growing globally through nonprofit organizations, conferences, and media with the goal of reinventing healthy food, maintaining cultural traditions, and encouraging local farmer production.

Slow food's politics today are highly varied and in many ways congruent with leading social and economic systems. Some of the aspects of the ideology of slow food have utopian nuances, since its ideal model harkens back to periods of human history in which farmers were the most widely represented segment of society. A middle-income movement, slow food's notion of the "right to pleasure" in one's food is articulated in humanist rather than elitist terms—from the preservation of traditions and biodiversity to more equal resource distribution among countries.

Slow Food Organizations

There are many nonprofit organizations with a variety of programs dedicated to sustainable healthy food and style of life. Slow Food International is a leading organization that has 100,000 members in about 130 countries. Its global membership is organized in local sections—called "convivia"—coordinated at the international headquarters in Bra, Piedmont, and by regional and/or national executive committees (e.g., Slow Food USA). Branches and programs of Slow Food include the Tierra Madre Network, U.S. Ark of Taste, Presidia, RAFT, Slow Food in Schools, Slow Food on Campus, and the U.S. Youth Food Movement. The main media outlet of Slow Food is Slow Food Editore, which was established in 1990. It publishes a range of guides in order to lead consumers to food products available in their local areas. *Osterie d'Italia*, a guide to the traditional cuisine of the Italian regions, is the leading publication in Europe, and is updated annually. The guides usually list small restaurants with healthy meals, historic cafés, artisanal ice cream shops, delicatessens that specialize in regional products, and traditional bakeries. Recently, some of these restaurants have gone through a process of gentrification and are promoting a kind of gastronomic tourism.

Alternative Scenarios

Slow–Fast Food. On one extreme of this scenario is that fast food icon, the hamburger, made from meat that came from a feedlot of grain-fed cattle and was shipped to large processing plants through gigantic distribution systems. It was then slapped on a refined, puffed-up hamburger bun, packaged, and eaten on the run. On the other extreme is dining on a healthful meal, featuring foods that honor regional traditions passed down through the generations, while surrounded by good friends and family. Moreover, these foods feature local, sustainable, minimally processed ingredients.

The problem with this scenario is that a structural component is not the healthy food but the presumption that any slow food is healthy while any nonslow food is unhealthy. There are many traditions that pass from generation to generation and do not promote healthy food. On the other hand, not all cuisine types in the fast food chains are unhealthy. The debate between fast and slow food

has been turning toward healthy versus nonhealthy food. Not everything that comes from a home garden is healthy (especially if you live in an area with air and soil pollution), nor is everything in a fast food restaurant unhealthy.

Rural–Urban. Another division that food policy offers is rural versus urban. The slow food philosophy and aesthetics are based mostly on rural concepts, while it is believed that the fast food philosophy is typically urban because of embedded standardization and mass marketing. A case study from Italy of the Bagnoli restaurant is an example of slow food embeddedness. Ristorante Bagnoli is located in a hilltop farmhouse in a forest close to the small village of Castagneto Carducci, on the southwest coast of Tuscany. It has strong ties, not only to the ecology and the associated products of the forest and the surrounding area but also to local socioeconomic institutions. For instance, the restaurant participates in the wine route Costa degli Etruschi, which was established in 1994. In this way, Bagnoli is able to build up its customer base while also ensuring that its products feature the local gastronomic landscape.

Tradition–(Re)Innovation. French cuisine is celebrated as the most refined and complex in Europe. This perception extends back to the French Revolution, when the breakup of the great aristocratic houses sent chefs out into the street looking for new sources of employment. At this time, the modern restaurant and a whole new social stratum (notably the bourgeoisie) gained access to fine food. Chefs like Marie-Antoine Carême (1784–1833), who invented "presentation," subsequently helped contribute to the fame of French cuisine. His cooking looked a lot like architecture, with the dishes fitted into vast, beautiful neoclassical structures. Another chef, Auguste Escoffier (1846–1935), known as the father of modern French cuisine, is linked to the invention of the "master sauce" as the unchallenged basis of haute cuisine. French cuisine came to mean elaborate preparation and presentation. However, following another French culinary revolution—the emergence of nouvelle cuisine in the 1970s—the emphasis on rich and ornate combinations of foods, gave way to a new concern for fresh ingredients and simple treatments. With nouvelle cuisine, the notions of "fresh" and "in season" became the new reference points for aesthetic judgment. Now the complex dishes of earlier periods were replaced by simpler and more subtle modes of preparation. Slow food is in the same line of (re)innovations as nouvelle cuisine.

Healthy Food and Waste

Slow food provides gastronomy with a rich background for development toward a civilization of healthy food, although many other issues of primary importance are also of concern to gastronomy—famine, poverty, and the opportunity to improve the nutrition of fast food and to advance lifestyles in all parts of the world.

Important slow food initiatives and/or collaborative projects address the problem of waste of food. An example is a protest held in the center of Turin to draw attention to waste by organizing a communal meal created entirely from surplus supermarket food destined for the trash.

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See Also: Consumption Patterns; Farms; Fast Food Packaging; Food Consumption; Food Waste Behavior; Grocery Stores; Household Consumption Patterns; Social Sensibility; Supermarkets.

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Sludge Worms

Sludge worms are freshwater sediment-dwelling worms known for their resistance and adaptation to polluted environments. They are often used as an indicator of watercourse toxicity.

Nomenclature

Tubifex tubifex is the binominal name of the sludge worm, also known as the sewage worm, or lime snake. Sludge worms are a segmented benthic worm inhabiting lacustrine and riverine sediment on several continents and occasionally in sewers. The genus *Tubifex* is thought to include multiple species, but the reproductive organs used to identify species are resorbed after mating, and external characteristics vary with salinity, making the species virtually indistinguishable. The 13 known species include *Tubifex tubifex*. The *Tubifex* genus is part of the Tubificinae subfamily of the Naididae (Haplotaxida order, Oligochaeta subclass of Clitella, Annelida phylum). The Naididae were formerly known as Tubificidae. After DNA analysis indicated the family was probably not monophyletic, the name was changed under International Code of Zoological Nomenclature (ICZN) rules in 2008.

Characteristics

A healthy sludge worm is bright pink and usually 19–32 millimeters long, but capable of reaching lengths of 200 millimeters. The worms live in clusters and burrow into mud to ingest sediment while extending their bodies in the water above to collect oxygen and suspended organic matter, which they excel at. The bottom sediment has little oxygen content and may be further deoxygenated by pollution. Animals in this environment rely on hemoglobin to combine with oxygen and vastly increase the oxygen-carrying capacity of their blood. As the sludge worm lives head-down in the tube it has burrowed, it uses its tail as a gill; the less oxygen available, the more of the hemoglobin-containing tail is extended up into the water. Able to absorb molecules through their body wall, the worms exchange carbon dioxide and oxygen through their skin and can selectively digest bacteria. Encystment and lowering metabolic rate protect against drought and food shortage.

Indicators of Pollution

Well known for tolerance to organic pollution beyond that of virtually every other species, sludge worm populations increase exponentially in watercourses polluted with decomposable organics. Organics are a source of food when in suspension and are easy to tunnel into. Undisturbed sludge worm colonies can cover large areas. R. E. Richardson reported sludge worm density in the Upper Peoria Lake as 31 per square meter in 1915, and 20,400 per square meter in 1922. In some tests of contaminated U.S. lake sediment, sludge worms and pollution-resistant midge larva made up 90 precent of the total number of species present.

The 1969 Cuyahoga River Fire, though minor, was an iconic event in the history of environmental protection. This was the last occasion where the river caught fire because of the level of pollution, the first fire having been recorded in 1868. *Time* magazine noted that the heavily polluted river had been found to be bereft even of sludge worms and leeches. Sludge worms are routinely used in scientific studies to test toxicity and bioavailability of sediment, using an American Society for Testing and Materials (ASTM) methodology. Their tolerance to inorganic pollutants was being tested by 2010. Tests indicate that the high defecation and metabolic rate of the sludge worm stops heavy metal accumulation, excepting cadmium (one of the most dangerous heavy metals). This means that

they are unsuitable bioindicators of heavy-metal pollution, and the accumulated cadmium presents a risk to predators.

An important link in aquatic food chains, when sludge worms are eaten by bottom-feeders, the concentration of absorbed toxins increases with every link in the food chain. *Tubifex* are also the only known animals that respond to contamination with autotomy (shedding contaminated segments); the worms are known to excrete metals this way. The role of organic compounds in sludge worm autotomy was unknown as of 2010, but it is hoped that studying autotomy will become a new bioindicator technique. Following autotomy, the worm is able to regenerate a functional posterior.

Breeding

Tubifex worms are hermaphroditic but do not self-fertilize as the male and female organs are not mature simultaneously. Easy to mass-culture and readily available from watercourses, sludge worms were once bred in containers for aquarium fish food. However, river cleaning has reduced their natural habitats, and without careful cleaning, the worms can introduce disease into aquariums; both are causes of their decline as a fish food. It was discovered in the 1980s that *Tubifex* worms are a host of *Myxobolus cerebralis*, the parasite responsible for whirling disease in fish (first reported in Germany in 1903).

Sludge worms were described for the first time in 1774 by Johannes Muller and are unknown in the zooarchaeological record. It is theoretically possible that their eggs could be preserved in anoxic waterlogged deposits or via mineral replacement, or for the worms themselves to survive encysted. A *Tubifex* worm colony became an Internet viral phenomenon after sewer inspection camera footage was posted online. The nature of the pulsating "sewer creature" from North Carolina was the subject of intense speculation on the Web. The San Juan Worm, a fly-fishing lure, is modeled on the sludge worm. This is thought to have been invented by Paul Pacheco in the mid-1960s on the San Juan River, New Mexico.

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See Also: Pollution, Water; Rivers and Harbors Act; Sewers; Worms.

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Slums

Slums are residential areas filled with overcrowded, poor, or informal houses with inadequate access to safe water and sanitation and insecurity of tenure. Slum housing may be built with either simple shacks or permanent structures. However, they usually lack enough light, ventilation, and heating and they are susceptible to fire, flooding, and other natural disasters. A slum can also be called a shantytown, skid row, *favela*, *barrio*, *bustee*, *Kampung*, *katchi*, *abadi*, or ghetto, in different countries, depending on the location, ethnicity, and type of the structures of the settlement. Poverty, illiteracy, and unemployment are usually high among slum dwellers, as are hunger and child malnutrition. For example, child malnutrition in Ethiopia in 2010 was around 49 percent. In Côte d'lvoire and in Brazil, malnutrition in urban slum children is three to four times higher than in children from nonslum areas. In addition, the lack of basic civil services, such as clean water and sanitation results in high levels of crime, drug and alcohol abuse, related health

and mental illness, and high rates of suicides and homicides. There are usually no medical facilities in slums. Local and international charitable organizations and churches provide some medical services. For example, in Shanghai, approximately three million workers do not have access to medical and social welfare or any other benefits.

According to the report "State of the World's cities 2010/2011" by United Nations (UN) HABITAT, the number of slum dwellers has increased from 777 million in 2000 to 828 million in 2010. Sub-Saharan Africa has the largest slum population. with 199.5 million people, followed by 190.7 million in southern Asia, 189.6 million in eastern Asia, 110.7 million in Latin America and the Caribbean, 88.9 million in southeastern Asia, 35 million in western Asia, 11.8 million in north Africa, and 6 million in Oceania. A UN Millennium Development Goal was to improve the lives of at least 100 million slum dwellers by 2020 in order to curb the estimated projection of 3 billion slum dwellers by 2050. More than double the goal has already been met as of 2010: 227 million people were lifted out of living in slum conditions. However, the slum population is growing at a rate of approximately 6 million each year, which will result in almost 1 billion slum dwellers by the year 2020.

The metal and mud homes that make up this slum in Kibera, Kenya, house over 1 million people. Slums are usually built around undesirable areas like landfills, in which Kibera slum dwellers find discarded bones from cows and goats to recycle into jewelry.

Some of the largest slums are in Dharavi (India), Kibera (Nairobi), City of God (Rio de Janeiro), and Orangi Township (Pakistan). Dharavi, the largest slum in Asia, expands over a total of 535 acres and accommodates more than 600,000 people. It houses many small industries with a considerable earning power on a prime location near the middle of the city, not far from the airport, about a mile from the city's new Bandra-Kurla business district. Kibera, the second-largest slum in Africa, is located about four miles from the central business district of Nairobi with a population of more than 800,000 spread over just 630 acres. Approximately 120,000 people live in the rough neighborhood of the slum called the City of God outside the wealthy neighborhoods in Rio de Janeiro. Over 1 million people live and work in the booming cottage industries located in the slums of Orangi Township in Karachi.

Slum Housing

Slums are usually built near naturally or artificially hazardous sites. Often, slum dwellers lose their lives and homes to natural disasters such as fires, floods, and earthquakes. Slums are built either on government-owned land (for example, Karachi, Delhi, and Shaanxi) or on peripheral and privately owned property (for example, Manila, Seóul, and Bangkok). These properties are usually located on floodplains, swamps, volcano slopes, unstable hillsides, mountains with garbage, chemical dumps, railroad sidings, and desert fringes, so that lands are considered unlivable for those with the means to live elsewhere.

Until about 1990, poor immigrants built their own shanties on those valueless lands for free or with very low cost. However, once the squatter makes the land habitable, the land becomes valuable to the rest of the society. In the 21st century, land prices have soared, as rural-to-urban migration has grown at a fast pace. Consequently, owning land or the housing in a slum area became a very profitable business for private owners, government officials, agents, and slum dwellers. Anyone who owns more than one shack rents them to others for a profit by charging a steep rent. For example, only 10 percent

of the people in Kibera, Nairobi, own their shacks. The average size of these shacks is 12-by-12 feet, built with mud walls that are screened with concrete. Corrugated tin is used for roofing, and floors are made of dirt or concrete. The density of people living in the slums is overwhelming. In Kibera, often eight or more people sleep on the floor of these shacks. An average of 13.4 people share a room in bustees in Kolkata, India. Slum dwellers often use building materials found locally for free or of very-low cost, such as tin, timber, plastic sheets, and other recycled materials, to built their shanties.

Drinking Water and Sanitation

Slums often do not have sources of clean water supply. Residents either use polluted water available locally or bring water from a faraway place. Selling clean water to slum dwellers is a profitable industry. Studies have shown that the slum residents pay much higher prices for clean water compared to city residents. Those who are unable to pay the high prices sometimes end up using sewage water and water from broken pipes, which causes diseases such as diarrhea, cholera, typhoid, hepatitis, tuberculosis, and malaria.

Children in the slums suffer from intestinal parasites, such as whipworm, roundworm, and hookworm, which are sometimes life threatening. The mortality rate for slum children is much higher than that for children from the rest of the urban areas. It was found that infant mortality in Quito, Ecuador, is 30 percent higher in slums than in wealthy neighborhoods, and it is two to three times higher in slums of Nairobi, Kenya, compared to the whole city.

Clean water could prevent many health-related problems. However, it is one of the most valuable commodities in slums. Most of the diseases in slums are caused by pollution of drinking water and poor sanitation. Sewage contaminates sources of drinking water, such as how slum runoff in Kampala contaminated Lake Victoria. In Nairobi's slum areas, the pipe water contains fecal matter. The sewage system in slum areas is either nonexistent or extremely inadequate. In Kibera, slum residents use polythene bags to collect their excrement and throw them outside. A study of 22 slums in India found that nine had no latrine facilities and there were 19 latrines for 102,000 people. The lack of toilet facilities in slums areas forces slum dwellers to use open public places. The women and girls in the slums have to wait for dusk to avoid being seen defecating in an open space. Not only it is emotionally degrading and hazardous for health but also they are sometimes sexually and physically assaulted in the dark.

Slum Economics

The informal economy of slums contributes significantly to the robustness of adjoining cities. Slum dwellers in Dharavi and other urban slums make their living on metal plating, dyeing, rendering, tanning, battery recycling, casting, vehicle repairs, chemical manufacturing, and small industries. Rickshaw pulling is the second-largest industry after the textile industry in Dhaka, Bangladesh. Gambling and prostitution are often taken up by slum dwellers to make a living. Research found that 20 percent of local income was redistributed through gambling and games in the Klong Thoey slum in Bangkok. Many slum dwellers, mostly women, are willing to sell their organs to support their family's need. The slum at Bharathi Nagar in India is also called "Kidney Nagar" because it has become renowned for supplying kidneys to the world. Cairo's slum dwellers provide body parts for rich Arabs from the Persian Gulf.

Most children in the slum have to work to earn a living. According to one study, nearly half of boys and girls aged 10–14 work, and only 7 percent of the girls and boys aged 5–16 years attend schools in Dhaka, Bangladesh. Children work in restaurants in Mumbai, in the silk sari industry in Varanasi, and in glass factories in Firozabad. Children gather and resell cigarette butts in Cairo, and they are employed in domestic services in Colombo and other cities. In Kinshasa, Democratic Republic of the Congo, the children of the Ndjili slum are sometimes accused of being witches by their parents, relatives, and local church leaders and are left on the streets on their own.

Many of these children are sick and HIV positive. These children are unable to find more than a handful of shelters in churches or centers run by international nongovernmental organizations (NGOs). They struggle to survive on their own or with the

help of other child soldiers and become part of the urban army.

Redevelopment of Slums

Slums continue to breed hunger, unemployment, poor health, and lagging education, which poses social, environmental, cultural, and political challenges to developing nations. Over the years, the international humanitarian and financial organizations such as the UN Development Programme (UNDP) and the World Bank have provided financial aid to local government agencies to improve the conditions of slum dwellers, without much success. They have increasingly worked directly with local NGOs, which are responsible for providing proof to the bank that the aid actually reached the intended poor. As a result, rapid growth of local and international NGO organizations has been observed in the early 21st century. However, there is a growing concern among activists that the NGOs have turned into a "new class" of middleman, unable to mobilize the grassroots activism in upgrading slums. NGO employees are usually the civil servants, business class, and social workers who are privileged with college education and do not have roots in the slums they are trying to change.

The eight Millennium Development Goals (MDG) were undertaken in the UN summit to fight extreme poverty, hunger, illiteracy, and disease worldwide. For example, UN-HABITAT has been working jointly with governments to upgrade slums under Kenya Slum Upgrading Project (KENSUP) pilot projects in Kibera, Kisumu, Mombasa, Kiandutu, and other slums in Africa. A major strategy of UN-HABITAT is to mobilize domestic investment resources by establishing local financing facilities called slum upgrading facilities (SUF), which help community groups to access credit from local commercial banks. The SUF project in Ghana is helping upgrade slums at Sekondi-Takoradi and Tema-Ashaiman metropolis. The slum-upgrading project in Amui Dior, Ghana, is led by the community to build 31 residential units, 13 shops, and a block of public toilets. Two quasi-government financial facilities in Solo and Yogyokarta are directly responsible to meet local and national slum upgrading objectives for 15 projects in Indonesia.

Microfinancing has been compared to a vaccine against poverty when applied to the entire population. The Access Africa project from CARE, with a goal of providing financial assistance to 30 million poor in Africa within a decade, has been providing economic empowerment to slum dwellers in the form of microfinancing. The Water for Africa program from UN-HABITAT worked with the African Development Bank in the construction and rehabilitation of water and sanitation facilities in the urban areas of Tanzania, Kenya, and Uganda. Mumbai's quest to be "a world class city with a vibrant economy and a globally comparable quality of life" has prompted local, state, and national governments to dramatically reengineer the Dharavi slum area with a $40 billion, 10-year program, based on a report by McKinsey, a global consulting firm. In the Orangi Pilot Project, slum residents have been working since the 1990s to successfully install sewer and water pipelines and build roads, schools, and clinics without any government help. Their booming cottage industries made saris and slippers, which are sold in Karachi and abroad.

Consumption and Recycling in Slums

Slums are usually built around cities' landfill areas because those lands are unwanted by city residents. In many cases, slum dwellers have to endure the emission of multiple toxins an from pollutants from the compiled garbage where they live and work. However, slum dwellers often find ways to recycle garbage to make a living. For example, in Kibera, waste products such as bones from cows, camels, and goats are used by slum dwellers to make jewelry.

Among the *zabaleen*, located at the outskirts of Cairo, 80 percent of the collected garbage is recycled by the poor to make their living. The edible garbage is fed to the pigs; pig droppings and human excrement are sold to the farmers for fertilizer; and scrap metal, glass, paper, and plastics are sold to the middlemen who sell them to craftsmen. In the award-winning movie *Garbage Dreams*, director Mai Iskander points out the inefficiency and higher cost of modern machinery compared to human recyclers to eliminate cities' garbage. In Dharavi, Mumbai, an estimated 15,000-single-room factory belongs to craftsmen who use recycled materials from car batteries, cooking-oil cans, computer parts, fluorescent lights, ballpoint pens, plastic

bags, paper and cardboard boxes, wire hangers, and many more items from the city dumps. Its recycling industry supports 250,000 slum dwellers.

As a part of ecological sustainability in Kenya, the solid waste management program uses nonmotorized transportation, such as bikes or pushcarts, for collecting waste from the poor community for a small fee. It provides incomes for the locals and keeps the neighborhood clean at the same time. Solar water disinfection (Sodis) technology is being used in Kibera to provide clean drinking water for a low initial cost. An estimated 4.5 million people are using this technology in Latin America, Asia, and Africa. Solafrica, a Swiss NGO, and Greenpeace have invested in a youth group in Kibera to assemble portable solar power lamps and solar panels to export and to use locally. The goal is to replace the lamps that use the traditional electric grid, kerosene, or other energy sources with affordable lamps that use the renewable energy source of sun. The solar lamps are being used widely in many slums around the world.

Conclusion

In redeveloping slums, the answers to several critical questions will unfold. Is a public–private partnership the best solution for the slums? Will foreign multinational corporations be interested in bidding for various contracts in slum-based projects? Will special types of retail formats be successful in operating in these new neighborhoods? How will various aspects of corruption and illegal transactions be alleviated? Will the residents of these slums be accepting of the redevelopment proposals and will social justice principles be upheld? How will the NGOs with vested interests in slum communities react to projected reengineering plans?

In a 2010 UN summit, it was realized that the target set in 2000 was too low in the context of rapid urbanization in the early 21st century. A serious commitment from the governments of developing countries as well as humanitarian organizations is needed to meet the new goal set to reduce the proportion of slum dwellers in half by 2020. According to a UN-HABITAT report, rural-to-urban migration will continue to increase, thus creating larger urban slum populations throughout the developing world. Successful management of these projects is key to the overall sustainability of the communities in which they reside.

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See Also: Cairo, Egypt; Environmental Justice; Environmentalism; *Garbage Dreams*; Junkyard; Kolkata, India; Mexico City, Mexico; Mumbai, India; Politics of Waste; Race and Garbage; Recycling Behaviors; Sewage Collection System; Street Scavenging and Trash Picking; Sustainable Development; Trash to Cash.

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Social Sensibility

Social sensibility is a complex emotional-cognitive competence and relation to surrounding people and situations. Two fundamental processes are at the heart of social sensibility: enculturation and socialization. Enculturation develops in every person and culture; through socialization, individuals become members of society and follow social norms of behavior and interactions. From a psychological point of view, the cornerstone of social sensibility is the ability to perceive and process information about the intellectual states of others. Social sensibility is in the skeleton of the social health, respectively, one of the most important drivers of human progress embedded in the everydayness of people.

Consumer Behavior and Social Health

From birth, people start demonstrating subconscious and conscious consumer behavior. Typically, parents and the education system begin teaching children how to develop active social understanding based on mechanisms of positive social reproduction, which include an economy of consumption. Growing up and aging influence a person's social sensibility toward consumption as a reflection of the complex processes of intergenerational influence, enculturation, and socialization, as well as of the place of every individual in society. The roots of modern consumption go back to the 18th-century "consumer revolution" as a move away from the subsistence economies of the earlier century and as an extraordinary growth in the world of goods. The development of a consumer society is based upon an important characteristic of consumption: consumption is not compelled since the consumer's decisions are free choices.

J. Schulkin promoted his theory about the psychological roots of social sensibility in humans' intentionality. He distinguishes three layers of intentional systems that refer to (1) events, (2) beliefs, and (3) desires.

The consumer's social sensibility relates, in particular, to product values. P. Laaksonen provides a case study of shampoo consumption to define four aspects of consumption values: hedonistic (pleasure), personal (self-confidence and self-image), social (good relationships with others and social acceptance and responsibility for the environment), and values expressing the more utilitarian aspects of consumption (economy and easy living).

There are national tendencies in the development of consumers' social sensibility. According to some statistics, primarily English-speaking countries (such as Canada, the United Kingdom, and the United States) have low household saving rates, high financial assets, low real assets, high consumption levels, and low Engle coefficients (defined as the budget share of food and nonalcoholic beverages). They differ from Japan and some European countries like France, Germany, and Italy in that these countries are characterized by high household saving rates, high real assets, low consumption levels, and high Engle coefficients. Furthermore, consumerism in culture has been expanding globally and influencing more and more countries, like Singapore, for instance. Then, it is possible to conceptualize social sensibility regarding consumer culture (the work-and-spend model) as a global aspect defined in the past as "Westernization."

Commercialization of leisure (as uncoerced activity undertaken during free time) is an essential feature of the consumer society that challenges social health and sustainable living by decreasing the opportunities for people to escape the financial dependence of their lives.

Social Sensibility and Sustainable Living

From an anthropological perspective, one possible analysis of social sensibility is within the triad of interrelations between consumer behavior, the ideology of garbage, and sustainable living.

Probably most important for the individual consumer is the way they understand culture, which overlaps with the problems of sustainable living in the 21st century. There are many people who do not ask the question "What culture ideals are imbedded

in the things that we consume?" Their questions are, instead "What do I like," and "What do I need?" People often neglect to ask another important question "Why do I need this thing?" Fashion, rumor, social grouping, or general environment can strongly influence the individual, but they may also leave a person without an opportunity for flexible behavior because of a specific socialization or a specific evolution of the aspects of social life. J. Schor argues that 40 years of increasing consumption up to 200 percent in the United States had not made the population any happier and more satisfied in the 1990s than it was in the 1950s, since there came always more desirable things to consume.

How people consume products is only one aspect of the problem of social sensibility from the perspective of sustainable living. Equally important is how social and environmental resources of common goods, spaces, networks, futures, and relationships need to foster respect for each other and, in turn, for the environment.

Although with strong emphasis, consuming and sustainable living are two interactive processes that can be traced back to the cradle of human civilization. For instance, prehistoric people kept pieces of the broken or out-of-use material culture (such as fragmented pottery) around for use as filling materials, as the base of household equipment, leveling and filling of cultural layers, or for the production of new goods as a means of recycling material.

Some houses were probably burned for hygiene reasons. In particular, in the Balkans, garbage pits were initially located beside people's houses for the discard of out-of-use objects and the detritus from activities, meals, and housecleaning. In later prehistory, the village inhabitants preferred a cleaner village environment and dumped their garbage outside the village. It is possible to interpret some garbage spots as locations of feasting or other forms of "positive wastage."

Social sensibility toward sustainable living also has historical dimensions, such as the economic implications of human taste. For instance, the global development of a taste for sugar created a massive slavery-based production system on plantations in the Caribbean and generated much wealth during the mid-17th century. In the early 21st century, there is an increasing interest in stevia as a sweetener, especially in Japan. China has developed as the largest distributor of stevia, while companies like Coca-Cola and PepsiCo have promoted products that will contain their new sweeteners.

Living in the technological age and as members of consumer society, the concept of consuming is two-sided. On the one side, people consume products and services; on the other side, producers of products and services often look at people just as consumers, instead of serving actual needs. Nevertheless, there are more and more companies adopting the green movement and providing products that support sustainable life. Government and private projects, for instance, support anaerobic digestion as an alternative to landfills.

In 2009, public outcry stopped the deposition of Italian radioactive waste in Utah. Aesthetization of refuse is also an option, as it was in the early 20th century. Finally, through life-cycle analysis, people can choose the most efficient products and make educated determinations of whether waste reduction, reuse, recovery, or disposal is the best practicable environmental option.

Social sensibility is a dynamic category that expresses the relation of people to the things around them from the perspectives of their enculturation and socialization.

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See Also: Consumerism; Culture, Values, and Garbage; Materialist Values; Shopping; Sustainable Development.

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Socialist Societies

Socialist societies, commonly referred to as "state socialism," emerged after World War II in those countries of Europe east of the River Elbe that were liberated from Nazi Germany's occupation by the Soviet Red Army.

State socialism has also existed in Asia (in China, Vietnam, Cambodia, Laos, and North Korea), Latin America (in Cuba), and Africa (in Tanzania, Ethiopia, Mozambique, and Angola), but there is considerable debate whether all of them can really be characterized as socialist.

Waste Characteristics

Socialist societies had three key features that impacted their waste issues: (1) their economies were based on the state ownership of the means of production and on central planning as a key mechanism of distribution, a function that in capitalist countries is performed by the market; (2) their political regimes were ruled by communist parties and lacked liberal, democratic institutions; and (3) their model of modernization relied very heavily on metallurgy and engineering.

It is commonly assumed that these societies were wasteful in the sense of producing low-quality goods and using materials inefficiently, thus producing more by-products, emissions, and waste per unit of gross domestic product (GDP) than did capitalist countries. Economists primarily have explained these data by the absence of the profit motive and by the relative backwardness of socialist economies. However, by the statistical measure of waste per capita, these societies actually proved to be less wasteful than many modern capitalist economies. The lack of Western-style consumerism not only tempered the amount of waste produced but also meant that the key logic of waste production was different from those of capitalist economies.

While market economies tend toward overproduction, and thus a key systemic source of waste in their case is that supply exceeds demand, centrally planned economies struggled with chronic shortages. Economist János Kornai, analyzing the systemic causes of what he called the "shortage economy," demonstrated that central plan quotas were too tight and did not leave room for accidents or other eventualities so as to prevent the diversion of materials away from building communism. The relative underdevelopment of production technologies and the scarcities of a postwar economy and infrastructure also would have required greater slack. As a result, enterprises had to devise strategies for fulfilling the plan, even when sufficient inputs were not available, such as the substitution of inputs and hoarding of raw materials and other products. Both strategies had significant consequences for waste production. Products manufactured with materials different from the ones technically prescribed were more likely to be defective and hence discarded. As Zsuzsa Gille shows, hiding and hoarding materials to ensure against shortages also resulted in their spoiling, rotting, rusting, or evaporating and were thus wasted without ever having been used.

Waste Management

State socialism's unique economic system also had an implication for the ways in which waste was seen and treated. Most of the East European

socialist countries also established an extensive state-run infrastructure by which all wastes in industry were recorded, and their distribution for reuse and recycling was organized. The central planning offices gave state-owned enterprises quotas that determined not only how much of a particular product they should manufacture but also how much waste they would generate and thus should hand over to the central waste-collecting company. Households were also encouraged to turn in their unused wastes (including paper, old metal pots and pans, bottles, feathers, and even animal bones) to the state, usually in return for small monetary compensation. Food and drink were usually sold in glass bottles or jars on which there was a deposit, rather than in plastic, so that consumers had an economic interest in returning these containers, which manufacturers then sterilized and reused. Grocery stores did not provide plastic bags, so consumers had to take their own bags or baskets for each shopping trip. Such concern with material thrift and collecting and reusing waste—especially metal scrap—was not related to environmental problems, at least initially, but primarily arose from the postwar scarcity of metals and the need for rapid industrialization due to the accelerating arms race and cold war–era competition in living standards between East and West.

While these measures seem to be progressive in the sense that they reused, rather than dumped, waste, these policies had some unintended consequences. First, waste quotas tended to encourage enterprises to produce more by-products than otherwise necessary. Second, the predominance of metal scrap among waste materials in the initial years of state socialism, due to the plethora of salvageable metal among the ruins of the war and the emphasis on heavy industry in socialist industrialization, gave rise to the expectation that—like iron and steel—other by-products could also be endlessly reused or recycled. This was doubly problematic. First, this assumption created a disincentive to preventing wastes. Second, when applied to industries whose by-products are not endlessly reusable or recyclable, such as much of the chemical industry, this insistence on reuse turned into a blanket prohibition against dumping, resulting in the unplanned storage of toxic wastes in inappropriate and unsafe locations where they contaminated the environment.

The collapse of state socialism (in 1989 in central Eastern Europe and from 1991 in the Soviet Union) implied rapid economic liberalization, which meant that the state was no longer allowed to operate the waste collection and recycling infrastructure nor dictate to enterprises what to do with their unwanted by-products. Former socialist countries also opened up their markets to Western goods, many of them packaged in unrecyclable materials and with short lives, ushering in a throw-away culture and an attitude that sees wastes as useless and thus to be dumped, rather than reused. This in turn has rendered end-of-pipe technologies, such as landfilling and incineration, the most preferred waste management solutions.

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See Also: Capitalism; Recycling; Sociology of Waste.

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Société BIC

The disposable razor, the disposable pen, and the disposable lighter are iconic symbols of waste. Société BIC pioneered the manufacture and sale of these cheap, mass-consumer products in the second half of the 20th century. In the early 21st century, billions of discarded plastic pens, butane lighters, and personal shavers appear in landfills, litter public land, and wash up onto the world's beaches, their petroleum-based plastic content augmenting the worldwide accumulation of toxic waste. Société BIC has developed life-cycle assessments of its prod-

The disposable BIC lighter is an iconic symbols of plastic waste. Billions of BIC products such as razors, pens, and lighters appear in landfills, litter the land, and wash up on beaches. The company manufactures over 40 million disposable products every day.

ucts, but the continued disposability of its product line encourages consumers to damage ecosystems across the globe with plastic waste.

History and Products

In 1950, in Clichy, France, Baron Marcel Bich and Edouard Buffard formed Société BIC and introduced BIC Cristal, a plastic disposable ballpoint pen for sale to the public. In 1973, Société BIC launched a plastic disposable butane lighter with the slogan, "Flick your BIC." In 1975, BIC introduced the world's first disposable plastic shaver. Through acquisitions and expansion of its product lines, BIC rapidly gained a global presence. In 2005, BIC sold its one-billionth ballpoint pen. In the early 21st century, BIC leads the global market in disposable ballpoint pens with sales exceeding 20 million pens each day. Each day, BIC produces 5 million plastic disposable lighters. With sales in 160 countries traversing all continents and 3.2 million retail outlets, BIC manufactures over 40 million disposable product units each day. BIC sells ancillary products: stationery supplies, plastic "sleeves" for storing plastic lighters, and ashtrays (product life: approximately five butts per ashtray), and a BIC plastic phone. BIC Sport produces surfboards, sporting gear, kayaks, and dinghies from plastic materials. Additionally, approximately 14 percent of the company's revenue derives from contracted advertising and promotions campaigns utilizing BIC products.

BIC, as the corporation now calls itself, regularly updates graphics and designs on its butane lighter skins, depicting a vast spectrum of imagery and trendy motifs, aimed at luring a culturally diverse market. BIC has launched a consumer-friendly Website (BICworld.com) and an iTunes for iPhones and iPods—a digital lighter aimed at concert crowds—the digital image of a flame is a novelty item and sways when you move the phone.

BIC product designs have been exhibited at New York's Museum of Modern Art (MOMA) in MOMA's Department of Architecture and Design. The BIC Cristal ballpoint pen is included in MOMA's permanent collection.

Hazardous and Nonhazardous Waste

Every day, consumers buy 24 million BIC stationery products, 5 million BIC lighters, 10 million BIC shavers, and 4 million advertising and promotional products. BIC faces global competition from both legal and illegal sources, including Gillette, Sheaffer, Papermate, and other corporations. In China alone, dozens of manufacturers turn out billions of "Looks-like-a-BIC" products, and a worldwide black market in fake "BIC" products is flourishing. The rate of disposable toxic waste grows exponentially.

Most plastics used in BIC products, as in their major competitors' products, are petroleum-based and therefore do not biodegrade but photodegrade, leaving toxic particles, which over time only partially break down to molecular proportions. When disposed of in water, petroleum-based plastics become toxic "food" for birds, ocean krill, bottom-feeding sea species, and invertebrates. These species are then consumed by bigger fish and mammals, carrying the toxic waste up the world's food chain, until the toxic waste eventually lands on the human consumer's plate.

Research conducted in the Pacific Ocean has turned up zones of ocean waters in which photodegraded plastic particles are six times more prevalent than krill within the same zone.

BIC employs SIMApro software in the 21st century to map environmental factors during premanufacture product design. BIC has introduced its Ecolutions™ line, a growing series of disposable ballpoint pens, lighters, and shavers, made of 74 percent recycled plastic, and it has launched a recycling program for its disposable shavers, wherein BIC consumers may return their used shavers for recycling. BIC lighters now offer more lights per unit. BIC has also produced longer-lasting disposable products: BIC's Cristal ballpoint pen, PVC free, writes a line approximately 1.5 miles long. BIC takes a minimalist approach both to product content and packaging, with the idea that lighter weight, longer-lasting products reduce environmental damage.

Meanwhile, a few upstart companies are changing the playing field: DBA produces "94 percent biodegradable" pens from potato starch. Manufactured with wind-powered energy, the only nonbiodegradable portions of DBS pens are the nib and nib holder, which do not compost in landfills but only in dedicated facilities. The company invites the consumer to return these parts to DBA for safe disposal.

As BIC expands its Ecolutions product lines, the corporation has released an annual Sustainable Development Report, which offers some statistical data on its efforts toward greening its footprint. In marketing literature, BIC appears to lead its major competitors in awareness of its environmental responsibility.

Between 2008 and 2009, BIC reduced hazardous waste materials by an average 0.8 percent generated per ton of production and reduced usage of nonhazardous waste by 3 percent per ton of production, while absolute reduction of nonhazardous waste dropped by more than 6 percent. Globally, BIC's water usage has been reduced by an average of 11 percent per ton. The corporation is studying agriculture-based and bioplastics as potential alternatives to petroleum-based plastics. In 2009, BIC reduced its greenhouse gas emissions to 10,930 tons of carbon dioxide equivalent, indicating 324 tons less than its 2008 emissions.

Employing the method Eco-Indicator 99 to measure life-cycle phases, what the corporation terms a *complete lifecycle assessment* of its three main products, BIC reports that raw materials, "Plastics and metals, from oil extraction through to the factory," make up 90.45 percent of its disposable ballpoint pens, 83.98 percent of the BIC Maxi flint lighter, and 62.97 percent of the BIC Classic single-blade razor. The energy required in production and assembling these products breaks down to 5.62 percent for ballpoint pens, 10.68 percent for lighters, and 29.43 percent for shavers, including "water used by the consumer during shaving" at 78 percent. Distribution energy usage from operations to store deliveries breaks down at 3.66 percent for Cristal pens, 4.87 percent for the Maxi lighter, and 7.33 percent for the classic single-blade razor. Finally, end of life cycle figures, intended to measure what happens after product disposal, break down to 0.27 percent for the pens, 0.47 percent for the lighters, and 0.27 percent for the shavers.

BIC is included in numerous sustainable development indices, such as the French Leadership Index of the Carbon Disclosure Project (CDP), FTSE-4Good Europe Index, ASPI Eurozone Index, and Ethibel Excellence Index Europe.

As predictions of a globally paperless society threaten the survival of hand-held pens, BIC and competing industries still depend on their customers, passing accountability for proper disposal on to the consumer at the end of discretionary consumption.

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See Also: Definition of Waste; Fish; *Garbage! The Revolution Starts at Home*; Gillette, King C.; Ocean Disposal; Recyclable Products; Sustainable Development; Sustainable Waste Management; Toxic Wastes.

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Sociology of Waste

As the study of society, sociology is intrinsically concerned with empirical observation of society, revealing patterns and divisions across space, gender, class, race, and ethnicity. The discipline is especially suited to analyzing socioeconomic divisions, social mobility, and deviance, all of which may be illuminated through studies of waste.

All societies waste. But while the fact that all societies work, worship, and get sick called for sociologies of work, religion, and medicine, waste has justified the call for a sociological study only recently. Since this is still a relatively new field, broad views of the sociology of waste are appropriate and waste studies in other social sciences (primarily geography, anthropology, and political science) and even humanities (history, philosophy, and literature) are informative. These approaches all share a key assumption of the sociology of waste, namely, that what people define as "waste" varies with time, space, culture, and social group; in other words, waste is socially constructed.

Social Construction of Waste

Waste is usually identified with one side of the following pairs of opposition: efficiency/inefficiency, usefulness/uselessness, order/disorder, gain/loss, clean/dirty, alive/dead, or fertile/sterile. The social construction of waste—which constitutes the foundation of all social science studies of waste—argues that there are social and cultural reasons for this variety in definitions. In capitalist countries, on the whole, waste was historically defined as useless and harmful, and this led to a mentality that prefers discarding waste to saving, reusing, or recycling it. In the developing world and in former socialist countries, in contrast, waste has been seen as valuable and fertile, which results in greater thriftiness and efforts to recover value from discarded materials. Some attribute this difference in attitude to higher average living standards and the abundance of commodities in capitalist countries, though some humanities approaches see this inscribed negativity of waste as a general feature of modernity.

Beyond pointing out this identification with one or another side of dichotomies, much of the waste scholarship has also invoked Mary Douglas's famous conceptualization of dirt as "matter out of place." Objects are labeled as waste or dirt not because of their objective physical composition but rather because they are in a place where they do not belong according to prevailing notions of order and rules that govern everyday life.

Others have argued, however, that applying Douglas's definition of dirt to waste is faulty for two reasons. One argument, advanced by Martin O'Brien, is that modern societies do not exhibit the kind of uniformity and homogeneity with regard to concepts of order as the traditional cultures from whose study Douglas derived her famous notion of dirt. The other reason for questioning the usefulness of Douglas's formulation is that by equating waste with dirt, one is immediately delegating waste to the negative side of the previously mentioned pairs of opposition, thereby not only contradicting the experience of many non-Western cultures but also ethnographic findings in the West. In the latter, wasting practices have been described not as simple transformation of objects of value into rubbish, but rather as a nonlinear and often reversible movement of objects through various stages of disuse, divestment, and disposal. Waste, therefore, is best seen as a liminal or border concept, one that can be valuable or valueless depending on various social and physical factors.

The social construction of waste, however, is not limited to historical and geographical/cultural variation, but can extend to variability within the same society. At the microlevel, studies have shown that social class can influence which things individuals and households discard and what they do with their surplus belongings. As Nicky Gregson shows in her ethnographic study in the United Kingdom, for example, people with fewer resources tend to purchase and hold onto used appliances and refurbish them as needed. While one may expect wealthier consumers to buy better-built and thus more-durable goods—thereby wasting less—the phenomenon Thorstein Veblen called "conspicuous consumption" and "conspicuous waste" may result in the opposite outcome. He argued that the rich consume profligately to demonstrate their status and wealth. In the early 21st century, people waste not only to announce one's social background but also to express one's identity, demonstrate a knowledge

of new consumer trends, and even fill a certain void in one's life. The treadmill of consumption propels people to buy more for these reasons, but in order to afford those things again and again, it is necessary to work harder, and when people work harder, they have less time and energy for meaningful human interaction for which people then try to compensate by consuming and thus wasting more.

Social Inequalities in Waste Issues

In general, sociological and historical studies of trash have found that the dirty and badly paid jobs of collecting, transporting, selecting, reusing, and recycling garbage tend to be done by the poorest and most marginalized segments of society. This is not to say that manufacturing new goods out of byproducts is never a profitable venture—often it actually is—but simply that profitability rarely trickles down to those whose waste labor such enterprises rely on. This is usually because the poor, having neither education nor tools or other property with which to make a living, often find that garbage is the only freely available resource. In Western metropolises, for example, many homeless people survive on deposits from discarded bottles. Even when a certain waste product is coveted, once the profit from waste collection promises to be steady and large enough, private professional companies take over waste collection, selection, and reuse. This is also currently a common trend in the developing world, and several studies conclude that in addition to eliminating this important source of livelihood of the urban poor, privatization of waste services also has negative environmental consequences. One consequence has been that waste selection, once mechanized, is not as detailed or thorough as when done by human hands, and that the profit motive in collecting waste for landfilling or incineration reduces economic incentives for salvaging certain unprofitable materials and, in general, for reducing and recycling waste.

In many societies it is not simply class but also race, ethnicity, or religion that determines who will hold waste-related jobs. In eastern Europe, it is the Roma (colloquially called Gypsies) who are the key collectors of discarded furniture, clothing, metal, and even food scraps. In Egypt, it is the mostly Christian *zabaleens* who specialize in collecting household trash that they use to feed their pigs, whose meat then provides food and cash. The majority of Egyptians follow a Muslim diet and do not eat pork, so the work of the zabaleen is doubly seen as dirty. In the contemporary United States, poor African Americans constitute the majority workforce in recycling plants, where they face many occupational hazards selecting municipal waste.

Epidemiological studies have demonstrated that there is a correlation between the frequency of cancer and other diseases in surrounding communities and the proximity to such waste facilities. Cancer clusters and such toxic facilities are both more frequent in neighborhoods that are less white and less affluent. A famous example is Louisiana's Cancer Alley. What is now called environmental racism has been a much-researched and hotly debated issue in U.S. environmental sociology.

Many statistical studies have proven that one's skin color has more to do with exposure to toxic waste-related harms than income. How to evaluate this correlation, however, has divided environmental sociologists. Some have argued that since correlations only indicate that things occur together and not which variable came first—in other words, what may be cause and what effect—it is not justifiable to call such findings evidence of environmental racism. For example, instances of African Americans moving into a neighborhood that already has toxic waste nearby—because that is the only kind of location they can afford—cannot be deemed environmental racism because the racial minority "chose" to move there and because the key reason they did so was economic rather than related to race. In contrast, other sociologists have claimed that a proper definition of racism is not one that reduces that term to individual bigotry and intentional discrimination but includes institutional and structural forces reproducing historically existing inequality, such as the economic coercion forcing ethnic minorities to move near toxic waste sites. In this interpretation, racist or discriminatory intent is not a prerequisite of environmental racism.

Finally, a few studies have called attention to the gendered division of labor in the household as having played an important role in wasting practices. While women have sometimes been at the forefront

of reusing and recycling, as in New York's 19th-century rag trade, women in contemporary Western societies may actually find that municipal recycling schemes add to women's unpaid labor.

Sociological Analyses of Waste Production

Sociological approaches have also contributed to the understanding of how waste is produced: what kinds, how much, and by what processes. Macrolevel approaches in capitalist countries have tended to focus on waste resulting from the tendency of market economies to overproduce, which leads to the squandering of many natural resources. This is not an entirely economic logic, however. To the extent that local and state governments and politicians' survival depend on taxes and employment, there is also what Alan Schnaiberg called the "treadmill of production," which creates a powerful incentive for continuous economic growth.

Competition propels producers to implement newer-and-newer technologies that—while they might result in greater efficiency in any individual company—also require increased production in order to recuperate the investment costs, resulting in overproduction. Vance Packard's classic concept of planned obsolescence captures the mechanism by which consumers are forced into profligacy. Products are intentionally manufactured in such a way that they break, go out of date, or out of fashion very quickly. This social fact also casts doubt on the rationale behind the distinction between producer and consumer waste, because consumers have a rather limited choice in how to waste.

Other scholarship has coined theoretical concepts that place more emphasis on microlevel, material-technological, and cultural factors than the concept of the treadmill of production. One example is the concept of *waste regime*, a term coined by Zsuzsa Gille, which expresses the interaction of the production, representation, and politics of waste. Other authors have focused on consumer waste and individual households, where macrolevel dynamics exert a less direct impact than production waste.

Another factor behind wasting practices, especially concerning food, is increasing consumer anxiety. Food scandals since the 1980s, such as mad cow disease (BSE), foot-and-mouth disease, and *E. coli*–contaminated beef and spinach, to mention just a few, have shaken trust in corporations and state regulatory agencies. While strengthening safety standards and labeling requirements give more information to consumers, such information can also create more anxiety and confusion. For example, consumers do not understand the distinction between labels such as "best before," "use by," or "display until." Because of their underlying anxieties, they tend to err on the side of caution, discarding food that otherwise is still appropriate for human consumption. BSE and foot-and-mouth incidents have caused most governments to also ban the traditional practice of feeding human food scraps to livestock, primarily hogs and chickens, which again results in food waste that primarily ends up in landfills where it generates methane, which is 25–30 percent more potent of a greenhouse gas than carbon dioxide.

These practices of caution all attest to the advent of what German sociologist Ulrich Beck called "risk society." He argues that society has reached a new phase of modernity in which people start to question whether mastery of nature is actually possible, whether it produces good outcomes, and whether it is worth the risks. According to him, in the most developed countries, people are becoming less concerned with the distribution of "goods" (such as income and assets), and more with the distribution of "bads," such as air pollution, toxic wastes in soil, and poison in food. Such concerns translate into a new politics in which access to a safe environment becomes a primary issue. Especially in the United States, struggles around toxic waste facilities have been a key issue in this new politics.

Social Movements Around Waste

In the 1980s, a new social movement swept across the United States. The movement originated in disparate communities' struggles against existing or planned toxic waste dump sites or incinerators, called Not in My Backyard (NIMBY). Soon, however, these isolated local struggles united and coalesced into a nationwide antitoxics and environmental justice movement. U.S. environmental sociology's key focus has been the study of these movements. Major findings of this scholarship include the unlikely mobilization of otherwise

apolitical citizens when facing life-threatening illnesses due to toxic emissions; the ability of this movement to effect an actual moratorium on toxic waste incinerators in the United States in the 1980s; the significance of racial and ethnic politics, as well as its role in Executive Order 12898, issued by President Bill Clinton in 1994, obliging federal agencies to consider the environmental justice impact of their decisions; the conflicts resulting from targeted communities' need for jobs and tax revenue and environmental and public health concerns; and the few success stories when the former interests could be reconciled with the latter.

A few authors have argued that such movements against toxic waste dumps and incinerators have made it so difficult and expensive for companies to get rid of their toxic wastes that eventually they have been pushed toward cleaner production. In other words, the politicization of waste distribution can have an effect on waste production, even when privately owned corporations successfully resist attempts to regulate which chemical compounds are to be used and thus generated in production.

A U.S. team of scholars under the leadership of the late Alan Schnaiberg focused on struggles in Chicago around municipal waste collection, arguing that private, for-profit collection services have hijacked the cause of recycling and demonstrating the occupational hazards of workers (who tend to be African American) in recycling facilities. Other, primarily comparative and quantitative sociological works have analyzed which factors have had an impact on the success of antitoxics movements.

In Europe, the focus on social movements around waste primarily has been on from-below initiatives promoting reuse and recycling, rather than on environmental justice. This is primarily because, due to its much larger population density, the kind of environmental ghettoization common in the United States never developed in European societies. Nevertheless, waste-related environmental racism may be on the rise in postsocialist countries of Europe, including the former Soviet Union, and even in western Europe, because of rapid increases in immigration from Asia and Africa and the resulting residential segregation based on race and class.

Cultural, Ethical, and Behavioral Issues

Some of the studies around this theme have carried out quantitative surveys of people's attitudes toward toxic and nuclear waste facilities and recycling, demonstrating the significance of various demographic factors, including age; gender and parental status; social class; and the presence of certain values, such as a sense of civic duty. Others, using qualitative methods, have investigated the kind of subjectivities produced by various waste recycling campaigns. Many scholars have documented the anxiety people have about throwing things away or not recycling; in fact, Gay Hawkins argues that Australian recycling campaigns rely on guilt for their success, and she considers this moralization manipulative. Scholars in this field, most of whom have a background in the sociology of consumption, have also tended to question the commonly accepted wisdom that consumerism leads to more waste and that it is individual profligacy that is responsible for overflowing landfills in the early 21st century.

Conclusion

The sociology of waste is a new and promising subdiscipline, but one that will continue to struggle with a lack of data other subdisciplines readily have, and one that will continue to develop conflicts around the meaning of waste, consumerism, and environmental racism. A new direction is the focus on specific waste materials and, inspired by actor network theory, the agency such objects exhibit in social life. Another theoretical direction relies on the argument that waste is not simply a derivate of social activity but rather it is its condition. This claim has been made in three different ways: (1) without disposal and other wasting practices, there is no consumption; (2) the relative absence or failure of waste regulations does make possible a particular social life; and (3) waste materials keep haunting society even after their disposal. These perspectives will continue to temper the currently predominant social constructionism of this subdiscipline.

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See Also: Capitalism; Consumerism; Culture, Values, and Garbage; Environmental Justice; Socialist Societies.

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Solid Waste Data Analysis

Solid waste data analysis is the range of activities to measure and understand two core aspects of solid waste: quantity and composition. Quantity may expressed in weight, volume, or number of product units. Composition refers to the relative percentage of materials, chemicals, or product types that are present in a standard quantity of waste. Together, these data enable scientists, engineers, and policy makers to construct a picture of how much waste is generated and what it consists of for a particular set of generators (such as residents, businesses, or industrial activities), for a particular jurisdiction (such as a city, county, state, or country), and in a set time period (such as per day, per year, or over a longitudinal time series). This information may be used to project the air, ground, water, and health impacts of waste transport and disposal; estimate the reduction of such impacts under prevention, reuse, recycling, or composting alternatives; and weigh the costs and benefits of disposal versus alternatives.

Quantity

Solid waste data analysis begins with data that is either directly measured or estimated using proxy variables. The most basic and reliable measure of quantity is collected tonnage. Most municipal solid waste and much hazardous industrial solid waste are weighed as a routine step in transportation through intermediate to final destinations. Because economic transactions between waste generators and waste handlers are commonly assessed by weight or volume, such information is widely maintained by private and public entities. The reporting of waste quantities aggregated over time and geographic jurisdiction, as part of state or local waste management planning efforts, is common. In cases where volume, as opposed to weight, is the metric reported, standard weight-to-volume ratios for different materials or products can be used to calculate an estimated weight for a volume of transacted waste.

In other cases, waste quantity may be estimated using variables that measure consumption of products that end in waste. Information on domestic production, imports, and exports of materials and products is used in conjunction with information on product life spans to estimate waste quantities that consumers will generate after using up goods. In many cases, production and marketing data kept by private industries can be used to estimate numbers of units bought and sold. In such cases, standard unit weights are used to convert information

into tonnages. This approach is basic methodology used by the Environmental Protection Agency's (EPA) long-standing national municipal solid waste report, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States," which is issued biennially. This report supplements its indirect quantity estimates with directly measured data provided by landfill operators, recycling processors, and municipalities.

Composition

Measuring waste composition is a quite different endeavor than measuring waste quantity. Direct measurement of composition does not take place routinely like waste quantity measurement does. Composition measurement begins by intercepting waste from generators or after collection, or in some cases by extracting waste from industrial properties, landfills, or incinerator inputs.

Multiple random samples are then broken down into constituent materials. This can be done at various levels of detail. State or local waste characterization studies, for example, assign workers to take samples of mixed garbage from collection trucks and to hand-sort contents into a range of categories that correspond to products or materials that are relevant to waste policy. By recording the total sample weight and the weight of each sorted category of material or product, such studies enable the calculation of a percent composition that can be averaged over many samples to develop an estimate that is statistically significant. Waste characterization studies use different category definitions and numbers of categories, but generally estimate the composition of paper, metal, plastic, glass, wood, organic, and inert inorganic materials in solid waste. Results of waste characterization studies are useful for understanding how much disposed of waste might be routed to recycling, reuse, or composting under different policies. Depending on level of detail, such studies also provide insight into the quantities of acutely hazardous categories of waste, such as batteries or electronics, that may be kept out of disposal through other policy interventions, such as disposal bans or extended producer responsibility programs.

Leachate testing takes samples of solid waste and subjects them to water in order to extract and evaluate the residual chemicals that are released when such materials come into contact with moisture. Similar methods may be applied to assess the chemicals present in air emissions from combustion of different waste types. In both leachate and emissions testing, the point is to assess the chemical composition of disposed of waste in conjunction with the contribution of constituent chemicals to pollution, given a particular disposal technology. In contrast to material- or product-specific waste characterization, which relies on visual assessment and weighing, chemical composition is measured in the laboratory using chromatography and is sensitive to materials at the molecular level. Either method may be used in conjunction with mass balance, a methodology used to understand the accumulation and transformation of materials within a system by studying the quantity and composition of materials entering and leaving that system. Applied to solid waste disposal systems, such as incinerators, mass balance can identify the efficiency of operation and the degree to which systems increase or decrease the emission of pollutants.

Indirect methods for estimating waste composition rely on consumption data as well as information on how individual product types are manufactured. The EPA's "Municipal Solid Waste Generation, Recycling, and Disposal in the United States" report estimates national waste composition among 13 major material and multiple submaterial and product categories using import, export, and domestic production data for different commodities, such as paper products, packaging, beverages, textiles and apparel, and other home goods. Information on the makeup of individual products, particularly those that are comprised of a mix of materials, as many electronic goods are, may also be used to estimate overall waste composition. Information on the relative quantities of plastics, glass, and different metals that go into a particular model of computer, for example, can be used in conjunction with statistics on the quantities of such models sold in the United States and the average life spans of these models to predict expected quantities of respective plastics, glass, and different metals in solid waste.

Applications

There are many analytic applications of solid waste quantity and composition data that go beyond the

analysis of solid waste. Frequently, such data are used in conjunction with data on the extraction, transformation through manufacture, transportation, and distribution of materials and products prior to the wasting stage, as with materials flows analysis and product lifecycle analysis. These forms of analysis examine the movement of materials—both those making up commodities and those associated with commodity production—at all stages in the material or life-cycle to work up a picture of the ecological impact of major categories of industrial activity, such as mining, manufacturing, forestry, or agriculture. Another application of solid waste data uses models to estimate the emissions, energy usage, costs, and fiscal benefits of waste management options using computer-based decision tools. The EPA's Waste Reduction Model (WARM), Cities for Climate Protection (CCP) Software, and MSW Decision Support tools are examples, which have been programmed to provide users with estimates of the environmental and economic impacts of different ways of handling solid wastes, based on input data about waste quantity and composition.

Studying differences in waste quantity and composition among different demographic groups or business sectors sheds light on methods to promote waste prevention, recycling, and composting. Numerous studies have examined how variation in socioeconomic factors such as income, education attainment, or housing characteristics relates to waste quantity and composition among residents, including how much waste is recycled instead of disposed of. Understanding the patterns of such variation is useful in targeting public outreach and education to different types of residents. Information on how the quantity and composition of commercial waste varies by business sector—or among businesses in the same sector that structure their internal operations in various ways—can be used to develop best practices that save businesses money while reducing waste overall. Providing sound, quantitative information to waste generators about how much they throw out—and what it consists of—is part of an ongoing effort by governments to bring them into the process of minimizing waste and waste disposal.

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See Also: Consumption Patterns; Environmental Protection Agency (EPA); Household Consumption Patterns; Incinerators; Landfills, Modern; Pollution, Air; Pollution, Land; Pollution, Water.

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Solid Waste Disposal Act

Before the Solid Waste Disposal Act (SWDA) became law on October 20, 1965, open pits of smelly garbage could be found rotting on the edge of sprawling cities and towns in the United States. This act, passed as Title II of the Motor Vehicle Air Pollution Control Act of 1965, was the first attempt by the federal government to address the growing problem of solid waste accumulation that was facing the nation. The SWDA authorized federal funding to state and local governments to conduct research on waste disposal practices and problems and to develop waste management plans. This research set the stage for several amendments over the following decades

that significantly altered the act, most notably the Resource Conservation and Recovery Act of 1976 (RCRA), which established a regulatory framework for the treatment and disposal of solid and hazardous wastes.

Problems of Waste

Congress specified two primary reasons for the SWDA. First, technological developments were causing a rapid increase in the amount of solid and hazardous wastes being created around the country. Second, because of the population explosion in the nation's metropolitan neighborhoods, urban areas experienced significant financial, management, and technical problems associated with waste disposal.

Whereas most wastes historically might have decomposed over time and become benign, the nation now faced the reality that its great industrial and technological progress brought with it waste products that increasingly did not decompose and contained toxic materials. At the same time, the emergence of cheap, single-use products was further transforming U.S. society from a Depression-era ethic of conservation and reuse into a culture of consumption and disposal enabled particularly by the advent of plastic. Coupled with urbanization and rising income levels, this shift in the character of consumption and waste was creating increasing problems, particularly for cities. Even though the quantity and types of waste being generated were advancing rapidly, technology and policy to manage these wastes were not keeping up. The primary advance to date was the advent of so-called sanitary landfills in 1959, where new waste was covered with soil each day to contain smell and rodents. However, this did little more than combat the aesthetic problems of waste, leaving the more fundamental issues of comprehensive waste management and pollution unsolved.

Historically, waste had been seen primarily as a local issue, and environmental concerns focused on the conservation of resources and sensitive lands. This paradigm began to change with the nascent environmental movement of the early 1960s, which recast waste as part of a larger web of interrelated threats to human health and the environment. No longer was trash just a nuisance that could be dumped outside the city limits and forgotten, but rather it became recognized as a source of pollution that could contaminate groundwater when buried, foul the air when openly burned to save landfill space, or impair rivers and oceans when dumped there.

SWDA

Leaders began to realize the need for more state and federal intervention to deal with the problem of waste, particularly given the downstream effects of air and water pollution and the lack of adequate technology to prevent it. Through the SWDA, the federal government made its first major foray into waste management by boosting funding for research and development to help localities better coordinate response to what was now a national problem. The act was administered by various entities in the Departments of Interior and Health, Education, and Welfare (HEW) until these functions were consolidated into the newly formed Environmental Protection Agency (EPA) in 1970.

The SWDA passed with strong support from both Congress and President Lyndon B. Johnson. Having won the 1964 election by a large margin, Johnson used his electoral mandate to expand federal powers in pursuit of his Great Society vision in which he elevated the issue of pollution alongside other threats to the quality of life and heritage of the United States, such as poverty and racial inequality. His January 1965 State of the Union address included a specific call for the control of harmful wastes and for research into methods of pollution prevention.

As research was conducted under the SWDA, and as environmental problems and solutions came to light, it became apparent that increased regulation of wastes had to follow. The following are major amendments to the SWDA: the Recovery Act of 1970, Resource Conservation and Recovery Act of 1976, Used Oil Recycling Act of 1980, Solid Waste Disposal Act Amendments of 1980, Hazardous and Solid Waste Amendments of 1984, Medical Waste Tracking Act of 1988, Federal Facility Compliance Act of 1992, and Land Disposal Program Flexibility Act of 1996.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Disposable Plates and Plastic Implements; Environmental Protection Agency (EPA); Landfills, Modern; Resource Conservation and Recovery Act; Resource Recovery Act.

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South Africa

In the 16 years since South Africa became a democracy, waste and its management have changed substantially, although—many would argue—not sufficiently. South Africa has a dualistic economy and unique waste legislation, including several significant policy changes since the 1900s. Landfills and their management have undergone controversy, and various key organizations and initiatives are being undertaken in South Africa.

Context

Statistics such as gross domestic product (GDP) and per capita income suggest that South Africa is a middle-income or emerging economy but this view hides the inequalities that, for many, define the country. Instead, South Africa may best be considered as part of both the developed and developing world simultaneously, and this perspective is particularly appropriate when considering South Africa's waste. Here, as is typical in developing countries, one can find people whose livelihoods come from the use and sale of materials collected on landfills or from waste bins, called "waste pickers." At the same time, the signs of conspicuous consumption are evident in large quantities of packaging waste, food waste, and goods tossed out because they are replaced by the latest fashion. The types of mining, industrial, agricultural, hazardous, and nuclear waste suggest an active, industrialized economy, while human waste—feces and urine from large impoverished settlements lacking adequate sanitation—are a major concern in water treatment. Efforts to manage waste are faced not only with the challenges resulting from scarcity and surfeit but also the opportunities that this juxtaposition provides, such as economically viable, labor-intensive recycling. Similarly, the South African

Taking in the view from Table Mountain in Cape Town, which is thought to be the most green South African city. Its WasteWise program implements a national policy of minimization that is well regarded for its positive impacts.

environmental movement contains two historically distinct streams: green advocates concerned with conservation, and anti-apartheid struggle activists concerned with human rights and environmental health, or so-called brown issues. While these movements are increasingly merging, their separate histories and priorities are evident.

Waste Management and Statistics

Municipalities are responsible for the collection of domestic waste, and the success of these efforts varies significantly across the country and within municipalities. Cape Town, which has a reputation for being South Africa's most green city, has carried out a WasteWise program, which seeks to implement existing national policy—including the priority of minimization—and is well regarded for its positive impacts. In contrast, waste management in Pietermaritzburg, the capital of KwaZulu-Natal Province, has worsened in the early 21st century. The municipal landfill under new management frequently catches fire, and waste management is notoriously inefficient and corrupt.

Recycling is a growing phenomenon nationally, in part because of economic incentives. For waste pickers, as well as schools and other charity organizations, recycling provides much-needed income. The high amounts of waste produced by the wealthy—combined with relatively low wages—result in a fairly unique situation internationally: high volumes of waste and low wages, enabling relatively cheap recycling. Experiments in electronic waste (e-waste) recycling, in particular, are seeking to take advantage of this.

Reliable statistics on waste are difficult to find, although efforts are being made as of 2010 to remedy this shortcoming. The South African Waste Information Centre has been tasked with improving national data and provides capacity for self-reporting. A commonly cited figure for national waste production is 13.5–15 million tons in 1998, although there is recognition that this figure has increased. Most of this goes to landfill, although there is increasing pressure—both for and against—incineration. By 2007, 61 percent of households had household refuse removal services. Some 80 percent of all national waste results from mining. Recycling rates vary significantly for different materials: around two-thirds for cans (made of steel, not aluminum, although there is a large aluminum smelter that exports what is produced), one-fifth for glass, and almost half for paper—although obtaining reliable data remains a challenge.

Legislation

The apartheid government passed environmental regulations for conservation as well as air and water protection, although there was no specific waste regulation. The democratically elected government transformed South African politics on many levels, including environmental. It provided the opportunity for an overhaul of existing policies, and consequently, South Africa has some of the most progressive legislation internationally. This is also true for environmental law, exemplified in the right to an environment free of harm enshrined in the constitution.

The primary waste legislation is the National Environmental Management Waste Act of 2008. The Waste Act is notable for including the waste hierarchy and prioritizing the avoidance and reduction of waste, as well as requiring the establishment of industry waste management plans. What such principles mean in practice is, however, not clear. The act is complemented by a National Strategy for Waste Management, to be revisited about every five years. As of September 2010, the latest strategy is in draft form and available for public comment. Additional relevant legislation is the 1998 Minimum Requirements for Waste Disposal by Landfill developed by the Department of Water Affairs and Forestry. This increased the standard for legal landfills and, consequently, the costs of landfilling.

Landfill Sites and Management

Historically, waste in South Africa was dumped wherever land was available. As is true internationally, this was typically near low-income communities of color. Apartheid planning exacerbated this trend, and post-apartheid efforts have faced challenges in redressing this inequality. The earliest environmental justice nongovernmental organization (NGO) in South Africa, Earthlife Africa, began drawing attention to the injustice and poor management, particularly of hazardous waste,

soon after the democratic elections in 1994. Building on the social networks and activism that overturned the apartheid regime, community-based struggles resulted in the closing of some particularly notorious landfills. Importantly, this also resulted in a discursive shift around the siting of landfills away from technical criteria toward consideration of human rights and environmental justice. Existing landfills are running out of capacity, and finding politically acceptable new sites is proving challenging. While this has been used as a motivation for incineration, the siting of such a facility raises equal and additional concerns.

Under the apartheid regime, the proximity to poor communities and minimal management of landfills had some silver lining: waste pickers were typically able to access such sites freely. Post-apartheid regulations have both strengthened the control over landfills and reduced access to this source of livelihood for many of South Africa's poorest residents. This controversial position has drawn the attention of the progressive environmental justice NGO agency Groundwork, which is working extensively with waste pickers. Projects have, for example, helped organize waste pickers who were removed from a landfill to regain access and to join together to negotiate better prices from those who purchase the recyclables collected by waste pickers.

Organizations and Initiatives

There are various organizations dedicated to improving waste management. The Institute for Waste Management (IWM) provides education and training, publishes the quarterly journal *ReSource*, and organizes the biannual WasteCon conference. There is a National Recycling Forum as well as various industry associations for plastics, paper, packaging, or cans that promote recycling. The Institute for Zero Waste in Africa (IZWA), linked to the international Zero Waste network, provides a radical edge to the waste discourse.

The eWaste Association of South Africa is a nonprofit association of manufacturers, recyclers, and NGOs initially established in collaboration with Swiss funds. It aims to improve the management of electrical and electronic waste in South Africa. The government is considering the implementation of an advanced recycling fee to subsidize e-waste recycling, but there is already a significant, profitable e-waste recycling industry. The combination of significant volumes of waste from government, business, and households with low-wage labor may make South Africa well positioned to profitably and safely recycle e-waste.

One notable initiative is the plastic bag levy. While many environmentalists support the initiative in principle, in practice it has proven controversial. Stores sell thicker plastic bags, increasing the overall quantity of waste from a single bag, although increasing the likelihood of reuse. Further, recyclers do not see any of the money that consumers allegedly paid as an environmental tax; this is instead allegedly put into the Buyisa-e-Bag fund for awareness-raising and other projects.

Thus, South Africa presents a microcosm in which the environmental challenges arising from wealth and poverty must be simultaneously addressed through the consideration of brown and green environmental priorities.

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See Also: Africa, Sub-Saharan; Economics of Waste Collection and Disposal, International; Environmental Justice.

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South America

From Colombian garbage pickers to dealing with rodents in Argentinian shantytowns and recycling film in Brazilian cinema, South Americans are creative in their approaches to waste. They find a myriad of interesting ways to resolve the problems it causes or to utilize waste to their advantage, transforming it into a social, economic, and artistic resource. Creative and socially engaged responses to waste illustrate how it is more than just the end product of social and cultural practices. Waste in South America is involved in the production and transformation of social and cultural life. How waste is valued and used can reveal a great deal about social relations in specific contexts across South America.

The State of Garbage

South America produces approximately 16 percent of the world's solid waste, over 120 million tons per year. Much of this is concentrated in megalopolises such as São Paulo and Buenos Aires. These cities, with populations greater than 10 million inhabitants, produce more than 10,000 tons of garbage each day—enough to fill a stadium in one week. This presents a major environmental management challenge for governments carrying heavy debt loads. There are also significant issues with agricultural refuse, industrial waste, and air pollution. Environmental neglect, social exclusion, and poor sanitation infrastructure have meant that the prodigious output of garbage creates serious public health problems. These are especially severe among marginal and shantytown populations and those eking out a living from garbage collection, either as formal employees or as informal recyclers.

South American waste harms those who, because of social and economic marginalization in some of the most unequal societies on Earth, least produce waste. The issue has therefore been firmly interwoven with struggles for social justice. Continent-wide political liberalization since the late 1980s has been accompanied by a boom in community associations and social movements, and this has had a dramatic impact on the manner in which South Americans deal with garbage. Thousands of grassroots recyclers' associations and cooperatives have joined ranks with other community organizations to promote the rights and interests of recycling workers and communities affected by garbage and pollution. To this end, they utilize a vibrant mix of political activism, social entrepeneurship, and creative cultural disruption.

Waste or Resource

Whether garbage is considered a waste or a resource depends upon whether it can be usefully and safely redeployed and whether anyone is willing to redeploy it. There are categories of waste that are unlikely ever to be reusable and are therefore pure waste, rather than resources in waiting. In South America, effluent and industrial pollution are perhaps the most important categories of unrecyclable waste and the most difficult to deal with. Poor infrastructure and lax waste management practices have led to both acute and chronic problems. For instance, in 1996, a lead-zinc tailing dam in Bolivia broke, dumping 235,000 tons of mercury-infused toxic waste into the Agua Castilla River, causing the death of three children who drank water from the river and damaging crops on nearby farmland. Improper disposal of garbage, effluent, and industrial waste exacerbates chronic problems of sanitation, leading to hospitalization rates of 400–1,000 persons per 100,000 per year in the worst-affected areas.

The location of waste disposal is critical for the issue of containment. Poorly located and poorly managed sites can have serious implications for public health. The Reconquista River is one of the most polluted rivers in Argentina. It is contaminated with effluent from factories and sewerage from Buenos Aires. Frequent floods displace river water, which can permeate the groundwater from which drinking water is drawn. The diversion of pollutants away from their sources is thus only partial, as waste is eliminated from households and factories only to end up polluting the environment where residents live.

The ability of a resource to be recycled can depend upon its stage of production and consumption. Waste from the production of copper damages the health of humans and the ecosystem. However, it is difficult to assess the impact of copper overall because it enters the waste management

system through a number of sources. Waste from refineries generally ends up in landfill or water sources; products with copper parts, such as cars and electronic equipment, may end up in municipal dumps, and from here copper may be recycled by entrepreneurial garbage pickers. In South America, copper waste from electronic equipment has a habit of rarely making it to a dump at all. Instead, people tend to store it in their garages or take it to recycling shops.

Reasons why people may be willing to store waste copper, rather than dispose of it are that it does not pose an acute health threat, does not rapidly disintegrate, and therefore holds its financial value, which is substantial. The aesthetic and practical properties of copper may also work in its favor. Easily worked, attractive, and usable in small quantities, it is easier to store than plastic bottles or concrete blocks. Hence, what ends up as waste does not depend only upon the use value of a material, but also on one's culturally conditioned relationship with it and the spaces available. Technology is also important, as reusing waste may require its transformation to a different form. For example, an incinerator and electrical infrastructure are needed to convert waste to energy and supply it to households. Brazil, the largest energy consumer in South America, is also the most advanced in converting waste to energy. Sugar industries produce approximately 4,000 gigawatt hours annually to run their own refineries and distilleries by recycling solid and liquid wastes, which present serious environmental problems if improperly disposed of.

Whether recycling occurs also depends upon government policy and business initiatives. In Brazil in 1996, a private-sector program from Compromisso Empresarial para Reciclagem (CEMPRE) began providing incentives such as credit lines and technical support to businesses to encourage them to recycle. More and more municipal governments are providing recycling services to deal with domestic waste. Across South America, municipal governments hire increasing numbers of poor people to clean the streets in teams, thus providing employment and solving the problem of litter in city centers. The availability of services and initiatives is thus transforming people's views of whether garbage is a waste or resource.

Recycling and Poverty

To understand relations to waste in South America, it is important to realize that they vary across different socioeconomic strata. The relationship between poverty and waste is curious. On the one hand, squatter settlement residents are associated with waste and stigmatized for it. Garbage picking, constructing houses out of scavenged materials, and insufficient sanitation mark poor urban residents as unsanitary. However, poor people consume fewer resources than wealthy people, and by recycling, they are performing an important environmental service. As environmental awareness grows and recycling gains popularity, poor people may become less stigmatized for their use of waste.

Poor urban residents play a central role in urban recycling because they have greater incentive to extract profit from any resources that are available to them. What is garbage in the hands of a well-off person may be building materials or a commodity in the hands of a poor person. If a resource is in short supply and the cost of recycling is lower than the cost of producing from raw materials, it is more likely that the resource will be recycled. However, this only holds if there is reasonable profit to be made in recycling relative to other kinds of work. Low wages and high unemployment rates in many South American countries have compelled many poor people to work as garbage pickers—people who go through municipal garbage to find anything that might be resold. Bottles, cardboard, and metal are the main items collected. Garbage picking and informal recycling is an occupation that has traditionally carried a heavy social stigma, with associations of homelessness, illiteracy, and unemployment, as well as unsanitary living and working conditions.

In Cali, Colombia, thousands of people have been collecting rubbish in municipal dumps for decades. One group of garbage pickers work in the dump; a second group work on the streets, walking ahead of garbage trucks to go through bins in the few seconds between when they are brought out to the street and when they are emptied into the truck. A third group collects paper from shops and offices (these workers are called *cartoneros* in Argentina). Many garbage pickers work full-time in the industry because there is no other form of employment available, whereas other people might

undertake garbage picking in slow times. Fruit sellers, for example, may collect garbage when supplies are limited. The work is stigmatized, but it requires no start-up capital and is therefore accessible to all able-bodied people. However, earnings tend to be very low and do not include any employment benefits.

Cultural Politics and Aesthetics of Waste

The politics of waste has a strong influence on people's opinions of whether waste can be aesthetically pleasing or not. As with attitudes toward recycling, this aesthetic varies across socioeconomic strata and can generate fervent political debates and social movements relating to political and environmental interests of different social groups. Recycling can become enmeshed with cultural practices that define a national identity, as in the case of Trinidadian steelpan percussion—originally made from oil drums. But recycling can also be much more contentious. For example, photos of shacks in *favelas* on the hillsides of Rio de Janeiro demonstrate the precariousness of existence for the poor, but they have captured the imagination of people around the world, partly because of their creatively improvised aesthetic.

Houses in squatter settlements exhibit a wide array of construction methods and decoration. Wood and tin may be scavenged from building sites or domestic yards to construct posts and walls; reams of material discarded by friends and relatives lines internal walls; and pictures from last year's calendars are cut out to provide decoration. Housing is an arena where creativity and sociality are evident. For example, residents of a Brazilian favela complete the façade of their house before they finish constructing the house behind it in order to let their neighbors know what kind of a house they aspire to construct. Creativity and community enhance residents' reputations as competent people who invest effort in their domestic environment despite severe economic constraints. These efforts provide some respite—albeit local—from the stigma that accompanies poverty.

Recycled building materials tend to mark residents as being not only economically poor, but also morally poor or at odds with how a city or nation would like to see itself. For example, Brasília was planned as a model modern city in which prefabricated concrete monumental buildings, rather than shacks of recycled wood and tin, would dominate the landscape. However, the city rapidly grew beyond its planner's designs in a jumbled and improvised fashion. Modernity has its own aesthetic based on technological prowess, rational mobilization of resources, order, and cleanliness. Squatter settlements, with their lack of planning and opportunistic building practices, are taken to represent baseline survival. As cities compete with each other on a global stage for capital investment, urban renewal becomes a key strategy in creating the kind of image that marks a city as successful. Squatter settlements and inner city streets alike become the targets of municipal programs to clean up cities.

Urban renewal programs often lead to tension between poor inner-city residents, governments, and developers. Street vending is often a source of tension between vendors and municipal governments, as the vendors are considered to be disturbing the order of the city and encouraging littering. Authoritarian policing practices have sometimes led to the escalation of urban cleanups into social cleansing, as homeless individuals and, in some cases, whole communities are moved out of sight. Urban renewal programs can also have paradoxical results. In Tacna, Peru, the municipal government has successfully managed to convince people not to litter in the inner city, but the lesson was not extended to the rest of the city. It seems that people feel guilty about littering a clean street because it will have the direct effect of making that space dirty, but they will litter a dirty street because it is already dirty.

The aesthetics and politics of waste can be effectively explored through art. Eduardo Coutinho's 1991 documentary *O Fio da Memoria* [The Thread of Memory] tells the story of a poor black man who has constructed his dream house out of garbage as a work of art. His use of cracked tiles, cans, and broken plates draws attention to the aesthetic properties of household waste and of the waste materials that squatter-settlement residents normally use in housing construction. Another 1992 documentary by Coutinho, *Boca de Lixo* [The Scavengers] shows the life of garbage pickers in a dump outside Rio de Janeiro. The film draws a contrast between the global commodities that are

present in the dump, symbolizing conspicuous consumption, and the hardships faced by the impoverished people who are trying to make a living from salvaging them. These films convey a sense that the objects in the dump were once aesthetically pleasing, but that they lost their aesthetic value in the act of disposal. By showing this contrast, the film demonstrates the power of different social groups to define what is and is not garbage and, by extension, who matters in society.

Environmental and Social Movements

Concerns about waste mobilize social movements to pressure governments to maintain sanitary environments for their citizens or to assert the responsibility of everyone to care for the environment to preserve it for future generations. Environmental movements take many forms in South America. A ubiquitous feature of these movements is the integration of environmental, social, economic, and cultural themes. The burgeoning social movement of garbage pickers' collectives combines themes of recycling with questions of social exclusion, stigmatization, and poverty.

Urban air and water pollution have led to mobilization motivated by health and quality of life considerations, with implications for equity. When in 1984 an oil spill in the Brazilian industrial city of Cubatão caused the death of at least 92 people, the fact that the victims lived in a shantytown highlighted the fact the beneficiaries of industrial production were relatively safe from the harm of industrial waste. Even before the accident, Cubatão had been dubbed the Valley of Death for its extraordinarily high rate of malformed births and cancers. The disaster galvanized both ecological and social justice movements, and the pressure led to a major government-sponsored cleanup campaign.

Argentina and Brazil are two of the world's largest agricultural producers, and concerns about biopollution, rogue introduced species, and genetically modified organisms have motivated both consumers worried about health implications and smallholder producers concerned about contamination of seedstock and control of the crops by transnational agrotechnological corporations. Organizations such as Via Campesina and its regional affiliates campaign vigorously on the issue, with linkages with the first world food security and smallholder agriculturalist movement.

In some countries, garbage pickers have begun their own collectives to coordinate their work and tackle any problems they face with government authorities and businesses, such as El Ceibo in Argentina. In São Paulo, some 350,000 people make a living from informal recycling activities, as informal garbage pickers (*catadores*) and junkyard recyclers (*sucateiros*). The dangers for the latter are dramatically illustrated by the Goiânia Incident of 1987, when recyclers found a lead vessel containing cesium-137, a potent radioactive element used in nuclear medicine that had been improperly disposed of. The workers were unaware of the danger posed by the attractive phosphorescent powder, leading to four deaths and contamination of hundreds of people. Working conditions for *catadores* are especially difficult, with 12-hour shifts of hard labor as pickers carry some 200 kilograms of garbage per day, typically with carts they push by their own physical effort. Incomes are typically very low, and the informal nature of their employment means that individual pickers have difficulties accessing services, including health, social security, and banking facilities. Middle-class attitudes toward these workers is at best dismissive, and it is not uncommon for expensive condominiums to place garbage in locked street-side cages to prevent rummaging. However, informal recyclers perform an indispensable social service, which, if effectively organized, has been demonstrated profitable.

Garbage pickers in Brazil and throughout the continent have reacted to these conditions by forming associations and cooperatives, beginning in the mid-1980s and acquiring a continent-wide profile in the first decade of the 21st century. The first Latin American Congress of Garbage Pickers took place in Caxias do Sul, Brazil, in 2003, with delegations from national organizations from Colombia, Brazil, Argentina, and Uruguay, founding the Red Latinoamericana de Recicladores [Latin American Network of Recyclers]. Following the "movement of movements" model established in the World Social Forum, this is a network composed of national networks, which are in turn composed of hundreds of local, community-based associations and cooperatives. The chief aims of this political activism are

to establish the legitimacy and vital social role of garbage pickers, improve their condition, and share practical knowledge on how to run safe and effective grassroots recycling enterprises. These include straightforward businesses dealing in profitable materials such as aluminum and copper, microcredit schemes, and organizations with a politically transformative agenda practicing the economy of solidarity (*economia solidária),* emphasizing barter and social equity in exchange.

Local or Global Responsibility

Opinions on the problem of waste have changed a great deal in South America since the 1980s. While the sources of pollution are much the same (especially domestic and factory waste), globalization and growing environmental awareness have shifted people's views on what the main sources of waste are and who is responsible for dealing with it. Tourism is viewed as a major source of environmental damage as cruise ships dump ballast contaminated with rogue species and garbage into the sea and tourists trample inadvertently over popular destinations such as Machu Picchu in Peru.

Foreign companies are identified as major polluters who take advantage of weak regulations to impose low environmental standards on their factories. Importing waste from overseas may raise crucial revenue for poor governments, but it comes at the high cost of polluting the local environment. People's increasing awareness of the damage waste does to the environment on a global scale builds upon anti-imperialist sentiments, which are widespread across the region. That is, waste is viewed as yet another way in which the region is subordinated to the interests of wealthier countries and business interests.

Rapid industrialization, authoritarian governments, and divided, unequal societies pose challenges for the handling of garbage and waste. At the core of the problem of waste lies the crucial question of social responsibility. With the emergence of the global environmental crisis, social mobilization, and awareness campaigns about the harms and potential of waste, a new dynamic is emerging in South America. Governments that once made allowances for pollution to foster industrial development find themselves far less able to justify their actions to populations emerging from poverty but not yet free of the environmental damage caused both by poverty and wealth. Upper-class complaints about haphazard, improvised shantytowns face countercritiques pointing out low wages and neglect of housing provision for the poor. The vigorous cultural production of recyclers has led to the aesthetics of poverty transforming from a condition of exclusion to a paradoxical position of simultaneous national pride and national shame. Social activism for the rights of garbage pickers is itself based on a denunciation of appalling conditions, even as the individual picker fights for recognition as worker or entrepreneur. South Americans inhabit this destructive but also creative landscape, seeking answers for global human questions: how should governments manage the imbalances of development? Who must bear the burden of producing a livable environment? What should be the social and political relationships between those who manufacture garbage and those who manufacture from garbage?

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See Also: Argentina; Brazil; Culture, Values, and Garbage; Garbage in Modern Thought; Material Culture Today; Open Dump; Recycling.

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South Carolina

South Carolina is a southeastern U.S. state on the Atlantic Coast and is significant to waste disposal studies for pioneering the use of artificial reefs and conservation cemeteries.

Named after King Charles by his son Charles II of England, the state was first settled as the proprietary colony of Charles Town (modern Charleston) in 1670. South Carolina became the founding state of the Confederate States of America when it voted to secede from the Union in 1860. Following the Civil War and Reconstruction, the state was gripped by racial and economic unrest during the populist and agrarian movements of the 1890s. A thriving textile industry developed in the early 20th century. This industry, and expanding the agricultural base to include more profitable crops than cotton, encouraged the tourism industry and the location of large military bases in the state. The southeastern part of the state is a region on the Atlantic known as the Coastal Zone; inland of this is the Coastal Plain. Further inland and increasing in elevation are the Sandhills, the Piedmont, and the mountains, where the Blue Ridge Mountains continue into North Carolina and Georgia. The largest cities are the capital Columbia, Charleston, and North Charleston, all with populations over 100,000. Metropolitan statistical areas are much larger than central city populations would suggest, as state law obstructs municipalities from annexing unincorporated areas. Columbia, Charleston, and Greenville all have urban-area populations of 350,000–500,000, but the metropolitan statistical area (MSA) populations are all over 600,000. Major outputs include textile products, chemical products, paper products, machinery, the automobile industry, and tourism. Chief agricultural products are tobacco, cotton, soybeans, rice, poultry, cattle, dairy produce, and pigs.

The South Carolina Department of Natural Resources began its Marine Artificial Reef Program in 1973, depositing myriad materials on the ocean floor to provide stable surfaces for algae and invertebrates to attach themselves. Steel-hulled ships are the most common scrap material used, as over 100 have been sunk off South Carolina since 1969. Other scrap includes ex-military airframes, ballistic missiles, and concrete culvert pipes. A reef was even made from decommissioned New York subway trains, which became colonized by sea turtles.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, South Carolina had an estimated 4,974,679 tons of municipal solid waste (MSW) generation, placing it 26th in a survey of the 50 states and the capital district. Based on the 2006 population of 4,330,108, an estimated 1.15 tons of MSW were generated per person per year (ranking 32nd). South Carolina landfilled 3,239,764 tons in the state's 18 landfills. It exported 133,606 tons of MSW, and 1,676,789 tons were imported. Landfill tipping fees across South Carolina averaged $35, where the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively. By 2010, South Carolina had 102,506,233 tons of landfill capacity remaining and was increasing its landfill capacity; it was ranked joint-24th out of 44 respondent states for number of landfills. Yard waste, whole tires, used oil, lead-acid batteries, and white goods were reported as being banned from South Carolina landfills. South Carolina's single waste-to-energy (WTE) facility burned 224,506 tons of MSW. The state recycled 1,510,409 tons of MSW, placing South Carolina 22nd in the ranking of recycled MSW tonnage.

South Carolina is key to the study of waste and consumption in that it is home to the first artificial reefs in the United States and the first conservation cemetery.

Marine Artificial Reef Program

South Carolina is known for its Marine Artificial Reef Program. The first recorded artificial reef in the United States, built to improve fishing, was created off South Carolina in the 1830s using log huts. Coral reefs are biodiverse environments that can be fished or observed only a few hundred yards from shore. There are no coral reefs off the coast of the continental United States north of the southern tip of Florida, where recreational and commercial diving and fishing are worth millions of dollars to the Floridian economy. Off the southeastern coastal states from North Carolina to Florida, there are hard-bottom and live-bottom areas in place of coral reef habitats. These more-temperate reefs occur only where the ocean floor is made from a suitable hard substrate, usually outcrops of limestone. Off South Carolina, only 5–10 percent of the ocean bottom is geologically suitable for reef formation, as the majority of the continental shelf is covered in several feet of sand. This limits the activities of fishermen and divers and leads to heavy use of the known hard-bottom areas of the South Carolina coast.

The South Carolina Department of Natural Resources began its Marine Artificial Reef Program in 1973, depositing material on the seabed to provide stable surfaces for algae and invertebrates to attach themselves. These organisms provide food for larger creatures, which use the reefs for shelter and habitat. The artificial reefs are located in waters 9–110 feet deep and range from inshore waters to 35 miles offshore. Reef construction sites are up to one square mile in size, with multiple reef structures placed within the boundaries of each area. All of the reefs are sited on flat, featureless sand bottom that previously offered little or nothing of interest to divers and fishermen. The sites are selected to provide easy access and avoid possible conflicts with the use of surrounding seabed or waters; most are marked by buoys to help find their location.

The artificial reefs are constructed from a wide variety of suitable scrap as well as specifically designed reef habitat structures. Steel-hulled ships are the most common scrap material used, with over 100 having been sunk off South Carolina since 1969. Other scrap fabrications recycled into the reefs include concrete and steel bridges, concrete culvert pipes, steel dry dock work platforms, ex-military airframes, and intercontinental ballistic missiles. A reef made from decommissioned New York subway trains became colonized by sea turtles. Many of the structures deposited in the reefs have no other practical use at the end of their use-life, and using them in the reefs saves valuable, limited space in the state's landfills. Using these structures as reef substrate also allows them to serve a purpose for hundreds of years beyond that specified for their original use.

The unpredictable availability of suitable scrap on a yearly basis has forced artificial reef managers to make increasing use of designed reef habitat structures. Specifically designed reef habitat units often create a higher-quality, longer-lasting reef than can be made from scrap and are thought likely to become more prevalent in artificial reef construction. While scrap is often donated, the costs

of labor, cranes, and barges needed for logistics are high. It is also more beneficial to recycle many items into new products than to leave them on the seabed. Funding may not be forthcoming as the benefits are spread widely across the community and there is taxpayer resistance to public spending on private recreation activities, even where they have a significant return to the local economy. The South Carolina Marine Artificial Reef Program leads the United States in the design, testing, and use of artificial reef structures, having introduced over a dozen designs since 1983.

There are many concerns about the environmental effects of artificial reefs and their long-term stability and viability. Smaller items such as cars and washing machines were found to have disintegrated after only a few years, and larger structures have collapsed due to component failure. Studies following Hurricane Hugo in 1989 showed that artificial reef structures off South Carolina could withstand a Category 4 hurricane with only slight damage and generally minimal movement of material, although some small structures were moved over 1.2 miles and a 153-yard-long 4,000-ton ship in 33 meters of water for a year was found to have moved 212 meters. Nonetheless, the storm had only minimal short-term effects on the sea life found in the artificial reefs, with no observable quantifiable adverse impacts.

Ramsey Creek

South Carolina also has the first conservation cemetery. Billy and Kimberley Campbell (Memorial Ecosystems Incorporated) opened a 34-acre reserve in 1998 at Ramsey Creek. The project was inspired by preserved tall-grass prairieland on old burial grounds that discouraged their development. Consumer attitudes toward funerals and death have changed steadily since the 1960s and are undergoing their biggest change since the Civil War. Traditional cemeteries are seen as taking up too much space, and the traditional funeral industry is seen as profiteering and too expensive. Environmental burial grounds, or conservation cemeteries, receive their certification from the Green Burial Council. There were around a dozen conservation cemeteries in the United States by 2010, and the Campbells were involved in the creation of many of them. Around 20 cemeteries in the United States have now designated unused areas as natural burial sites to create what are known as "hybrid cemeteries," although these do not include the preservation aspect that is key to the Campbells' original model.

Traditional cemeteries are increasingly becoming regarded as a hazard to the environment and a waste of resources: 75 percent of caskets sold in the United States are made from metal, which is subsequently buried and lost; coffins can be coated in polyurethane, which produces harmful decomposition products such as isocyanates and hydrogen cyandide; and the three to four gallons of embalming fluid used per corpse are also toxic chemicals. Ramsey Creek does not use embalming techniques and biodegradable interment is carried out in simple wooden caskets or textile shrouds. Concrete and steel burial vaults and grave liners, ordinarily used to prevent subsidence when the weight of the backfill crushes the decomposing coffin, are also forgone (although their use outside the United States is unknown). Grave markers other than optional flat-lying ones made from indigenous rocks are not used and the site does not resemble a burial ground; GPS coordinates for the gravesites are kept on file.

Apart from environmental objections, cemeteries also use up too much space, with each standard burial plot taking up 35 square feet. Rural U.S. cemeteries from the mid-19th century are now in the center of built-up metropolitan areas. Made ground, hillsides, and wetlands are among the ground types that cannot be used for cemeteries, and in urban and suburban areas there is a lack of open land for new cemeteries. This issue has already been faced by smaller countries such as South Africa, Greece, and even the United Kingdom, which has a 74-percent cremation rate.

While cremation rates have continued to rise since 1963 and most American dead are predicted to be cremated by the mid-21st century, conservation cemetery interment still holds the environmental edge. A typical cremation requires two to two-and-a-half hours of 1400–1800 degree Fahrenheit heat, and it is estimated that cremating a 110-pound body releases 363 pounds of carbon dioxide. The company Eternal Reefs, which turns cremated remains into artificial reefs, dedicated its first commercial memorial reef off Charleston, South Carolina, in 2001.

Ramsey Creek is situated in rural upstate South Carolina, an area known for Christian conservatives and Confederate sympathizers, not immediately associated with the cemetery's environmentalist and conservationist philosophy. However, a wide-ranging demographic use the burial ground, a fact attributed to many reasons: aesthetic appeal, leaving an environmental legacy, spiritually becoming a part of nature, Genesis 3:19 "for dust thou art, and unto dust shalt thou return," and for value—costing around $3,000, environmental burial is up to half the price of a traditional burial.

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See Also: Funerals/Corpses; North Carolina; Ocean Disposal; Pollution, Water.

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South Dakota

Located in the Great Plains region of the United States, South Dakota is named after the Lakota, part of a confederation of Sioux tribes, who were originally known as the Dakota. Pierre is the state capital, while Sioux Falls is the largest city, with a population nearing 160,000. The state is divided by the Missouri River into two halves with their own geographic and social identity, known to South Dakotans as East River and West River. eastern South Dakota has the greater population and is a fertile growing region, while western South Dakota has a ranching agriculture and an economy driven by tourism and defense spending (Ellsworth Air Force Base, near Rapid City, is the state's second-largest employer). The Black Hills, in the southwest, are a group of pine-covered mountains of major religious significance to Native Americans and the location of Mount Rushmore. Other natural and historic attractions in the southwest include Badlands Wilderness and Wind Cave National Parks, Custer State Park, the Crazy Horse Memorial, and Deadwood, a National Historic Landmark District.

The Sioux were the dominant inhabitants until the late-19th-century Black Hills gold rush and the arrival of the railroad in the east, events that triggered several Indian wars. Following the Dust Bowl and Great Depression of the 1930s, the state's fortunes were reversed when the war effort required South Dakota's agricultural and industrial products. Federal spending was sustained throughout the 1940s and 1950s against a background of continued agricultural change. Historically, South Dakota has had an agricultural economy with an attendant rural lifestyle, having the fifth-lowest population density and total state output in the United States. In the early 21st century, the service industry is the largest contributor to the South Dakotan economy.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, South Dakota had an estimated 988,433 tons of municipal solid waste (MSW) generation, placing it 47th in a survey of the 50 states and the capital district. Based on the 2006 population of 788,467, an estimated 1.09 tons of MSW were generated per person per year (ranking joint 38th). South Dakota landfilled 778,100 tons (ranking 44th) in the state's 15 landfills, and it was ranked 27th out of 44 respondent states for number of landfills. There was no data reported for import and export of waste. South Dakota has no waste-to-energy (WTE) facilities. It recycled 83,476 tons of MSW, placing South Dakota 46th in the ranking of recycled MSW tonnage. In 2006, South Dakota was increasing its landfill capacity, the volume of which was not reported. Yard waste, whole tires, used oil, lead-acid batteries, and white goods were banned from the state's landfills. Tipping fees across South Dakota were an average $35 per ton, where the cheapest and most

expensive average landfill fees in the United States were $15 and $96, respectively.

POET

South Dakota is home to POET LLC, a biofuel company specializing in bioethanol, headquartered in Sioux Falls, and it is one of the biggest success stories in renewable energy. The Renewable Fuels Association named POET the largest U.S. producer of ethanol (1.1 billion gallons per year). In 2007, POET adopted its new name, which is not an acronym, as commonly thought, but a word chosen to represent the company. Prior to 2007, the company was generally known as Broin, although the different divisions had their own names. The Broin family farm in Wanamingo, Minnesota, was the site of their first experiments in small-scale ethanol manufacture in 1983. In 1987, when the operation reached the commercial stage, they relocated to a foreclosed ethanol plant in Scotland, South Dakota, which would later become the company's flagship for the latest refining research and pilot projects.

When production started in May 1988, the plant was the only working ethanol plant in South Dakota, and the full production capacity of one million gallons was achieved in June. In 1990, Congress passed the Clean Air Act, introducing strict new standards for reducing U.S. air pollution. Meanwhile, the Scotland plant, still unique in the state, began an expansion that would increase its annual ethanol output from 1.1 million to 2.7 million gallons. Heartland Grain Fuels, a new Broin plant in Aberdeen, South Dakota, came online in 1992. Not only was it making a profit in its first month of operation but the Aberdeen plant also ran above design capacity in its first year. Further expansion at Scotland saw productivity increase 600 percent after six years in business. Opening its first plant outside South Dakota in 1995, POET had 30 ethanol plants across South Dakota, Minnesota, Iowa, Indiana, Kansas, Missouri, and Ohio by 2010.

Broin made a breakthrough discovery in 2000. BPX, or Broin Project X, was seen as one of the most important endeavors in the history of biorefinery. BPX uses proprietary enzymes, allowing starch to be converted to ethanol without cooking, delivering higher yield at less energy cost. Four years in development, BPX changed the way that bioethanol was made.

By 2009, having invested over $40 million in research, POET was on the verge of viable cellulosic ethanol as the Pilot Scale Cellulosic Plant in Scotland produced nearly 20,000 gallons of cellulosic ethanol in its initial year of operation. Cellulose is the most abundant organic compound, and with over 1.3 billion tons of biomass available, it could potentially replace all gasoline made from imported oil. The POET cellulosic ethanol process uses corncobs and other harvesting residue that pass through the combine harvester. However, only 25 percent of this material can be removed for refining, as the remaining 75 percent has to be left to lie in the field to avoid erosion and soil exhaustion. POET hopes that the enzyme technology can be expanded to allow other sources, such as switchgrass and wood chips, to be used. In addition to the breakthroughs in cellulosic ethanol, POET put Inviz on the market, a biobased product for films, coatings, packaging, and glazing, which provided an alternative to petroleum-based products. Inviz is produced from zein, a nontoxic edible protein soluble in alcohol and other solvents, but only slightly water soluble. Another product, Voilà, recovers a low- or free-fatty-acid corn oil from distillery coproducts, which can be used to produce biodiesel and can be further processed into other products that traditionally use petroleum.

Clandestine Methamphetamine Lab Cleanup

In 2005, writers such as Dirk Johnson and Nicole Bettendorf noted that over half of all methamphetamine ("meth") labs were found in the midwest. In the early 21st century, there has been an upsurge in the number of clandestinely operated meth laboratories, or meth labs, in South Dakota. Meth has been dubbed "the No. 1 drug in rural America" by the Drug Enforcement Administration (DEA). Rural areas are targeted for the seclusion they offer and their ability to conceal the strong odors produced by the fumes from the process. These labs make methamphetamine by following a recipe that involves cooking the ingredients to remove the buffers from ephedrine used in over-the-counter medicines, hence the term *cook* for a meth manufacturer. One-third of the chemicals used to cook meth are extremely toxic, being reactive, flammable,

or corrosive. The cooking process releases meth and other chemicals into the air; for every pound of meth produced, there are five to six pounds of toxic byproducts, which frequently end up being dumped or poured away, polluting the environment. The distinctive trash from meth labs is often dumped clandestinely to avoid its being associated with a particular address. Meth lab trash commonly includes ammonia, blister packs from nonprescription medicines, brake cleaner, cat litter, engine starter, lithium batteries, matches, and soda bottles. The Methamphetamine Remediation Research Act became law in December 2007, establishing a federal research program to help develop voluntary cleanup of former meth labs.

The investigation of meth labs is tasked to the state Attorney General Office, Division of Criminal Investigation (DCI) and the federal DEA. When a criminal investigation is complete, hazardous waste contractors identify, package, and remove all methamphetamine-related chemicals and items for disposal. It is a common misconception that this process (best defined as "initial identification, processing and removal of meth lab evidence" or "initial processing") involves any cleaning up of indoor contamination. At this point, the property is returned to the custody of its owner, whose responsibility it is to undertake any cleanup, often erroneously referred to as "secondary cleanup," when no previous cleanup has taken place.

In response to property owners' inquiries about the safety of inhabiting former meth labs, South Dakota developed a guideline document for removing the residues produced by the gases created during methamphetamine manufacture. The document was an action item of Governor Mike Rounds's Statewide Methamphetamine Task Force and, although not the first such document to be produced by a state, it is key in that it synthesizes earlier works and addresses some points of confusion. By 2010, there were no state mechanisms in place to evaluate, certify, or license contractors offering clandestine drug lab cleanup services. At least one company now exists in the Dakotas that advertises itself solely as a meth lab cleanup contractor.

Jon Welsh
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See Also: Crime and Garbage; Emissions; Farms; Fuel; North Dakota; Toxic Wastes.

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South Korea

Since the 1950s, the Republic of Korea (South Korea), once one of the world's poorest countries with a largely deforested ecosystem, has became one of the fastest-growing export economies with the proactive goal of creating a green society. The advanced South Korea of the 21st century, which grew to keep up with Western development, is based on a philosophical foundation focused on education and an appreciation of nature. This belief in the importance of an educated population exists throughout Korea's 5,000-year history, one of the world's oldest civilizations, and helped the country thrive despite conflicts that devastated its economy and natural environment. The most notable conflict was the creation of separate Korean governments in 1948 and the subsequent Korean War, which divided the country along a demilitarized zone (DMZ). Since no peace treaty was signed as of 2010, South Korea and North Korea were technically still at war. South Korea did announce, however, that the DMZ, designated a biosphere zone for its ecological diversity by UNESCO, would be turned into an ecological peace zone. Throughout the country, South Korea works toward becoming a world leader in integrating economic and environmental sustainability by becoming a low-carbon society.

The Republic of Korea is a peninsula adjacent to the People's Republic of China, Japan, and North

Korea. Largely bordered by the Sea of Japan and the Yellow Sea, South Korea has a 1,500-mile coastline—about the same amount as Egypt or Germany. South Korea is about the size of the U.S. state of Indiana or the United Kingdom, with a similar population, at a little more than 50 million people. It has a temperate climate with four distinct seasons. South Korea is a mountainous country with low areas around coastlines and rivers. Its highest point at 6,397 feet is Hallasan, a volcano mountain on Jeju Island, a designated national park, central to ecotourism in South Korea. The majority of the population, more than 80 percent, live in urban areas. The capital city Seóul, which is classified as a "megacity," or one of the world's largest cities, has a population of about 12 million people. Seóul has always been known as a modern city, but now it is a vision of a modern green city.

History and Politics

Since the 1980s, South Korea has become more environmentally aware and active in regional and global environmentalism. Many of its agreements relate to South Korea's strong economic and cultural connection to the sea and sea-going trades. Several of the international agreements signed by South Korea include the Climate Change–Kyoto Protocol and agreements relating to the protection or regulation of the Antarctic, biodiversity, endangered species, timber hazardous waste and marine dumping, ship pollution, and whaling. Many of these are through South Korea's membership in the Organisation for Economic Co-operation and Development (OECD), an international organization founded in 1961 to stimulate economic progress and world trade by a forum of 33 countries committed to democracy and the market economy by coordinating domestic and international policies. In addition, South Korea has strong partnerships with other Asian countries to address transboundary environmental issues and to reduce transboundary environmental impacts.

In 1998, South Korea created an environmental conservation plan called Green Korea, which it continues to build upon to create an environmentally sound and sustainable society. The goal of the plan is to work with central and local governments to improve air and water quality, especially in urban areas; improve waste management, specifically food waste; expand water supplies, specifically clean rivers; and increase green industry, particularly green technologies and ecotourism.

Economics, Industry, and Culture

Since the 1960s, South Korea has grown into one of the 20 largest industrial economies in the world. This growth is attributed to the government's focus away from consumer goods and instead proactively focusing on investing in the import of raw materials and technology, while encouraging citizens to save and invest. However, this growth came with costs that South Korea continues to tackle, such as deforestation, air pollution, industrial site pollution, and destruction of natural habitats due to industrial and urban expansion. In the early 21st century, South Korea works to integrate its environmental and economic goals by sharing responsibility with government, industry, experts, and the general public, such as through a certification process for life-cycle environmentally friendly products.

South Korea's role as an exporter can be traced back to its history as a port nation. In the early 21st century, it is a leading exporter of electronics, including semiconductors, electronic displays, and other computer parts, as well as automobiles. South Korea remains one of the world's foremost shipbuilders; Ulsan Shipyard is the largest in the world and builds commercial, offshore, and naval vessels. Fishing has also remained a historically dominant South Korean industry, with aquaculture increasing as the government increases fishing oversight and management in order to prevent overfishing and related environmental issues.

In South Korea, industry is responsible for reducing or recycling its environmental footprint by being responsible for its own waste from cradle to grave. In many cases, this waste is incinerated to heat industrial facilities. Worldwide Korean companies such as Samsung and LG have promulagated the "take back" approach in which consumers can return used products to the manufacturer for disposal.

Waste Composition

Waste in South Korea is controlled under the Solid Waste Management Act, which classifies waste into

household, industrial, and hazardous waste. More than 30 percent of the waste generated in South Korea is household or consumer waste, with a growing industrial and hazardous waste. According to recent reports, almost all waste collected in South Korea is managed in some manner. Most of the waste in South Korea is incinerated—the country has more than 20 incinerators. This is the second-highest number in the world but does not come near the more than 1,800 incinerators in Japan. One of the major challenges to recycling in South Korea—and the reason incineration is so popular—is the lack of a market for recycled materials, lack of space to process recycled materials, and the prohibitive cost of processing. Another challenge is processing and storage of spent nuclear fuel, because South Korea uses nuclear power to produce more than 40 percent of its energy and plans to increase this amount.

The rest of South Korea's waste is recycled, with a small portion sent to modern landfills—mainly incinerator residue and other items that cannot be disposed of another way. South Korea has also begun to pioneer the use of methane or natural biogas produced by landfills to create energy. An example of this is the creation of an "ecopark" powered by biogas on the site of Seóul's now-closed but long-standing landfill.

The energy generated is used to heat Seóul World Cup Stadium. The use of waste to create energy through incineration and landfill gas is an example of how necessity leads to green practices. Because of its population density, mountainous terrain, and shrinking usable land, solid waste management in South Korea focuses heavily on waste reduction and reuse by municipalities, industry, and the public.

Consumer Consumption and Consumer Waste

Consumption patterns in South Korea are unique because of the highly concentrated nature of the population, and these patterns contribute to its success in balancing consumption and waste management. South Korea has the highest rate and amount of online purchasing in the world, specifically, mothers purchasing goods for their families. Korean consumers tend to be highly educated and brand conscious. However, while online purchasing is very popular, so is buying from family-owned businesses and local companies.

As in many countries, residential waste receives the most attention, but produces the least amount of overall waste. Recycling is mandatory in South Korea; households are expected to segregate waste items and are fined for not correctly separating waste. Households and businesses use a "pay per use"–based system in which they are required to pay for special bags.

The incentive is for users who generate more trash to pay more for trash pickup, while there is no fee for collecting separated recyclables. Another approach used to curtail consumption waste is that stores require consumers to pay for shopping bags. Similar to the "pay per use" municipal waste disposal, it puts the onus of thoughtful consumption and waste reduction on the consumer and industry. However, although worldwide South Korea has a reputation as one of the countries with the best recycling rates, the government continues to strive to increase that rate to more than 60 percent.

Ecotourism and the Future

South Korea's natural parks, such as Jeju Island and the country's many smaller islands, make it a desirable country for ecotourism. The demilitarized zone between North Korea and South Korea, which has been isolated from human habitation since the end of the Korean War in 1953, is set to become another unique ecotourism draw. It encompasses the biodiversity of Korea and its endangered plants and animals through a major river delta, grasslands, and mountainous terrain.

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See Also: Consumption Patterns; Incinerators; Seóul, South Korea.

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Space Debris

When it comes to the topic of space debris, the adage that "One man's trash is another man's treasure" springs to mind. Known variously as space junk, space objects, orbital debris, and space waste, the term *space debris* refers collectively to the wide assortment of human-made objects found in orbit around the Earth and for which there is no current use. The Australian Space Academy distinguishes between two types of space debris: natural (such as meteoroids) and artificial (items that are the result of human agency). It is the latter that is typically denoted when invoking the term *space debris*.

The remains of Vanguard 1, a communications satellite launched into low Earth orbit (LEO) by the United States in 1958, was widely regarded as the oldest item of space debris in orbit as of 2010. Ranging from items the size of paint flecks to defunct satellites, there are likely tens of millions of items of space debris orbiting the Earth. Occasionally, such items reenter the atmosphere and plummet to the planet's surface—as was the case in July 2009 when a four-pound piece of extremely hot metal crashed through the roof and into the attic of a home in West Hull in the United Kingdom (UK). The story was updated in the *London Mail Online* several months later, when the property owners were subsequently contacted by staff of the Royal Air Force, who assured them that the item recovered from their home was most likely space junk that had been orbiting the planet for more than a decade. Such instances are rare because many items burn up upon reentering the atmosphere or fall harmlessly into the open sea or other unpopulated areas, as was the case when the National Aeronautics and Space Administration's (NASA's) Skylab station fell out of orbit in 1979 and distributed debris over western Australia.

The greatest risk such items pose is to functioning satellites, telescopes, and manned space stations or spacecraft—as was the case when astronauts aboard the International Space Station were "buzzed" by a roughly five-inch piece of debris in 2009. Such a collision would have wrought significant damage to the station as well as potential loss of life. As such, space debris is of major interest to the international community. That interest, however, assumes quite distinct forms: one that celebrates it and the other that sees it as a serious problem to be mitigated.

There are likely tens of millions of items of space debris orbiting the Earth, ranging in size from paint flecks to defunct satellites. Impacts with Earth are rare, as debris usually disintegrate upon reentering the atmosphere or drop into the sea or deserted areas.

Space Archaeology/Space Heritage

On the one hand are the "space archaeologists," who value the orbiting objects as artifacts attesting to individual nations' as well as humanity's shared space heritage. Some scholars have even framed their discussion of these assemblages as a form of *cultural landscape*, a term frequently used in reference to gardens, parks, campuses, town plans, and other examples of the human-modified terrestrial landscape. Used widely in the meeting halls and sessions of the annual meetings and intercongresses of the Society for American Archaeology, the World Archaeological Congress (which even has its own Space Heritage

Task Force), and the Australian state committee of the International Council on Monuments and Sites (ICOMOS), this notion of space archaeology—with its central focus on space heritage—involves "the archaeological study of material culture found in outer space relevant to the exploration of space, that is, exoatmospheric material that is clearly the result of human behavior and the evaluation of its significance in terms of preservation for the future."

Space heritage enthusiasts have distributed their message far and wide using everything from blog sites such as the Space Archaeology Project (brainchild of Dr. Alice Gorman of Flinders University, aka Dr. Spacejunk) to conference sessions, published articles, and entire book-length studies on topics as varied as the cold war, the recent past, and cultural tourism with which space heritage articulates. In 2000, three scholars completed a nomination of the Apollo 11 Tranquility Base lunar landing site as a National Historic Landmark.

While the nomination was ultimately unsuccessful, the effort—complemented by the successful nomination of collections of associated material culture possessed back on Earth to the National Register of Historic Places—served as an important consciousness-raiser. Thus, space heritage aficionados have championed the likes of space debris as tangible parts of humanity's international cultural heritage that merits thoughtful and deliberate management and, where necessary, threats posed by space debris need to be carefully mitigated by multidisciplinary teams of scholars from the space, natural, and social sciences. However, these scholars are not advocating the preservation of all space debris.

Instead, they are advocating the establishment of standards and methodologies for assessing resource significance for space heritage (only one component of which includes space debris) and that a means for designating the most significant items be devised. Such a designation process might profitably be modeled on already existing systems such as the World Heritage List (WHL) criteria, which include items of cultural, natural, and mixed cultural/natural heritage that are deemed of outstanding interest and importance to humanity. This rationale is twofold: the WHL program is successful and well regarded and, given that it stresses the significance of such heritage to humanity, it is less likely to be held to provisions of the Outer Space Treaty of 1967. Space heritage falls soundly in the realm of cultural heritage, and many space archaeologists advocate preservation in place as the most appropriate management strategy for those space heritage resources deemed worthy of formal designation.

Space Debris as Problem

In marked contrast to this perspective is the larger number of physicists, environmentalists, and legal scholars who frame space debris as everything from potential collision risk to orbital litter to national security threat. Since the earliest days of the space race, groups such as the North American Aerospace Defense Command (NORAD) and NASA have maintained databases containing records of the launches and other objects known to have reached orbit. In addition, NASA maintains an Orbital Debris Program Office, which publishes a newsletter titled *Orbital Debris Quarterly News*. Downloadable data sets of space objects are available from the U.S. Strategic Air Command, and these can be opened inside Google Earth, with results that are visually quite dramatic. Such heuristic devises and tracking tools are essential to grasping the sheer quantity of space debris girdling the Earth and to appreciating the potential risk such objects pose.

The topic of space debris was featured in the Institute for Disarmament Research's (UNIDIR) report titled "Security in Space: The Next Generation." In identifying the two main sources of space debris—routine space activity accompanied by the accidental breakup of satellites and stages placed in orbit and the use/testing of antisatellite weapons that physically collide with satellites—President of the Union of Concerned Scientists Dr. David Wright stresses that the lack of international restrictions on the use of antisatellite (ASAT) weapons poses a significant danger. Wright and others argue that controlling the production of space debris must be made a priority—as must minimizing intentional attacks on satellites—framing it as an issue of the sustainable use of outer space. The Space Debris Mitigation Guidelines, adopted in 2007, identify seven key principles that center on limiting the amount of space debris produced moving forward and mitigating the threats posed to spacecraft and

people on the ground via controlled removal of equipment from LEO at the end of its mission. As of 2010, these mitigation guidelines were little more than voluntary guidelines.

In a similar vein, one legal scholar frames space debris strictly as an environmental issue and advocates the development of environmental law for outer space. Neither framework either acknowledges or contains provisions for considering the heritage aspects of such materials.

Surmountable Divide

One of the World Archaeological Congress Space Heritage Task Force's stated goals is to lobby international and national bodies to be included in management and preservation discussions. If successful, such efforts will go far toward spanning the seeming chasm between the two views of space debris. The work of the International Council of Scientific Unions in envisioning the International Geophysical Year (1957–58) is characterized as "a massive effort of international scientific cooperation on a scale never before undertaken."

The development of well-reasoned policy that bridges the security, environmental, and heritage aspects of space debris—and all forms of space heritage—will prove a massive undertaking. But future generations as well as the talented innovators and scientists since the 1950s who worked diligently in service to their nation's space programs—and, indeed, the objects themselves—deserve no less thoughtful and far-reaching deliberation and policy formulation.

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See Also: Australia; Material Culture Today; Pollution, Air; Trash as History/Memory; United States.

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Spain and Portugal

Spain and Portugal are the countries that make up the Iberian Peninsula, which is situated in the southwest corner of continental Europe. The population of mainland Spain is 45.3 million, for a total land area of 313,657 square miles, while Portugal has a population of 10.6 million and a land area of 57,211 square miles. The Balearic Islands in the Mediterranean and the Canaries in the Atlantic are part of Spain, as are the two autonomous cities of Ceuta and Melilla in north Africa. Portugal also includes the island groups of the Azores and Madeira, both in the Atlantic Ocean. The Iberian Peninsula is not a uniform land area, despite the many historic and

cultural affinities between the two countries. Unlike Portugal, Spain is a country that operates as a decentralized federation of 17 autonomous communities.

There are several separatist political movements and different languages, and Spain's comparative statistical data for economic, social, and industrial development place it in a stronger position. In the Human Development Index for 2009, Spain is 15th, while Portugal is 34th. The two countries have in common the fact that, among the European nations, they had the longest dictatorships of the 20th century and joined the European Union (EU) in the same year, 1986. Both countries sought to take the first firm steps toward social and economic development within a framework of a new political freedom and, at the same time, had to come to terms almost immediately with demanding European environmental standards.

Waste Management

Like the rest of Europe, Spain and Portugal have had to deal with the problems arising from the huge quantities of waste they produce and the significant changes in the nature of such waste—containing more and more artificial products, chemicals, pharmaceuticals, paper, glass, plastic, electronic waste, and hazardous substances. The changes in the amount and nature of waste took place alongside other factors of the post–World War II era, in particular, industrial development, economic growth, changes in patterns of consumption, and membership in the EU. Compliance with European norms and the availability of sizable funding have enabled Portugal and Spain to make significant improvements in legislation, waste treatment infrastructure, information systems, and specific regulation for different types of waste. Joining the EU was an event of fundamental importance: environmental policy in the two countries has been influenced much more by outside forces and agendas and less by endogenous pressure from civic movements and national political forces.

Waste management policies in both countries are subject to the rules and regulations of the EU. Portugal and Spain have developed national strategic plans for each type of waste in accordance with the waste hierarchy, which requires member states to reduce the amount and harmfulness of wastes; to reuse and recycle; and finally, when any of these options are not available, to use wastes as a source of energy (for example, by incineration), with depositing waste in landfills the least desirable option. These plans also comply with the principles of "self-sufficiency" and "proximity" in waste disposal, which demand that each member state should be self-sufficient in treating its wastes and that waste be disposed of as close as possible to where it is produced, as well as the "polluter pays" principle, according to which the costs of waste disposal should be borne by the holder.

Waste management plans embody these principles and are the foundation on which subsequent national, regional, and local decisions are taken. Spain has its *Plan Nacional Integrado de Resíduos* 2008–2015 (PNIR) (Integrated National Waste Plan), which has subplans for 13 specific types of waste (including urban, hazardous and nonhazardous industrial, contaminated ground, used batteries and cells, and vehicles for scrap) and has also set out the strategies to be adopted by the various autonomous regions. In addition, Spain has specific regulations for the autonomous regions, as well as legislation on nuclear waste and a nuclear graveyard called El Cabril, located in the Sierra Albarrana, near Cordoba.

Portuguese legislation applies to the whole country, and there are no nuclear plants or nuclear wastes. There are plans for each particular type of waste: *Plano Estratégico de Resíduos Sólidos Urbano* (PERSUII) [Solid Urban Waste Plan], *Plano Estratégico de Gestão dos Resíduos Industriais* (PESGRI'01) [Industrial Waste Management Plan], *Plano Nacional de Prevenção de Resíduos Industriais* (PNAPRI) [Industrial Waste Prevention Plan], *Plano Estratégico de Gestão dos Resíduos Hospitalares* (PERH) [Hospital Waste Management Plan], and *Plano Estratégico de Resíduos Agrícolas* (PERAGRI) [Agricultural Waste Plan].

Despite some positive developments and all the efforts to achieve effective and sustainable prevention, consumption, and use of waste, there is still a tendency for increasing amounts of waste to be produced, and the actual levels of achievement of these plans are still generally very rudimentary. In both countries, urban waste is the type that has grown the most, reflecting economic growth, new

habits of consumption, and both countries' vocation as tourist destinations (Spain was the number one tourist destination in Europe in 2008, and Portugal number eight). According to the *Eurostat Yearbook 2010*, urban waste production was around 1,268 pounds (lbs) per inhabitant in Spain and 1,052 lbs per inhabitant in Portugal, compared to a European average of 1,155 lbs per person, 62 lbs (5.3 percent) higher than in 1998. Disposal in landfill sites in both countries continues to be very high compared with the EU average of 40 percent. In 2008, Spain sent 57 percent and Portugal 65 percent of its urban waste to landfills. There is less incineration in Spain than in Portugal—9 percent compared to 19 percent, but both are below the European average of 20 percent.

Recycling and composting rates are also very different. In Spain, 20 percent of urban waste is composted, a figure that is close to the EU average of 17 percent, while 14 percent is recycled, below the 23 percent EU average. In Portugal, only 9 percent of urban waste is recycled and 8 percent is composted. This shortfall in terms of composting and the nonuse of the potential of organic waste for agricultural purposes end up increasing the amount of waste that finds its way to landfills unnecessarily. Even though the statistical data is not fully comparable across countries, it is significant that for 2007, the European Environment Agency put Spain in the group of countries that have high material recovery and low incineration, together with Italy, Ireland, and Germany, while Portugal is in the group of countries with low material recovery and incineration, together with Cyprus and Greece.

Infrastructure and Hazardous Waste Disposal

The ability to implement an effective policy of prevention, reuse, recycling, and recovery of waste depends on having the necessary infrastructure for treatment, elimination, and disposal. In this context, Spain has a stronger and better-established network of facilities and Portugal is in a weaker position. For decades, Portugal lacked the infrastructure it needed, so waste was regularly exported, above all, to Spain. According to data from the Portuguese Environment Agency, total waste exports increased from 117,000 tons in 2004 to almost 195,000 tons in 2008. Almost all of this was hazardous industrial waste, transferred mainly for the purpose of elimination. In order to make the country self-sufficient in waste management, avoiding illegal disposal, indiscriminate incineration, and export, Portugal has since mid-2008 operated two Integrated Centers for Recovery, Improvement and Elimination of Hazardous Waste. These centers have separate units, which make it possible to sort 80–85 percent of the hazardous waste Portugal produces, as well as previous environmental waste stored in older industrial estates.

Conclusion

The waste situation in Spain and Portugal in the 21st century is a considerable improvement over the 1980s and 1990s. One of the most notable aspects has been the closure of numerous illegal open-air waste dumps in both countries. But even after the millions of euros spent on landfill sites, incineration plants, sorting and transfer plants, and recycling points, among other facilities, landfills continue to be the most frequent destination for waste. Spain and Portugal still have a long way to go to match those countries that occupy the top environmental positions in the EU. The correct definition of strategic waste management plans depends to a great extent on having reliable and uniform statistics; by 2010, these contained discrepancies, because different methods and criteria were used for recording information on the production, transportation, treatment, and final destination of wastes both between and within countries.

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See Also: Composting; Consumption Patterns; Definition of Waste; European Union; Recycling; Typology of Waste.

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Sports

Sport consumption is an expansive subject. Consumption includes participation in a sport and watching or reading about the sport or purchasing items with which to participate, watch, or read about the sport. Defining "sport" is controversial, and the varying definitions are complex. Sport consumption has a rich history starting in 776 B.C.E. in Greece. The history of sport participation, including the Olympic movement through amateur and professional developments of leagues and individual sports, and new extreme sports is an interesting topic of study. Deviations from traditional sport consumption such as wagering, gambling, and fantasy leagues are also complex social behaviors.

Appeal

It is difficult to argue with the fact that newspaper readers often open first to the sports page. When asked why, a scientific answer is hard to find. One can only speculate on why people choose sports over the front page or some other section. A possible explanation is that there is always a triumph, something to celebrate (there is always also a tragedy, a loser) in the sports section, whereas the front page is often filled with tragedy. Some of these front-page stories are predictable, as if they were stories recycled from a year earlier, but most involve misery, loss, and embarrassment. While in the sports section for every winner there is a loser, the wins and losses do not typically involve senseless death or bloodshed. The winner and loser are familiar to the reader, and the conflict is well understood. Individuals identify with the athletes and can either emulate them through their own sports participation, vicariously revel in their successes, or empathize in their losses. In sport, as in most consumption, the creation of identity and the importance of social consequences of consumption are vital to understanding why and how individuals engage in sport.

Definitions

Sport consumption can mean one of three things: either participating in sport activity; attending a sporting event; or watching or reading about sport activity on television, in magazines, in newspapers, or on the Internet. The term *participating* regarding sports generally refers to active consumption, whereas the term *passive consumption* refers to watching, listening to, or reading about sport. Within the three categories, there are subcategories of consumption; for example, buying things with which to consume the sport—these activities are termed *indirect consumption*.

What defines a sport is often hotly disputed. While often thought of as an athletic activity requiring physical skill and a competitive nature, the definition also includes leisure, recreational diversion, or pleasant outdoor activities. Many definitions of sport highlight the pleasant nature of a sporting activity that amuses the participant using synonyms such as "play." Others exclude the lighter nature of sport and focus on well-defined rules with paid referees or the requirement that monetary compensation be paid to the participants, especially the winner. Some sport researchers refuse to recognize motorized sports or any sport that has something more than a simple tool (such as a racket, wicket, or ball).

Some purists insist that to be a sport, scoring must be objective, which would exclude sports like platform diving or figure skating, or many of the extreme board sports such as "skate vert" (skateboard vertical). These purists might even exclude boxing (a quasi-subjectively scored sport). Some sport researchers include a physical exertion and

skill requirement in their definitions of sport, ostensibly excluding chess and many coaching or managing positions.

The most comprehensive, yet simple definition of the Council of Europe's European Sport Charter of 1992 is best: "sport is a physical activity which, through casual or organized participation, aims at expressing or improving physical fitness and mental well-being, forming social relationships, or obtaining results in competition at all levels." This definition avoids most of the contentious issues.

Measuring Consumption and Participation

The study of sport has proliferated rapidly, paralleling revenue growth in professional sports since the 1980s. Sports economics courses are taught in many large economics and business departments worldwide. The appeal to the student is that it is salient to their interests; for professors, it offers many data-driven applications ideal for teaching. Sport is rife with statistics, and sport fans are often fascinated with numbers of the game. Like sport consumption in general, sport participation is also difficult to measure.

Sport governing bodies tend to overestimate the number of participants; approximately 250 million people globally play soccer, while the international association of volleyball claims that nearly 1 billion people play volleyball. The latter figure is nearly one in six people worldwide, which means that again the definition of "participation" (once a year at a company picnic) may differ from sport to sport. The National Sporting Goods Association based in the United States surveys U.S. citizens about sport participation, citing 484 million participants, while there are only a little more than 300 million people in the United States.

What data exist suggest that participation in sports worldwide has grown substantially since the 1980s. Membership in gyms and clubs dedicated to all forms of sport participation has multiplied since the fitness craze of the last part of the 20th century. Health concerns coupled with more leisure time in the developed world and a culture of the body have led to increased sport consumption in the form of participation and to at least a perception of healthier individuals at upper-income levels. This movement in sport participation has curiously paralleled a substantial increase in obesity—particularly childhood obesity—in many parts of the Western world.

Sport is big business but pales in economic terms in comparison to other banal private businesses like cardboard boxes or bottling or public business such as sewage treatment. Growth in professional salaries, media coverage, and global advertising in monetary terms is astonishing, as is the expansion of media coverage and advertising in what were once thought to be fringe sports, now called "extreme sports." Coverage of women's sporting events, both amateur and professional, has increased, although not to the extent that sports like football, American football, and basketball have experienced.

Benefits and Demand

Both active and passive sporting consumption have increased substantially in terms of the numbers of participants and resources dedicated to engaging in sport-related activities. This may be because direct benefits—besides a healthy body—are manifold. Sport in the ultimate sense can bring people together in fair games ("games" being used in the friendly sense). Sport played under well-defined rules can demonstrate and inculcate values; show a commitment to excellence; provide the challenge of testing oneself either alone, against the clock, or against an opponent; and may form the basis for communication and friendship. Passive sport-related consumption (spectating, watching, or reading) also provides a common space in which to enjoy similar benefits.

The primary determinant of most sport consumption is income and leisure time, although the relationship between the two is tricky. In general, the higher the income, the more time and money one has to engage in both active and passive consumption. In addition, marketing's focus on tying the grace, athleticism, and competitiveness of sport to products and services has increased demand for identity—forming connections between sport and individual. This connection in turn increases consumer demand for indirect consumption, raising the value of excellence in sport and the monetary returns to those who excel.

Some research has identified this so-called superstar economy as giving most of the benefits to the

best of the best, while the rest of humanity is left with little similar to entertainment megastars. Critics of the superstar economy say that unequal distribution of the spoils of sport leads to a world of passive junk food and beer-consuming couch potatoes growing obese and wasting their lives away when time on the couch could be used better elsewhere.

Supporters tout the benefits of unbridled fair competition and the miracle of markets to solve society's ills—with hard work and practice, anyone could be that superstar rising from poverty to become famously rich. Parents have taken the path of sport to success to heart, hiring coaches for toddlers and spending a large portion of their time and income on developing their child into the next superstar. Economists have questioned this undying dedication to sometimes unpromising athletes as exercises in futility, claiming that the time spent practicing sport may be better devoted to developing other talents more beneficial to the individual in terms of future productivity and to society as a whole.

Indirect benefits from sport participation, other than health benefits, include social influences of belonging to a team or group, positive psychological benefits from exercise, community building, and confidence from the continual challenge of sport and goal setting. Like all forms of consumption, sport contributes to building one's identity. For some, sport is a way of life.

Olympics

No better exemplar than the Olympic experience exists for sport as a way of life. The so-called Olympic movement is founded on the idea of building a better, more-peaceful world through sport. The cherished ideal of amateurism encompassed in the Olympic movement was to encourage sport participation as an endeavor for value creation: sportsmanship, fitness, cooperation, teamwork, dedication, and goal-setting. The Olympic movement parallels the development of participatory sports in ancient Greece, although its modern incarnation is attributed to Pierre de Coubertin around the turn of the 20th century. The origins of the first games are disputed as being either a quadrennial quasi-religious celebration of Zeus's victory over Cronos for world domination, or a tribute to a daughter's trickery in a chariot race. Supposedly, Hippodamia, daughter of King Oenomaus, was tired of her father challenging suitors to a chariot race. If the beau won, Oenomaus would give the suitor his daughter's hand in marriage. If not, he sported their heads on sticks. After 12 beheadings, Hippodamia sabotaged her father's chariot, leaving him dead, and her married.

The Olympic movement symbolizes the ability of humans to cooperate through sport in response to changing social conditions. Through war and peace, tragedy and conflict, the movement has survived and prospered every four years, bringing the world together. The movement has spawned similar festivals of sport. The development of the Special Olympics provides opportunities for athletes with disabilities of all abilities to experience the joy of sports. The Paralympics offered more opportunities for elite athletes with disabilities to compete on the world stage.

Fans

Sport fandom, like sport participation, can be a way of life. The word *fan* stems from the word *fanatic*. Fanatics identify with the team or individual player in intense ways, sometimes bizarre, vicarious relationships that are as much about the fan's identity as about anything else in their lives. Some English football fans claim that they would give up sex for a year if England were to win the World Cup of football. Watching sports offers tangible economic benefits to fans and governments. Research has shown that sales of lottery tickets increase after college football victories, and medical studies have even shown that the immense fervor and euphoria following an important victory can reduce mortality due to heart attacks. Studies have shown statistically significant drops in stock market indices the day after losses and positive gains the day after wins and positive increases in economic growth due to a World Cup victory.

Media

Demand for professional sports is filled by media providers, networks, cable companies, and satellites, who in turn are supported by advertisers, who in turn serve consumer products and producers. Advertisers pay for ad slots to media providers, who pay

rights fees to professional sports teams and leagues. These advertising slot fees and broadcast rights fees have ballooned over time because demand for passive sports consumption has increased. This increase began in the 1930s, born of the controversial and what was then thought of as risky move of broadcasting baseball over the radio. Most baseball owners thought radio broadcasts would devastate gate receipts—instead, they brought baseball to women and children, who would continue to listen to games on the air but also flock to stadiums in droves. This astute radio move, growth in population, urbanization, income, and leisure time has increased sport consumption and sustained most sports broadcasting into the 1960s. In 1980, the introduction of ESPN marked the modern boom in sports participation and broadcasting and value increases witnessed since then. ESPN, a small start-up from Bristol, Connecticut, grew exponentially and in the early 21st century is present around the globe with a magazine, stores, and even restaurants in many cities.

Families

Sport can often play an essential role in family coherence, whether it is the parent teaching sport, or watching sports together. The role of a parent teaching a sport and fostering a love for sport, the stories of sport, and watching sports may be one of the most compelling reasons for supporting sport consumption. Personal narratives often revolve around leisure pursuits, and for many families, engaging in sport is an essential family activity—work to play.

Time spent playing sports within families or attending sporting events is relatively small compared to time spent watching sports on television. In the United States, individuals watch an average of 2.8 hours of television per day, and approximately 20 percent of adults engage in sports or exercise on a daily basis. The average number of hours spent watching television has exploded since the 1980s. This explosion has led to a corresponding increase in the value of broadcast rights, resulting in higher salaries for players and profits for owners. From a cultural perspective, the importance of team affiliation to a family's identity (e.g., born a Steelers fan, always a Steelers fan) has significant implications for how families spend time. Around the world, on any continent, one can find adults watching football or American football for over 10 hours per weekend. Critics of sports argue that time watching could be spent better in a nonsedentary, off-couch activity.

For example, one could do charity work, actually engage in physical activity, or talk to family members or friends. The counterargument is that watching sports keeps families together and that, in effect, family members are connected by surrounding the television rooting for a common team. While the question of individual preferences over leisure time and the social impacts on the family are unresolved, there is no question that preferences for watching, listening to, and reading about sport is growing and different avenues for delivering sport to consumers are increasing.

Gambling

Perhaps the most dangerous impact of sports from a social perspective is gambling. Sport gambling was recognized as far back as 1600 B.C.E. in Mesopotamia, where bets were placed on chariot races. In the Americas, Native Americans wagered on running races and ball games. Betting on horse racing has a long history in the United States, as does betting on baseball and college football. It is difficult to find a newspaper that does not carry the odds and the betting line for most major sports. In 2007, over $8 billion was bet on the Super Bowl, and $2.5 billion on the 2007 NCAA men's basketball tournament. Gambling is widespread; over one in five U.S. adults gamble (15 times per year, on average). Gambling addiction is commonplace, and crime—both organized and not—is linked closely to gambling. Athletes and officials have fixed matches or outcomes in Italian football, the National Basketball Association, Japanese sumo wrestling, major league baseball, NCAA basketball, and international figure skating. Government resources to control or contain sport gambling are relatively ineffective, although some governments have had success in limiting offshore betting. Most government enforcement of gambling rules protects gamblers from themselves or secures tax revenues.

One of the derivatives of sports gambling is fantasy sports, which has proliferated at a rapid pace since the 1990s. The origin of the now multimillion-

dollar fantasy sport league phenomena was a probability-based simulation game using dice for major league baseball designed by an undergraduate at Bucknell, Hal Richman, in 1954. William Gamson patented an improved simulation game played by mail with real-time data called the National Baseball Seminar in 1960. The boom in information technology in the 1990s meant that games could be played simultaneously or asynchronously in real time and made possible the creating of fantasy sports, not only in baseball but also in nearly every sport imaginable, from the Olympics to amateur college sports.

Negative Factors

Commercialization and commodification of sport and individual athletes has led to a reality gulf between spectator and participant and to a bastardization of sport as game or recreational pastime. Pressures to succeed have driven young athletes into moral and ethical quandaries that drive attitudes toward winning at all costs. This attitude carries some deleterious social implications. Use of performance-enhancing drugs like the hormone erythropoietin (EPO), human growth hormone (HGH), amphetamines, and testosterone have provided some athletes with an unfair advantage, driven other athletes to use the same drugs to remain competitive, and have had negative health consequences for many. Fans and athletes both lose. Technological advances in disguising performance-enhancing drugs have made it difficult to detect and test individuals, although many practices allow for retroactive testing of samples taken as long as 10 years ago. Cycling, baseball, track and field, and American football have all been marred by scandal.

Sport is often marked by discrimination of the worst types. Recognition of gender discrimination in women's sports created concerted efforts to make participation equal across genders. Gender equality in opportunity to participate in collegiate sports was aided by the introduction of Title IX—which, although not explicitly mentioning sports, required colleges and universities receiving federal funds to provide equal access to athletic opportunities. Title IX opened up access to female participation at the intercollegiate level, but it remained unclear as of 2010 whether or not equal opportunity existed because of measurement problems and a significant backlash and unwillingness to comply with the order.

Racism continues to plague sports globally. European soccer leagues and the governing body of football, the Fédération Internationale de Football Association (FIFA), continue to engage in social marketing designed to end discriminatory practices but appear to have little impact on the worst offenders—the fans. Professional sports in the United States was not officially desegregated until the 1950s, and management of professional sport teams in the United States remains a bastion of the "old boys' network." European football is not much better. An offshoot of racism is the bigotry and violence of hooliganism rampant in Europe and South America. Hooligans are gangs of fans loyal to a club or team who violently attack opponents' supporters or perform random acts of violence against innocent bystanders. European security techniques to limit hooligans' travel internationally have been successfully adopted by U.S. security forces attempting to stem terrorist travel after the attacks of September 11, 2001.

Political power of sporting leagues and institutions and the successful marketing of sport in society have driven public expenditures for sports stadiums to unsustainable levels. Monopoly power of owners and close relationships with political officials have created a bizarre corporate welfare system in many cities worldwide where owners dictate the terms of stadiums and taxpayers foot the bill. Credible or not, owners threaten to leave the city and take their teams with them if the owners are not provided sufficient public funds. This extortion happens at the expense of other public goods expenditures like schools and water systems because there is a vocal minority who push the issue and are politically connected. Wildly inflated estimates of the benefits of new stadiums or the economic impacts of mega-events like the Olympics provided by industry lobbyists typically secure stadiums for owners at great costs to taxpayers. This phenomenon exists globally; in the United States, however, the numbers are supersized.

Waste

Aside from the economics of sports facilities, major sporting events produce waste and pollution. Obvious examples include packaging waste from concessions, especially since plastic cups and bottles

replaced glass in the 1970s (in part due to problems of bottles being thrown onto the field). People exiting sports facilities after an event regularly leave masses of paper, cardboard, and plastic in garbage cans and on floors.

Less obvious are the wastes involved in sporting events played on grass. The uniform green surfaces demanded in golf helped spur the development and sale of lawn movers, pesticides, and fertilizers in the early 20th century; football (of both the European and American varieties) and baseball also prized perfect green blankets. These efforts have both produced pollution to groundwater and increased consumers' desire for the perfect green lawn.

After World War II, many sports facilities used green chemicals to dye brown grass green where fertilizers failed. Although artificial turf grew in popularity after the opening of the Houston Astrodome in 1965, preferences for grass continued in most outdoor venues. Skilled groundskeepers such as Roger Bossard of the Chicago White Sox are prized and employed by the same team for decades. Bossard was contracted in the mid-1980s to develop soccer fields in the Saudi Arabian desert, allowing the perfect green lawn to flourish even where water was scarce. Grass lawns may be developed in almost any climate in the 21st century, allowing golfers in Phoenix to enjoy their game, despite its effects on the local water supply. A single golf course in Tampa, Florida, consumes 178,800 gallons of water each day; combine that with the pesticides and fertilizers golfers are regularly exposed to, and the costs of using perfect green playing surfaces emerge.

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See Also: Commodification; Consumerism: Economics of Consumption, U.S.; Stadiums.

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Stadiums

Of all the activities of a sports organization, operating a stadium has one of the greatest environmental effects. Construction of sports facilities boomed as economies in the United States and Europe expanded in the 1990s and public investments in spectator sports were perceived as beneficial to civic identities. In 2010, 22 of the 30 Major League Baseball (MLB) teams played in buildings completed after 1990, and hundreds more buildings were built in the United States for National Football League (NFL), National Basketball Association (NBA), National Hockey League (NHL), minor league, and college teams during the period. The new buildings

included features not seen in older facilities, such as luxury suites that mirrored the amenities of hotels, as well as expanded plumbing, catering, and concession services for all spectators. Development of these structures generated a considerable amount of construction waste and, once open, their lighting, scoreboard, public address, and other systems consumed energy. In the early 21st century, in response to economic crisis, consumer interest, and unstable energy costs, many sports organizations have made an effort toward more sustainable practices. Both Chicago and Tokyo included sustainability plans in their 2016 Olympics hosting bids, for instance, including Chicago's plan to recycle stadium seating into wheelchair seats. Some 75 percent of professional sports teams, according to a 2008 survey, have implemented or developed a sustainability plan for their team or stadium.

LEED Stadiums

The MLB Washington Nationals, the NHL Atlanta Thrashers, and the NBA Atlanta Hawks and Miami Heat have become the first four professional sports teams to play in LEED-certified venues. Developed by the U.S. Green Building Council, the Leadership in Energy and Environmental Design (LEED) Green Building Rating System focuses on energy efficiency, sustainable construction practices, and creating a healthy working environment. In part because it was formulated in 1998, when alternative energy sources were less commonly available, the LEED standards focus on energy efficiency with the assumption that fossil fuels are in use, and so do not properly reflect the advantages of other energy sources.

The resource consumption of a typical stadium is enormous, but much of it can be trimmed through proper design and practices. Some alterations are obvious: these LEED-certified venues use compact fluorescent lightbulbs, like many energy-conscious households. Furthermore, water conservation can offer significant savings. American Airlines Arena in Miami has reduced its water bill by $3 million per year. Recycled materials can be used for many

When the new Yankee Stadium was completed in 2009, it purchased renewable energy certificates sufficient for two years of electricity usage (33 million kilowatt hours). Much of the cooking oil in the stadium is recycled to produce biodiesel, and vendors have converted to recyclable paper products with no petroleum-plastic cups allowed. Converted plumbing fixtures conserve millions of gallons of water per year, the Great Hall uses natural cooling instead of electric air conditioning, and automated control systems and reduce lighting wattage.

purposes, including the carpeting at Philips Arena in Atlanta.

Sustainability

As of 2008, MLB has been advising its 30 franchises on environmental stewardship and sustainable resource management. As of the 2010 season, teams began issuing sustainability reports regularly to track their progress in attaining greater energy efficiency and reducing waste. While the NFL has not involved individual franchises in its environmental program, it has worked with the host cities of major events like the NFL Kickoff, the Pro Bowl, and the Super Bowl to use local renewable energy capabilities when possible, recycle as much attendee-generated waste as possible, and offset the environmental impact of these major events.

In March 2009, following MLB's initiation of baseball's sustainability ambitions, Yankee Stadium purchased renewable energy certificates sufficient for two years of the stadium's electricity usage: 33 million kilowatt-hours. The stadium is also an early adopter of C-Neutral, an energy product from Hess Energy that uses carbon offsets to balance out the greenhouse gas emissions associated with electricity usage. Much of the cooking oil in the stadium is recycled to produce biodiesel, and the stadium became the first major league ballpark to convert to 100 percent recyclable paper products—though it has not gone the additional step of converting to recycled paper products.

Plumbing fixtures have been adjusted to conserve millions of gallons of water per year, and the stadium's Great Hall relies on natural cooling instead of air-conditioning, which stadium administrators describe as "about the same as 10,000 New York City apartments shutting off their air-conditioning for a summer day." New control systems and building automation reduce the total wattage of stadium lighting by significantly reducing the light pollution onto adjacent property, while increasing the lifetime of the lighting system and fixtures. Petroleum-based plastics have been eliminated from beverage cups, and about 40 percent of the stadium's waste is diverted from landfills through recycling and composting.

The Philadelphia Eagles have pioneered green sports in the United States, greening their stadium and training facilities as early as 2003 and hosting the NFL's first carbon-neutral game in 2005. The stadium even recycles its cooking fats to make biodiesel and supplies a portion of its electricity with solar power. The Meadowlands Stadium, home to the New York Jets and New York Giants, followed suit with the start of the 2010 season, as the New Meadowlands Stadium Company signed a partnership agreement with the Environmental Protection Agency covering wetlands and wildlife protection, green construction practices, water conservation and energy management, recycling and waste management programs, and community initiatives. The pavement at the Meadowlands site is crushed granite stone, in lieu of concrete medians, in order to better allow rainwater to recharge the groundwater. Water is conserved through the use of synthetic turf, saving the 3.5 million gallons used annually to water a grass football field, and waterless urinals have been installed in all the men's rooms, along with low-flush toilets. Despite the new stadium being twice as large as the previous stadium in square footage, its design will see an energy usage reduction of 30 percent as a result of more efficient equipment, heating and cooling systems, and lighting, along with energy-efficient window coatings, lighting control systems such as those used in Yankee Stadium, and outdoor transformers powered by biofuels. Serving items in the concession area are made of compostable material, and all compostable waste is sent to local farms or a compost facility in Woodbridge, New Jersey.

Stade de Suisse

Even the Eagles are said to be outmatched by the Stade de Suisse, in Bern, Switzerland. Opened in 2005, the soccer stadium for the FC Young Boys in the Swiss Super League first division has 12,000 square meters of solar panels; while Taiwan's World Games stadium has a larger solar roof, Stade de Suisse's produces more power. The stadium is hailed as the greenest in the world, attracting tourists who are allowed to visit the stadium's panoramic sun room for a demonstration of how solar power works. The efficiency of the panels is about 15 percent. Environmental groups have challenged Stade de Suisse's green claims, pointing out that there is more to sustainable practices than one's energy source—the solar panels

provide only about 2 percent of the stadium's energy consumption, for instance. It is worth pointing out that Stade de Suisse is not only a soccer stadium but is also home to 36 shops, businesses, and offices not affiliated with the team—a combination sports stadium, mall, and office park, which thus changes the nature of the building's energy demands.

Furthermore, the lighting rigs used in soccer stadiums, which not only provide illumination for night games but are also used to encourage the growth of the natural grass used on the field, are a significant source of consumption. Stade de Suisse has made no apparent effort to be more efficient in this area, nor in its use of floodlights, resource-intensive enclosed box seating, or jumbo screens. The 12 lighting rigs at English Premier League soccer team Arsenal's Emirates Stadium are equipped with sunlamps that run year-round and—independent of any other consumption in the stadium—use as much electricity as a small English village. The technologically advanced setup includes sensors that determine which parts of the turf need how many hours of light, and even while many U.S. sports teams are moving toward greater sustainability, international soccer teams are adopting these new lighting rigs at a fever pitch—projects similar to Arsenal's have been implemented in Germany, Greece, the Netherlands, Spain, Russia, Ireland, and even Qatar.

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See Also: Composting; Recycling; Sports.

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Steel

Steel is one of the most abundant man-made materials that exists, and it forms an essential part of industrial society and everyday life. It has been important for its functional and aesthetic properties since its early use and is a continually recycled material. The future of steel remains uncertain, as environmental concerns and issues of sustainability have been raised. The shortage of steel in the early 1970s had an impact on economies and societies, ushering forward new technologies to recycle existing steel as well as seeking more efficient means to produce it. The global trade in steel scrap is increasing, along with the demand for the metal.

Steel exists in most daily utilities and appliances and forms a great deal of the material world where people live. Without steel, great skyscrapers, mega structures, and everyday dwellings would not exist. It reinforces concrete, suspends bridges, maintains tunnels under great pressure, and provides a means for storing chemicals and foodstuffs. As well as forming the infrastructure of the industrialized world, steel provides people a means to travel by land, sea, and air at increasingly longer distances and shorter duration. Steel has helped people traverse the globe and gain access to environments beyond Earth. While steel has helped industrial societies in both physical and economic terms, its social and moral well-being are not entirely passive, for it has played a key role in the instruments of warfare.

Composition

Steel is a hard, strong metal alloy of iron (Fe) containing small amounts of carbon (C), usually less than 1 percent. This is also known as carbon steel. The terminologies used to define steel are not entirely universal, as it can be categorized and defined in various ways. Some steels contain additional alloying components, and this is why carbon steel should be differentiated from other steels, such as stainless

steel. Chromium and molybdenum can be added to increase resistance to corrosion, and nickel can be added to increase ductility and toughness, hence why stainless steel is an alloy containing chromium-molybdenum. Low-carbon steel contains less than 0.3 percent carbon and is sometimes referred to as mild steel. High-carbon steel contains 0.45–0.75 percent carbon, while very-high-carbon steel contains more. Steel can also be categorized by its purity (plain, low-grade, and high-grade) and by its use (stainless, cutting, or structural). Depending on whether one is an archaeologist, metallurgist, engineer, or consumer, steel can be defined in different ways.

History

The origins of steel are complex. New finds in archaeology are increasingly supporting the idea of multiple origins of iron smelting in central Africa and Eurasia, along with emergent technologies in the production of steel. Steel was made in much of the Old World 2,500 years ago, with continuous developments in its manufacture right up into the 21st century. Archaeologists and anthropologists have long been interested in the differences in technological practices used to manufacture steel, aiming to understand daily life practices and organization of industry in the past and present, in both pre- and postindustrial societies. With steel industries closed down, relocated, and developed since the 1970s, its production has directly affected local communities. Livelihoods and skilled occupations have been lost in some communities along with an upsurge in unemployment where steelworks have been closed down. Other communities around the world are welcoming new steelworks and enjoying the positive benefits of local industry.

Steel has not only formed the backbone of the 21st-century world but it is has also long been appreciated for its aesthetic qualities. Since the early Middle Ages in western Europe, steel was interwoven with other irons in a process known as pattern-welding to achieve stunning banded and swirling textures. A more intensely banded appearance was also achieved much earlier in the Far and Near East, as well as in central Asia from the production of liquid steel. Artists, craftspeople, and smiths still harness the visual beauty of different steels to produce eye-catching works for consumers.

Production and Recycling

In the early 21st century, steel is made using either a basic oxygen furnace (BOF) or an electric arc furnace (EAF). Steel production in a BOF requires 70–90 percent iron along with 10–30 percent steel scrap (or ferrous scrap). This process is preceded by mining along with iron and coke manufacture, which have raised questions about environmental concerns and sustainability. Since the 1970s, the EAF method has increasingly dominated production as steel in this process is made almost entirely from recycled scrap. Over half of steel production in the early 21st century is through recycling new scrap steel. Recycling steel in this way provides significant energy savings as well as environmental benefits. Less than half the amount of energy is required to produce secondary production steel than primary production. Recovering steel this way results in less pollution and reduces both solid waste and the need to extract resources from the environment. Producing steel from scrap is referred to as secondary production, distinguishing it from primary production where the metal is made from primary mineral resources.

Facts and figures about ore extraction, steel production, and recycling come from various sources in the form of national statistics, international steel institutions, and environmental agencies. Some of the principal sources are the World Steel Association, the International Iron and Steel Institute, and the International Stainless Steel Forum.

With an estimate of 4 percent of world energy consumed to produce iron and steel, recycling is becoming increasingly paramount to the future sustainability of the industry. International policies are placing recycled steel on the agenda to promote a sustainable life cycle of iron and steel. While some steel is produced from secondary resources, a great deal of steel is made through primary production by mining iron ore. Iron ore extraction is a dirty and energy-intensive process that is increasing rapidly. In 1994, nearly 1,000 million metric tons (mmt) of iron ore was extracted worldwide, recovering just over 500 mmt of iron metal. This increased more than twofold in 2007 to just over 2,000 mmt of iron ore mined worldwide. Estimates of the life expectancy of iron ore reserves vary from country to country, but it appears that they will be exhausted by 2060. Steel production worldwide has

increased nearly 20 percent every five years since the mid-20th century. Some countries have grown in their production, while others have contracted. The share of the world's steel is highest in the Asian countries. The main producers are China and Japan, closely followed by the United States, as well as Russia, South Korea, and Germany. The demand for steel has increased dramatically in China and India in the 21st century.

Since its beginnings, steel has always been recycled, and it is now one of the most recycled materials on the planet. There is a global market in steel scrap. In 2008, the Steel Recycling Institute reported that 83 percent of steel was recycled in 2008 in the United States, with over two-thirds of automobiles being made from secondary production steel. Turkey was the world's biggest importer of steel scrap in 2004–05, and roughly 90 percent of its steel output is made from recycled steel. However, it is difficult to know precisely how much steel is recycled worldwide because of differing definitions of the terms *recycling* and *recovery*. Similarly, it is difficult to judge how much steel in end use consumption is lost to landfill, because it is difficult to judge how much steel is locked in the iron cycle and as old scrap. On a global scale, it is estimated that around one-quarter of the steel required is met by purchased scrap.

Scrap

Is all steel scrap? The three types of steel scrap are home scrap, new scrap, and old scrap. The first two types come from the fabrication and manufacturing process. Home scrap originates from the initial stages of steel production during melting, casting, and rolling. Also known as circulating, revert, or in-house scrap, these initial cuttings and rejects are often highly valued because of their known composition. When steel is made into finished products, the rejects recovered at this stage are new scrap, also commonly referred to as prompt industrial or processing scrap. The scrap metal most people are familiar with on a day-to-day basis is old scrap. Old scrap comes from steel goods that have been discarded as they are no longer regarded as useful, also termed *obsolete* or *post-consumer* scrap. This used steel is recovered from many sources, for example, municipal waste, appliances, cars, railway tracks, trains, and buildings. Because of the nature of steel products, they may be in circulation for several decades before becoming old scrap, whereas home scrap and new scrap are recycled almost immediately.

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See Also: Automobiles; Industrial Waste; Iron.

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Street Scavenging and Trash Picking

Street scavengers, also called trash pickers, are ambulatory garbage collectors who search for items of value in the waste streams of cities, towns, and villages. The majority of 21st-century scavengers make a living by selling recyclable paper and metals, but many also collect uneaten food and reusable products, such as appliances and clothing. Street scavengers have been part of the culture of consumption and waste for centuries, and they remain a vibrant part of the trash economies of Europe, the United States, India, China, Africa, and Latin America. The public exposure of trash pickers to health and economic risk makes them symbols of urban poverty, yet their work is a crucial part of the global trade in recyclable paper, cardboard, plastic, aluminum, tin, copper, bronze, and steel. From an environmental and economic development perspective, street scavenging can be beneficial. Scavengers clean dirty streets and, by recycling, conserve space

in landfills and dumps. Unlike so-called dumpster divers, who pore through already-disposed of refuse, trash pickers generally work in unsorted garbage, in alleys, gutters, and ditches. Thus, they act as de facto sanitation workers as well as independent entrepreneurs. Doubts remain, however, about whether street scavenging should be legalized and, if legalized, how it should be regulated. Most trash pickers work informally, receiving no official recognition, licensing, or sanction for their activities. Scavengers often sell what they find to larger and wealthier junk brokers, who in turn sell to bulk buyers on a global scrap market.

It is difficult to pinpoint the historical origins of street scavenging. Archaeological and ethnographic data on metalworking from Africa and south Asia indicate that artisans developed economic relationships with people who collected iron and bronze scraps. With the dawn of the industrial age in Europe and the Americas, itinerant "rag pickers" and "junk men" became a more prominent presence in the cityscape.

Social scientists have begun to learn more about the world's two million scavengers and how their work contributes both to municipal waste management and to the market for recycled goods. By extracting valuable material from dumps, streets, and sewers, scavengers help to forestall the ecological degradation of cities, reducing the volume of solid waste in streets and other public places. This work is especially important in fast-growing metropolises of Latin America, Africa, and Asia, where municipal solid waste collection has not developed as quickly as consumers' appetites for disposable goods. As an activity in which poor and marginalized people can easily participate, garbage scavenging may also expand the benefits and reach of the recycling movement. From this perspective, then, trash picking can strengthen communities by giving their poorest members an economic stake in keeping them clean.

Regulation

This positive view of street scavenging ignores a crucial set of actors: middlemen. Development economists, urban activists, and ethnographers have criticized the tendency of garbage brokers to take advantage of children and other marginalized trash pickers. These critics favor more formal organization and regulation for scavengers. They cite success stories such as the cardboard collectors (*cartoneros*) of Argentina, who have managed to secure fair compensation for their work by organizing trade unions with strong political ties. Brazil's government has experimented with programs that give trash pickers (*catadores*) food subsidies in exchange for their work. In Managua, Nicaragua, on the other hand, dump and street scavengers (*churequeros*) have clashed with municipal authorities. Managua's churequeros launched demonstrations in 2008, claiming that city garbage workers were collecting valuable recyclables on their collection routes, effectively "stealing" from trash pickers. In that case, Managua's government sided with the city garbage workers and their powerful union, severely curtailing churequeros' access to the waste stream.

One challenge for those who wish to regulate trash picking is the volatility of the worldwide market for scavenged goods. Scavenged aluminum from the dumps of Managua, for example, is routinely shipped to China and the United States, where it is used in manufacturing and construction projects. Gold from automotive catalytic converters in New Jersey may end up in a Malaysian electronics factory just days after harvest. Some business leaders and environmentalists trumpet the advantages of such global circulation. They contend that encouraging free trade in salvaged goods eventually benefits all parties, from industrialists to street scavengers. Often, however, powerful traders have weak or indirect relationships to the small-scale trash pickers who collect most of the world's scrap metal. When global prices for recyclable items drop, as they did after the 2008 global financial crisis, the free market provides little in the way of a safety net for scavengers. In 2008 and 2009, plastics and metals that had lost their market value began to glut the gutters and alleys of major cities. To combat this problem, pro-scavenging activists suggest that governments should guarantee minimum prices for aluminum, copper, paper, plastic, and other items commonly found in pickers' bags.

Ownership of Waste

Although the global recycling market has become a powerful force in scavengers' lives, the transformation of objects from waste to value remains a legally

contested process. Contradictory notions of ownership are at play, since scavengers rummage through public space in search of items that will bring them private profit. In many places, trash pickers face prosecution for trespassing and theft. Many cities discourage trash picking, driving scavengers underground. In these places, scavengers fearful of prosecution tend to work at night. Under cover of darkness, laws against trash picking are more difficult to enforce, but clandestine work may actually increase deposits of unwanted refuse in streets and parks.

While curbside trash pickup and organized trash disposal are increasingly prevalent across the globe, it remains difficult to decide with certainty when waste has gone from private property to public resource. Debates over who should benefit from the economic value of garbage persist. In recent decades, municipal governments have tried to solve this problem by contracting trash collection to private waste management firms. Proponents of waste privatization argue that it relieves cities of the burden of deciding which waste belongs to whom. In some cases, it also provides informal trash pickers with legitimate jobs as employees of waste management contractors. Given that trash pickers work in streets and gutters, areas in which the enforcement of ownership rules is almost impossible, city governments have found it as difficult to enforce private companies' rights to trash. Even when companies employ trash pickers, informal scavengers continue to work alongside them.

Trash picking remains an essential, if largely invisible, part of waste management around the globe. Globalization of the trash trade has brought attention to the plight of scavengers, especially children, who face health and developmental risks from work in the streets. Although some favor putting a stop to scavenging, questions remain about whether this is prudent in an era in which urban pollution is a growing concern and in which scavenging is one of the few realistic livelihood options for poor and marginalized people.

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See Also: Commodification; Dump Digging; Dumpster Diving; Economics of Waste Collection and Disposal, International; Recycling Behaviors.

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Street Sweeping

Street sweeping collects a tremendous amount of waste off roads and parking lots across the world. The waste is highly heterogeneous and varies geographically from region to region. The management of the waste impacts the volume and type of waste that is collected. Street sweeping is conducted for a number of purposes: (1) it helps keep streets and parking lots neat and tidy, (2) it keeps roadways safe by eliminating debris, and (3) it helps maintain the public health of a community by removing contaminants and other harmful materials from roadways.

The waste collected from street sweeping is highly variable and typically consists of a mix of natural parent material, fill, road material, leaf and tree litter, grass clippings, animal waste and corpses, litter, urban dust, and chemical pollutants. The natural parent material varies from place to place and includes local sediment and rocks. In contrast, fill, which is used for land development, can be brought from distant locations. Grass clippings and leaf and tree litter vary from place to place, depending upon the tree canopy, lawn size, and management. Animal feces and corpses, particularly road kill, are often mixed with street sediment as it is collected.

A wide variety of litter, including cigarette butts, fast food waste, spark plugs, condoms, and glass, seem to be omnipresent in most street wastes and represent the random debitage of modern life. More sinister are the urban dusts and chemical pollutants that also vary from place to place; moreover, their invisibility makes them problematic for waste management. Street sweeping has seasonal challenges. In colder regions, spring thaws cause melting snow to bring large volumes of sediment-laden salty meltwater into the streets. Seasonal leaf fall is also

notable in that huge volumes of leaves are removed. During large summer storms, streets can turn into ephemeral streams; and, when the water drops, the sediment load left behind can provide challenges for sweepers.

There are many types of street sweepers. Typically, a rotary-brush sweeping mechanism brushes waste material toward a vacuum, which carries the waste into a waste hopper. Often, the rotary-brush sweepers are combined with a high-vacuum regenerative air mechanism, enabling the collection of very fine particles. The hoppers can be emptied into a roving dump truck so that the sweeper can continue on its path. There are also a number of specialized sweepers that are used for airports, parking lots, and sidewalks. Of course, many areas employ individuals to manually conduct street and sidewalk sweeping and cleaning.

A street sweeper in Trondheim, Norway. Specialized sweepers are used for airports, parking lots, and sidewalks to remove debris that seems omnipresent in curbs and roads. Sweeping can even protect public health by removing hazardous waste and toxic dust.

Throughout cities around the world, fleets of street sweepers embark across the developed landscape to remove sediment from paved surfaces. In most areas, streets and parking lots are swept on fixed schedules, with the majority of the work being performed at night. Many would be surprised to learn that highly trafficked streets are swept daily and that most streets and parking lots are swept on a weekly or monthly basis.

Managing street-sweeping waste is highly problematic, mainly because of its heterogeneity. Some communities consider street debris a hazardous waste because elevated levels of metals and other contaminants can be found in random samples. In these cases, thousands of tons of the waste must be transported to hazardous waste landfills, where it is mixed with other, arguably more-dangerous hazardous wastes. In other cases, the waste is transported to regular trash landfills where the debris is often valued as landfill cover.

In contrast, a number of communities utilize the waste as a resource. Some cities, for example, utilize the debris as fill for low areas. Others mix it with salt and apply it back onto the roads during the winter months. Still others separate the debris into recyclable litter, organic material, and inorganic material, using the organic material as mulch and the inorganic material as fill. Street-sweeping waste is often high in nutrients because it contains material that runs off lawns. For this reason, there is great interest in using street-sweeping sediment as a growing medium. However, the unpredictable presence of metals or other pollutants makes widespread reuse of the sediment unlikely.

Illegal dumping of street-sweeping waste is a problem in many areas. Small street-sweeper operators contracted to sweep parking lots or particular road segments may be inclined to dump their loads on vacant lots in order to reduce tipping fees or to save time. This problem is pronounced in many areas where vacant lots or brownfields are prevalent, as well as in the rural-urban fringe.

There is growing interest in the use of street sweeping to reduce stormwater pollution, as it has been shown that increased street sweeping has an impact on stormwater pollution. It is important to note that the timing of street sweeping is a significant variable in pollution loads. For example, sweeping conducted immediately before a storm has a distinctly different impact compared to street sweeping conducted weeks before.

Street sweepers remove tons of heterogeneous waste from the world's streets. The material collected is considered a hazardous waste in some communities, while other areas utilize it as a resource. The unpredictable presence of metals and other pollutants makes the waste problematic for widespread reuse.

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See Also: Archaeology of Garbage; Economics of Waste Collection and Disposal, U.S.; Public Health.

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Styrofoam

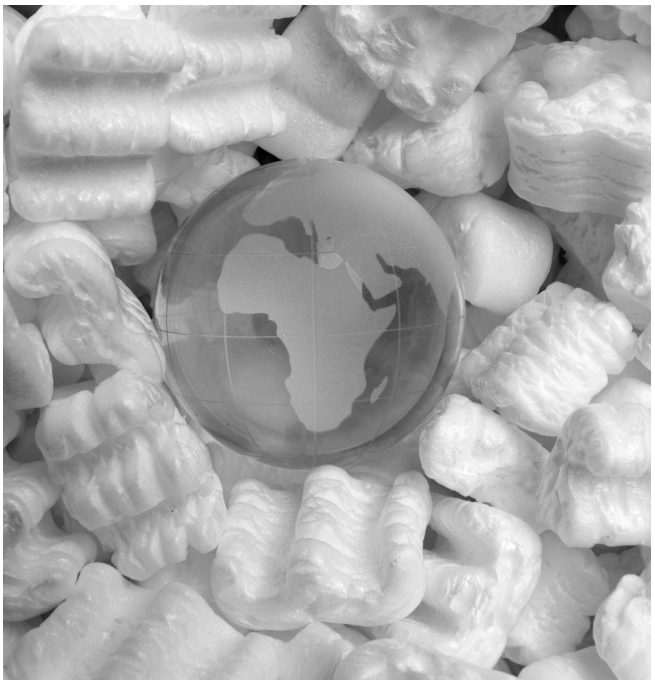
Styrofoam brand foam (or extruded polystyrene foam) is a registered trademark of the Dow Chemical Company. It was invented by chemist Ray McIntyre. Styrofoam is a generally blue, closed-cell, moisture-resistant foam insulation material that was first patented in the United States in 1944 and is typically used in housing insulation, roofing, and under-highway applications. Due to its insulating properties and buoyancy, it was used by the U.S. Coast Guard and the U.S. Navy beginning in World War II. In the early 21st century, Styrofoam applications were expanded to include spray foam insulation and termite-resistant foundation insulation. Styrofoam is also used in craft and floral design applications. All forms of Styrofoam can be reused and recycled. According to Dow Chemical Company, applications of Styrofoam reduce annual U.S. energy costs by $10 billion and, over a 20-year period, could save 10 trillion pounds of carbon dioxide emissions.

Uses and Characteristics

There is a common misconception that Styrofoam is the generic foam used for cups, disposable coolers, and packing peanuts. However, these items are not made of Styrofoam but are actually expanded polystyrene. Polystyrene, in its nonexpanded form, refers to the substance produced from the monomer styrene. Polystyrene is one of the most widely used plastics. It is commonly used to produce CD cases, disposable utensils, disposable razors, and the housing for smoke detectors, among other products. Like expanded polystyrene, polystyrene is a petroleum-based product, and this fact has raised concerns among environmentalists who are concerned about the future shortage of oil. A second concern is the impact of polystyrene products on the environment. Products made from this substance do not easily biodegrade (perhaps taking 500 years to do so). While they are recyclable, the practices of consumers are often to simply discard these items.

Expanded Polystyrene

The generic foam known as expanded polystyrene is incredibly light in weight (about 95 percent air) and thus has wide application as a method of keeping beverages hot or cold and protecting valuable items, such as electronics, during shipping. While this foam version of polystyrene offers convenience and utility for consumers, the products produced



Contrary to popular belief, packing peanuts, cups, and disposable coolers are not made of the product commonly known as Styrofoam; these items are actually made of expanded polystyrene,which poses hazards to land and marine environments.

and later discarded pose a number of concerns. As is the case with nonfoam polystyrene, the foam version relies on the use of petroleum in the production process. Additionally, workers producing the substance may be exposed to styrene and other chemical by-products. The products produced from this substance have limited recyclability. Part of this is due to its low weight and high volume, and even when recycling does occur, it is not closed-loop recycling. This means that the expanded polystyrene recycled will become a lower-level product than the original product. In 2008, 19 percent of expanded polystyrene was recycled. Some forms of expanded polystyrene, including packing peanuts, may be recycled at local centers in some cities, or may be mailed in for recycling. Another issue associated with expanded polystyrene is the disposal of the product after its use. Expanded polystyrene, because of its ubiquitous use, poses hazards to the environment both on land and sea. Americans waste nearly 2.5 billion disposable polystyrene cups per year. Some expanded polystyrene products end up in landfills and alongside the streets of cities and towns across the United States. Other products end up in waterways and pose threats to marine animals that sometimes mistake small pieces of polystyrene for food.

Bans and Limits

In the United States, over 100 cities (including all those of Orange County, California) have passed ordinances that either ban or limit the sale of polystyrene food ware, expanded polystyrene food ware, or polystyrene products at city-sponsored events. One city, Berkeley, California, passed a ban on this form of packaging in part because of the impact of fast and take-out food. According to a city resolution in 1990, fast and take-out food packaging represents the single greatest source of litter in the city. Taiwan has also passed such a ban. Reasons for the ban include the problem of biodegradability, prevalence of litter, impracticality of recycling, the physical harm caused to wildlife, and the impact of polystyrene production on the ozone layer. Reaction to these ordinances has been mixed. In Taiwan, there is concern that the ban will threaten jobs in the plastic industry, while in cities like Portland, Oregon, concern has been raised that the products being manufactured in the place of polystyrene are twice as expensive and end up in landfills anyway. In the late 1980s, McDonald's Corporation discontinued the production of the McDLT in part due to controversy related to packaging. The hamburger was marketed through its packaging and offered the customer two separate sides of a package—one side kept the burger hot, the other kept the lettuce and tomato cold. Examples like the McDLT illustrate that many of the issues associated with polystyrene are connected to corporate decisions and consumer choices.

Alternatives and Solutions

Alternatives to polystyrene-based food containers include recyclable paper, bamboo, and biodegradable corn plastics. Some restaurants have turned to utensils made from plant-based starch and polylactic acid (corn)-based cups and straws. Many restaurants are turning to such alternatives, despite increased packaging costs of up to 20 percent. Another solution is to encourage consumers to avoid the use of polystyrene and expanded polystyrene products. For example, when ordering take-out food at restaurants, consumers can bring their own reusable food storage containers to transport their food home.

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See Also: Fast Food Packaging; Packaging and Product Containers; Recycling; Shopping Bags.

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Sugar Shortage, 1975

Once a very rare commodity reserved for special occasions, sugar and sugar-sweetened products are now widely consumed throughout the world. The popularity of sweets in the United States is especially immense, but many of these products are not actually sweetened with sugar, but rather with high-fructose corn syrup (HFCS). The events of the late fall in 1974 when the wholesale price of sugar skyrocketed nearly 850 percent help explain why this is the case.

This massive jump drastically increased the retail prices of foods containing sugar through most of 1975. Despite being labeled as a "sugar shortage," the price swell resulted from a combination of U.S. tariff expirations and a poor sugar beet harvest in the former Soviet Union. The fallout from the 1975 sugar shortage has been long lasting in the U.S. food industry. Specifically, higher sugar prices led many food-producing companies to seek cheaper alternatives, such as sugar substitutes and HFCS, to sweeten their products.

History and Causes

The United States imposed tariffs on imported sugar from the 1930s until the middle 1970s. These tariffs date back to the Jones-Costigan Sugar Act of 1934 and were implemented to protect domestically produced sugar. A series of similar acts followed until the Sugar Act of 1948, which solidified a method of establishing quotas and maintained sugar tariffs. At the urging of many top economists, the U.S. Congress allowed this act to expire in 1974, despite protest from sugar lobbyists. Without the tariffs in place, foreign producers would, in theory, be able to flood the United States with cheap sugar and drive down both wholesale and retail sugar prices. The potential for lost revenue caused some U.S. sugar producers to switch to other crops. In the north, many sugar-processing plants shut down and the sugar beet industry practically disappeared overnight. Many farms switched to corn to take advantage of federal subsidies. This move later led to an exponential growth of HFCS production. During the late summer into the fall of 1974, it appeared the economists had miscalculated, as the price reduction they had anticipated from free trade did not occur. Rather, the price of sugar skyrocketed. In the New York Coffee and Sugar Exchange, the price of sugar reached $0.66 per pound (lb) in November 1974, which was up from $0.074 per lb in October of the previous year.

To understand this staggering price hike, it is important to also consider what took place at the same time in the Soviet Union. The Soviet Union was one of the world's largest sugar beet producers, but it experienced a poor beet harvest in 1974. During this time, the Soviets bought up both sugar futures contracts and actual sugar from the London Exchange while keeping quiet about their domestic shortage. Had they disclosed this information, the price of both futures contracts and actual sugar would have been higher. With commodities experts in the dark, the Soviets were able to procure sugar futures and actual sugar at well over 50 percent of their estimated value. Suspicions arose among the experts when the U.S. Department of Agriculture sent a team to the Soviet Union to inspect wheat-growing areas. The Kremlin did not allow the inspection team to leave Moscow, so they returned to the United States having not inspected any fields. Shortly thereafter, a report released in West Germany told of flood-damaged Soviet crops. Commodity experts immediately reacted to this news in November 1974, and sugar prices rose sharply.

By 1975, a larger sugar beet harvest around the world caused wholesale sugar prices to fall. From their high of nearly $0.66 per lb, prices fell to $0.23 per lb in August 1975. While sugar commodities exchanged at this much lower price, consumer prices lagged far behind. Beginning with the initial price spike in November, supermarket prices increased almost every day through the end of 1974 into the following year. During this time, many people went to their local grocer only to find bare shelves in the sugar aisle. Consumers responded by stockpiling whatever additional supplies of sugar they could find.

This buyer panic prompted some stores to reserve sugar for their regular customers. Some consumer watchdog groups even accused large supermarket chains of hoarding sugar, though no evidence was ever found to support this claim. These rising costs and decreasing supplies corresponded with a significant decline in per capita sugar use from 103

lbs in 1972 to roughly 90 lbs in 1975. In addition to raw sugar costs, consumers were also hit with price hikes for foods and beverages that contained added sugar, including sodas, juices, cookies, candy, breakfast cereals, jams, and jellies. Sales dropped across the board for these products. In their place, consumers chose low-calorie beverages and opted for products like crackers that contained little or no sugar.

Effects

The consequences of this consumer shift were twofold. First, consumers reduced their sugar consumption by turning to sugar substitutes to sweeten their beverages and foods. The most widely used brand was Cumberland Packaging Corporation's Sweet'n Low. This product blends saccharin with dextrose and cream of tartar and has 300 times the sweetness of sugar by weight. During the sugar shortage, the low-calorie substitute sold at one-quarter the cost of equivalent amounts of sugar, which caused the substitute to gain a tremendous share of the sweetener market. While their market share decreased slightly after prices dropped back down, Sweet'n Low and other sugar alternatives cemented their place as viable sweeteners. The other outcome was the proliferation of HFCS as a sweetener. HFCS was first created in the 1960s when researchers used xylose isomerase to convert the glucose contained in corn to the much sweeter fructose. With corn both widely farmed and federally subsidized, HFCS could sweeten products at a fraction of the cost of sugar. Manufacturers embraced the cheaper alternative and placed heavy investments in HFCS production. Thus, in 21st-century U.S. grocery stores, most all sweet products not sweetened with substitutes contain HFCS, not actual sugar.

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See Also: Beverages; Food Consumption; Grocery Stores; Supermarkets.

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Supermarkets

The supermarket is rapidly becoming the most popular way to buy food and household goods throughout the world. According to a study by the Smithsonian Institution, the supermarket is defined by self-service, product departments, discount prices, marketing, and volume selling. In the 1930s, supermarkets changed the face of food distribution and retailing in the United States, and these large stores became a symbol of U.S. prosperity and modernity.

History

Before the supermarket, buying groceries was a slow, labor-intensive experience. Grocery store customers would line up at a counter and they would ask a clerk for what they wanted to buy. This would entail the clerk measuring out the correct amount and packaging each item. Shopping at covered or open-air markets was a similar process but required multiple interactions with many market vendors.

At the turn of the 20th century, many grocery stores in the United States introduced self-service. Clarence Saunders opened the Piggly Wiggly in Memphis, Tennessee, in 1916 and was one of the first retailers to introduce self-service. Self-service grocery stores are the roots of the modern supermarket. Self-service meant a major reduction of labor and also gave shoppers the opportunity to handle the goods and compare them with others. The first self-service grocery stores did not sell perishable goods, such as meat and fish.

The first supermarket was opened on August 4, 1930, by Michael J. Cullen in Jamaica Queens in New York City. What differentiated Cullen's King Kullen store (who's name was inspired by the film *King Kong*) from the self-service grocery was its size, the logic of the store layout, and the presence of a

parking lot. The layout of the supermarket ushers the shopper through a maze in which they are exposed to as many products as possible—the customer circulates through the entire store. Shopping carts were also introduced so that shoppers could easily cover the distance and buy as much as they liked without struggling. Many brands of the same item are carried in supermarkets, and shoppers can compare products and prices. Modern marketing and merchandizing developed alongside the supermarket; customers had to be able to recognize a brand and its qualities in order to select it over another similar product. Once a shopper has finished selecting goods, the final destination is the checkout. This is one of the few places where the shopper has contact with other people, either waiting in line or talking to the cashier. In most of the original supermarkets, the cashier or a helper bagged the groceries.

Growth and Effects

Borrowing from the principles of Taylorism, supermarkets quickly increased sales and reaped the benefits of economies of scale. Many grocery store chains morphed into supermarkets, such as the A&P (the Great Atlantic Tea Company), which is still in existence in the early 21st century. As supermarket chains grew, regional distribution centers developed. Chains could buy large quantities of goods at discounted prices and pass these savings along to shoppers. Margins were slim, but the sales volumes were high. Cullen's original sales mantra, "Pile it high. Sell it low," embodied this idea.

Centralized buying has had a huge impact on farmers as well as on competing food retailers. Farmers no longer needed to take their goods to market and the connection between consumers and producers was slowly lost as supermarkets took over the largest market share in food retailing. It is also easier for supermarkets to deal with one large producer who can assure sufficient quantities of goods. For this reason, many small-scale farmers and producers went out of business. Producers were not the only people who suffered at the hands of supermarkets; small grocery stores, and eventually specialty shops like butchers and bakers died off because they could not compete with the low prices offered by supermarkets. Supermarkets advertised aggressively in local newspapers and sent around fliers featuring loss-leader items that attracted shoppers into the store. For this reason, supermarkets expanded rapidly during the 1930s and the Great Depression when price was of the utmost importance.

The U.S. retail landscape changed greatly in the post–World War II period because of supermarkets and the rise of suburbia. Supermarkets were built in locations that were central to new suburban neighborhoods and featured large parking lots. The U.S. car culture also led to the decline of the small, downtown shop. If there was no place to park and few people lived in the center of cities, the best solution was to go to a supermarket where one could find just about everything at low prices. This was the period in which the U.S. supermarket branched out and began to carry everything from cereal and milk to meat, baked goods, and household items. Diversification and volume are the supermarket's great strengths. By 1958, 95 percent of all food sales were self-service, and 68 percent of these sales took place in supermarkets.

A U.S. invention, the supermarket spread quickly throughout the Western world after World War II. In western Europe, supermarkets took off somewhat later but have become the main mode of food distribution in countries such as France and Germany. Auchan, Carrefour, and Walmart developed the concept of the hypermarket (an oversized, discounted supermarket), which has been exported to developing countries throughout the world. Supermarkets are being built throughout Latin America and serve the growing middle class in these countries. To shop at a supermarket is an expression of status, much like it was in the 1950s and 1960s in Europe: to shop at a supermarket is part of modern living. Bright lighting, hygienic conditions, self-service, and extended store hours make the supermarket fit the ideals of a modern life that is fast, clean, impersonal, economical, and efficient.

Supermarkets changed the way people buy food from a number of perspectives. First, consumers now had to inform themselves about products in order to choose between brands. The most common information they could receive was through advertising; the clerk was no longer there as a point of reference. Brands and their identities became increasingly important, and advertising played a major role in shaping people's consumption. Jingles on the radio

and ads in newspapers and, later, television commercials cemented brand names into people's minds. People were no longer choosing the best product but rather the most familiar product. Second, between the invention of the refrigerator, shopping cart, and automobile, people started buying and eating more food. Rather than shopping several times a week for fresh produce and other food, people began making fewer trips to the supermarket and stocking their cupboards and refrigerators. Third, part of this trend was the rise of prepared foods and frozen foods, which are readily sold at supermarkets—these products also fit into the ideals of efficiency and the cult of the modern. Finally, people started to eat more because of package sizes, low prices, and abundance. Too much food is not always a good thing.

Waste

Where there is abundance, there is waste. Supermarkets are major consumers of energy and producers of waste. Large amounts of electricity are required to light, heat, and cool supermarkets. The movement for greener supermarkets is only getting under way in North America and Europe, but true efficiency will likely only come with the end of frozen food. The green movement has started with recycling programs in most supermarkets. Packaging and shipping products make up a large part of the waste produced by supermarkets and most now have major paper and plastic recycling programs. Many supermarkets no longer provide disposable shopping bags to customers and only sell reusable or biodegradable bags, encouraging a reduction of nonbiodegradable waste. However, the most unethical waste produced by supermarkets is food—they produce an excessive amount of food waste. This is a great symptom of cultures where there is much abundance but no system for equitable redistribution. There are few supermarkets that give imperfect produce and nearly expired food products to food banks and other charitable organizations. Most waste is locked in dumpsters and sent off to dumps or organic recycling programs. Tons of edible food are dumped by supermarkets monthly. This is something that the freegan movement and dumpster divers are fighting.

Supermarkets are a product of modernity and have left their mark not only on urban and suburban landscapes; modern supermarkets have changed the way that people think about food and how they eat.

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See Also: Consumerism; Consumption Patterns; Food Consumption; Grocery Stores; Household Consumption Patterns; Shopping; Shopping Bags.

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Surveys and Information Bias

Surveys are the most popular form of data collection. However, there are many biases that have to be minimized. The biases can broadly be characterized as sampling errors, which occur because of insufficient sample sizes, and nonsampling errors, including errors of conception, logic, misinterpretation of replies, tabulating, coding, and reporting results. Such biases also include selection of respondents for the survey, sampling technique biases, and sequencing biases based on the order of the questions asked.

Meta-Analyses and Studies

A meta-analysis of 1,607 studies published between 2000 and 2005 in 17 refereed academic journals identified 490 studies that had used surveys. The authors examined response rates from these studies, which covered more than 100,000 organizations and 400,000 individual respondents. The average response rate from individuals was 52.7 percent, with a standard deviation of 20.4, while the average

response rate from organizations was 35.7 percent, with a standard deviation of 18.8. The study also found relative stability in response rates in the past decade and higher response rates for journals published in the United States. For organizations, incentives were not found to be related to response rates, while reminders were associated with lower response rates. Electronic data collection via the use of e-mail, phone, or Internet resulted in higher response rates than those obtained through traditional mail methodology.

In another meta-analysis, 59 methodological studies were analyzed to assess the magnitude of nonresponse bias. The strongest predictors were the design features of the surveys, characteristics of the sample, and attributes of the survey statistics computed in the surveys. Other studies have also shown a strong link between nonresponse and measurement errors; in other words, nonrespondents are also likely to be poor respondents if coerced into participation in a survey. For example, past research has demonstrated that nonvoters misreported political views and were less likely than voters to take part in surveys.

Empirical studies have also suggested the use of different recruitment methods for additional survey efforts in order to reduce nonresponse biases. The use of multiple protocols has been shown to increase the response rate, change the point estimates, and achieve lower total nonresponse error. Socioeconomic status also has been shown to influence nonresponse biases—less-educated individuals were shown less likely to have participated in health surveys than those with a higher level of education. A new measure for the risk of nonresponse, the fraction of missing information (FMI), has been proposed as an alternative to the response rate in assessing accuracy of survey results. It measures the level of uncertainty about the values one would impute for current nonresponders and can assist researchers in maximizing the information in the data set.

Survey Research Biases of Consumption and Waste as Determined by Garbology

Since the 1970s, William Rathje and his colleagues have conducted archaeological excavations in several landfills across North America. Their studies produced results that differed from common perceptions as reported via survey data. There was significant difference between what individuals consumed and what they claimed to have consumed. Alcohol consumption was underreported by 40–60 percent, while asparagus consumption was overreported by 200 percent. Other underreported statistics were household wastes, which comprised 15 percent of the foodstuffs; construction debris accounted for 20–30 percent of the materials in the landfills, while paper products took up 40–50 percent.

Finally, consumers also reported thinking that Styrofoam, fast food packaging, and disposable diapers account for great quantities of landfill space, but the three items together actually made up less than 3 percent of the garbage.

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See Also: Alcohol and Consumption Surveys; Consumption Patterns; Diet and Nutrition Surveys; Garbology; Household Consumption Patterns; Marketing, Consumer Behavior, and Garbage; Overconsumption; Solid Waste Data Analysis; Underconsumption.

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Sustainable Development

Sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment, so that these needs can be met not only in the present but also for future generations. It means different things to different people, but the most frequently quoted definition is from the report "Our Common Future" (also known as the Brundtland Report) stating that sustainable development is the development "that meets the needs of the present without compromising the ability of future generations to meet their own needs."

History

Sustainable development is not a new idea. Many cultures over the course of human history have recognized the need for harmony between the environment, society, and economy. What is new is an articulation of these ideas in the context of a global industrial and information society. Sustainable development focuses on improving the quality of life for all of Earth's citizens without increasing the use of natural resources beyond the capacity of the environment to supply them indefinitely. It requires an understanding that inaction has consequences and that people must find innovative ways to change institutional structures and influence individual behavior. It is about taking action, changing policy and practice at all levels, from the individual to the international.

Discussions about the limits and implications of economic growth have recurred in economic history. In 1972, the Club of Rome published "Limits to Growth," a highly controversial report, which assumed a certain relationship between population growth, industrialization, pollution, and the depletion of natural resources. The debate spurred by the report mainly focused on the prospects of shortages in material stocks of nonrenewable natural resources and on whether economic growth would inevitably lead to environmental degradation and social collapse. At that time, economic growth and environmental quality were largely perceived as opposing each other. "Limits to Growth" became controversial because it predicted terrible consequences if economic growth were not slowed down. The report gave birth to a political movement advocating zero or even negative growth. At the same time, it was criticized by northern countries because it did not take into account technological innovations and by southern countries because it advocated abandonment of economic development. The report reinforced the concept that the environment and the economy are irreconcilable.

In the 1980s, the importance of reconciling economic growth with the environment was recognized, providing an intellectual underpinning to efforts to elevate the importance of environmental issues in policy making. The origin of sustainable development dates back to 1982, when the World Commission on Environment and Development was initiated by the General Assembly of the United Nations and its report, "Our Common Future," was published in 1987. The Prime Minister of Norway Gro Harlem Brundtland was the chair of the commission. At that time, both northern and southern countries feared that environmental protection would threaten their prospects for development.

As with previous efforts, the report was followed by major international meetings. The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 (the so-called Earth Summit) issued a declaration of principles, a detailed Agenda 21 of desired actions, international agreements on climate change and biodiversity, and a statement of principles on forests. Ten years later, in 2002, at the World Summit on Sustainable Development in Johannesburg, South Africa, the commitment to sustainable development was reaffirmed.

The Johannesburg Declaration created a collective responsibility to advance and strengthen the interdependent and mutually reinforcing pillars of sustainable development: economic development, social development, and environmental protection at local, national, regional, and global levels. The World Summit addressed a running concern over the limits of environment and development, wherein development was widely viewed solely as economic development.

Concepts

The sustainable development debate is based on the assumption that societies need to manage three types of capital—economic, social, and natural—which may be nonsubstitutable and whose consumption might be irreversible. Some authors point to the fact that natural capital cannot necessarily be substituted by economic capital. While it is possible that people can find ways to replace some natural resources, it is much less likely that they will ever be able to replace ecosystem services such as the protection provided by the ozone layer, or the climate-stabilizing function of the rain forests. In fact, natural capital, social capital, and economic capital are often complementarities.

Before this conciliation was formally adopted by UNCED, developing countries often viewed demands for greater environmental protection as a threat to their ability to develop, while wealthier countries viewed some of the development in poor countries as a threat to valued environmental resources. The concept of sustainable development attempts to couple development aspirations with the need to preserve the basic life support systems of the planet. It was an attempt to bridge the gap between environmental concerns about the increasingly evident ecological consequences of human activities, and sociopolitical concerns about human development issues. In that sense, sustainable development was a logical extension of arguments within the environmental literature of the 1960s, 1970s, and early 1980s. One of the successes of sustainable development has been its ability to serve as a common ground between those who are principally concerned with nature and the environment, those who value economic development, and those who are dedicated to improving the human condition. At the global scale, this concept has engaged the developed and developing countries in a common endeavor.

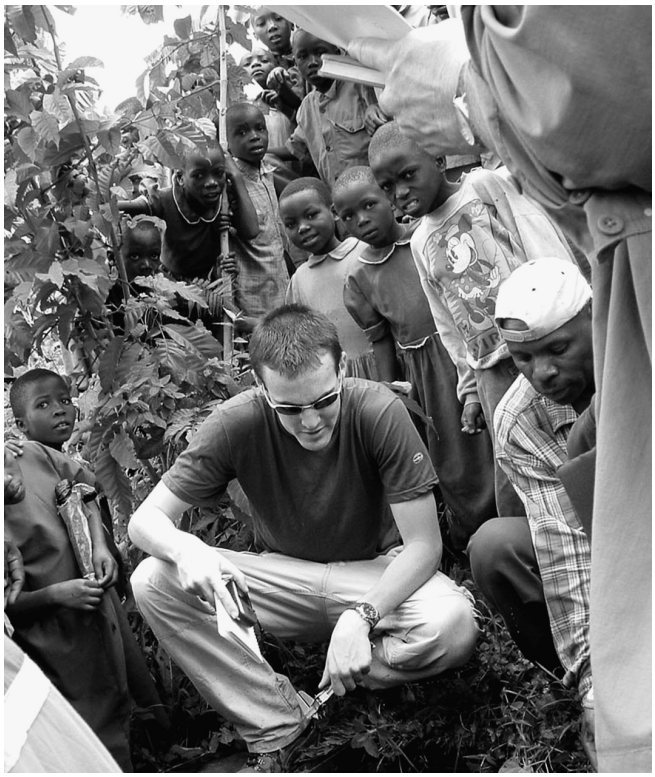
Sustainable development is an open, dynamic, and evolving idea that can be adapted to fit very different situations and contexts across places, scales, and time. It opens spaces for participation at multiple levels, from local to global, within and across activity sectors, and in institutions of governance, business, and civil society to redefine and reinterpret its meaning to fit their own activities. The concept of sustainability has also been adapted to address different challenges, ranging from urban planning to sustainable livelihoods.

Sustainable development requires the participation of different stakeholders and perspectives seeking to reconcile diverse values and goals toward mutual actions to achieve sustainable practices worldwide. Increasingly, goals and targets for sustainable development are being adopted by global and local consensus. Sustainable development can be interpreted as a path along which the maximization of human well-being for the 21st century does not lead to declines in future well-being.

Interactions between the economy, environment, and society must be taken into account in formulating different strategies. All too often, measures targeted to specific dimensions of development do not consider effects on other dimensions, leading to unforeseen effects and costs. Responding to the challenge of sustainable development requires the institutional and technical capacity to assess the economic, environmental, and social implications of development strategies and to formulate and implement appropriate policy responses. In that sense, sustainable development is often presented as being divided into the economy, environment, and society. Sustainable development is presented as aiming to bring the environment, economy, and society together in a balanced way to reconcile conflicts—although in most debates about sustainable development, either the environment or the economy is given priority.

Precautionary Principle

An important and complementary aspect for the discussion on sustainable development is based on what has been called the "precautionary princi-



Evan Thomas of Engineers Without Borders assesses a surface-water pipeline in Rwanda, Africa, a sustainable engineering solution for a community in need of this critical resource. Leaders in the community are trained to maintain the pipeline.

ple," also known as the "precautionary approach." It is referred to as a close and important feature of sustainable development. Human beings have been adopting precautionary actions for a long time. In that sense, the principle relies on the number of preventive measures that societies have been applying to a wide range of environmental and public health issues without articulating it in a principle of law. However, parties to the Vienna Convention of 1985 and the 1987 Montreal Protocol formally stated their determination to adopt precautionary measures to prevent emissions of ozone-layer-depleting substances.

Since 1987, the precautionary principle has been implemented in many international agreements, including the Second North Sea Declaration, the Framework Convention on Climate Change, the Maastricht Treaty of the European Union, the Helsinki Convention, and the Biosafety Protocol. Particularly, the 1992 Rio Declaration of the United Nations Conference on the Environment explicitly stated that "in order to protect the environment, the precautionary approach shall be widely applied by Nations according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." In other words, if there is a body of evidence pointing to serious irreversible damage to human health or the environment, measures should be taken to prevent harm rather than wait for full scientific certainty.

Applications

Sustainable development is also advocated as a powerful strategy to overcoming poverty, environmental degradation, disease, and other problems afflicting the world. It calls for attention to important issues of fairness, as the rich usually consume a great proportion of the world's resources and emit a large share of the world's pollution. A critical way to change this situation is to improve institutions and policies so that they can lead societies to a sustainable future because economic growth, environmental protection, and social equity are closely linked. There is need to develop integrated policies to achieve socio-economic goals. In that sense, a growing economy and a healthy environment are essential to local, regional, national, and global security.

The issue of climate change is one of the crucial tests of the global community's willingness to pursue sustainable development. Society has to change its consumption patterns, thus freeing space for ecosystem maintenance. There is a need to cut carbon emissions immediately if Earth is to be saved from the consequences of climate change. But the Kyoto Protocol—a critical first step toward implementing concrete action on this agenda by the industrialized countries—is far from fully operational.

Future

Predicting the future of sustainable development is very difficult, although the goal remains ever desirable. By 2010, there was no consensus on the definition of sustainable development. There are groups and interests that still consider growth as a fundamental premise for sustainable development

and that do not accept the need for a steady-state economy at the global level. The absence of a consensus on the definition of sustainable development is perhaps inbuilt in the concept itself, given that sustainable development is an oxymoron emphasizing both "to sustain" and "to develop," and therefore prioritizing one or the other yields very different results.

The practical consequences of the conflict of development (growth) versus environmental sustainability are that little progress has been actually achieved in reconciling these two objectives. However, the term *sustainable development* goes beyond the boundaries of science and business development and trade to include human development, values, and differences in cultures. In fact, many organizations are referring to "sustainable human development" as opposed to "sustainable development" in order to emphasize issues such as the importance of gender equality, participation in decision-making processes, and access to education and health.

In the early 21st century, urban areas—where more than 50 percent of world's population live—have become the focal points of these components as major consumers and distributors of goods and services. However, many cities tend to be large consumers of goods and services, while draining resources out of external regions on which they depend. As a result of increasing consumption of resources and growing dependencies on trade, the ecological impact of cities extends beyond their geographic locations. It has been recognized that the concept of sustainable development is an evolving, debatable term.

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See Also: Consumerism; Developing Countries; Overconsumption; Sustainable Waste Management.

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Sustainable Waste Management

The notion of sustainable waste management is highly contested. Its interpretation can differ sharply between government officials; environmental activists; community activists; poor, working-class, and middle-class individuals; politicians; and corporations. Meanwhile, segments of the population may be completely unfamiliar with the term. On one hand, sustainable waste management may be defined with an emphasis on economic constraints and efficiency, irrespective of the social and ensuing environmental or ecological consequences. On the other hand, these issues may be taken into consideration, involving substantially different decision-making processes and funding approaches. Generally, people subscribe to this latter approach in which the health and socioeconomic well-being of the affected communities, as well as the choosing of processes and practices that are environmentally sound (that avoid the transfer of pollutants from the solid state to the water or

the air environs of these communities) is of paramount importance.

First Global Declarations of Sustainable Development

Sustainable waste management is embedded in the broader policy of sustainable development. The notion of sustainable development became internationally renowned as a result of the 1992 United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro, which came to be known as the Earth Summit. The UNCED defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." In addition, the precautionary principle, which first arose in Europe during the 1980s, became part of environmental thought and acquired prominence as a result of the Earth Summit. The precautionary principle, in its more modern form—known as the 1998 Wingspread Statement—asserts that "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

The 1992 Rio declarations on sustainable development make no direct claims regarding waste management. They are mostly concerned with the sustainable economic development of nations—the industrial, production, and distribution stages of the process. However, both the United Nations (UN) definition of sustainable development and the precautionary principle become inconsistent if these same principles are not applied to the disposal stage of the life span of the products and by-products generated by the production and distribution processes. Thus, solid waste management is an integral part of sustainable development if applied with due consideration to the protection of the health of humans and of the environment, the conservation of resources (whether land or reusable/recyclable materials), and the avoidance of creating a burden for future generations.

Landfills

The treatment of solid waste (also known as garbage, trash, rubbish, or refuse) has undergone a similar path in both advanced and developing countries. Historically, solid waste was initially discarded by communities in open land spaces (hereby the term *landfill*) or dumps and frequently set on fire to recover some space to resume the open disposal of the waste on the primitive landfill. However, in developed countries like the United States, new environmental laws and regulations put an end to such practices in the 1970s. This started the era of scientific solid waste management. As the developing countries advance, their solid waste management practices follow a similar path.

Modern waste disposal practices still frequently follow the strategies of waste landfilling and combustion but with an elaborate set of regulations regarding the construction and operation of landfills and the technology and constraints imposed on waste incineration facilities. This does not mean that landfills and incinerators provide for the best practices regarding sustainable waste management but rather their modern operation is an improvement over the open landfilling and garbage burning of the past, which generated immense problems regarding water and air pollution, as well as runaway health hazards.

A modern landfill is designed to have several layers of clay and plastic lining at its bottom and external sides to prevent the percolation of the rain water trapped by the landfill into the water table of the region where the landfill is located in order to avoid contamination of these waters. This percolated water, called the leachate, contains a significant concentration of harmful chemicals. In a properly designed landfill, it is collected through a series of pipes and sent to a leachate treatment station. Since water percolation is considered such a problem, landfills are designed to be as water impermeable as possible according to the regulations of the Environmental Protection Agency (EPA). This creates such conditions that even biodegradable materials remain relatively untouched by microorganisms for many years. For example, garbage archaeologists have found decades-old phonebooks essentially unchanged in landfills.

On the other hand, landfills still produce a certain amount of slow biodegradation of the most biologically labile garbage components, such as food waste. Since the landfill is designed to be as

water impermeable as possible, within the depths of the buried debris, oxygen is also in short supply. This condition favors the growth of anaerobic microorganisms, which slowly digest the most labile organic debris while producing a variety of gases, particularly, significant amounts of methane. Since methane is flammable and can be explosive in the conditions under which it is generated in the landfill, another set of pipes are incorporated into the landfill structure to extract the methane. Furthermore, other noxious gases (such as hydrogen sulfide) have been recorded above the surface of landfills equipped with the best technology for gas recovery.

Every landfill has a limited lifetime that depends on the surface area allocated to it. Once full, the landfill must be closed, and according to EPA regulations, the leachate and methane production must be monitored and processed by the landfill owner for up to 30 years. Beyond this time limit, the owner is not responsible for any additional monitoring and treatment. This is the time when the lining of the landfill may be more prone to fail, allowing the leachate to mix with the water table and contaminate wells. However, the limited lifetime of the landfill becomes a prominent issue of social concern because another site has to be found to continue burying the solid waste. Many communities, aware of how the siting of a landfill in their proximity might affect their health, quality of life (landfill odors), and property values, have resisted the placement of a landfill nearby. This is what is termed *NIMBY* (Not in My Backyard). The NIMBY phenomenon is a rational response by the citizens of these communities, which highlights the issue of sustainable waste management.

As the population of a country and the disposable incomes of its citizens increase, the amount of solid waste generated increases. In the United States, the amount of trash generated per resident has increased steadily since World War II. Not only have the incomes and population increased but also the variety of products and their packaging have resulted in growing amounts of trash. This is particularly accentuated by the postwar introduction of plastics into the waste stream. Plastics have the distinctive characteristic of occupying a substantial amount of volume relative to weight. Since landfills are the principal method of waste disposal, the plastics that find their way to the landfill occupy an inordinate proportion of the landfill space compared to their weight. Furthermore, since they are a recent introduction to the environment—regarding their chemistry and biodegradability on an evolutionary time scale—they can remain relatively intact in landfills for hundreds of years. It was more than just plastics that environmentalists, the public, and solid waste managers found that entered landfills without being degraded in a pattern similar to other wastes by the chemical and biological forces of nature on a reasonable human timescale. This compelled scientists, environmentalists, and other concerned groups to look for and advocate alternatives that are sustainable.

Incinerators

Some scientists and engineers, as well as municipal and regional government administrators, came to the conclusion that burning trash in large incinerating facilities was an alternative to landfills. These incinerators have capacities to burn between 300 and 2,000 tons of trash per day. Most incinerators operating in North America in the early 21st century also have the capacity to capture the heat generated during the trash combustion and generate either electrical energy or steam, which can then be sold. On the surface, incinerators seem like a win-win situation. Incinerators get rid of trash and produce energy. However, incinerators have a series of environmental drawbacks that have made them also the target of the NIMBY phenomenon. Incinerators, even those equipped with sophisticated pollution-control equipment, emit very harmful chemicals such as dioxins, heavy metals, and colloidal ash into the atmosphere. This ash, called "fly ash," can have a significant content of heavy metals. The regular ash produced by the incinerator still needs to be landfilled. It is also considered hazardous and thus needs to be buried in special landfills for hazardous waste. These risks have compelled many communities to oppose the placing of incinerator facilities in their midst or to demand that existing incinerators be closed down.

All incinerator facilities are privately owned, and their economics are based on efficiencies of scale. This compelled the incinerator companies to pur-

sue exclusivity rights for the disposal of solid waste. Communities and activists took their opposition to this exclusivity to the U.S. Supreme Court, which in 1994 overruled any ordinances intended to control the flow of solid waste exclusively to incinerator facilities, allowing for the refuse to be appropriately diverted to other venues, such as recycling centers. This was considered a significant victory for the recycling proponents, and it resulted in more favorable circumstances for the processing of solid waste according to the principles of sustainable management.

Recycling and Composting

Another alternative to landfilling involves the recycling of materials (such as paper, plastics, and aluminum) and the composting of organic materials (such as yard waste and food waste), which together with landfills and incinerators are considered part of what is referred to as "integrated solid waste management" (ISWM). By splitting the solid waste into these various streams, many municipal solid waste management administrators consider that they are implementing sustainable waste management. However, as long as the community is not fully engaged in decision making, the market and economics of these various treatments remain the critical factors in the decision-making process and landfills and incinerators remain the largest components of the ISWM practice, while the health and socioeconomic well-being of the communities remains vulnerable.

It is estimated that Americans produce four to five pounds of trash per day per person. The EPA estimates for 2006 indicated that approximately 250 million tons of municipal solid waste were produced in the United States. Of this trash, more than two-thirds was either paper, yard waste, food waste, or plastics, which could be recovered and recycled or composted. Another 8 percent was metals and 5 percent was glass that could also be recovered and recycled. However, nationally, about 33 percent of this trash (as of 2006) was recovered for recycling or composting, while 55 percent and 13 percent went to landfills and incinerators, respectively. However there are some U.S. cities that achieve a 50-percent recovery rate, while Edmonton, Canada, achieves a 65-percent rate. This marks a contrast with developing nations in which, because of the nature of their economies, most of what is recyclable is recycled by the population in order to secure additional sources of income, while most of the organic waste reaches the landfill.

Industrial Waste

Municipal solid waste is supposed to be limited to household waste plus institutional waste (for example, schools and government). However, it also incorporates commercial and industrial nonhazardous waste, for which businesses pay a fee and much of which ends up in landfills or incinerators. Nationally, the United States produces an amount of industrial solid waste that is about the same as that of municipal solid waste (approximately 250 million tons in 2006). In some cities with a significant manufacturing base, industrial waste can be one-and-a-half times the amount of municipal waste. This puts pressure on landfills, causing them to reach full capacity at a faster rate. A main goal has become to accomplish significant reductions in the amount of refuse that reaches the landfill or that is sent to incinerators.

Reduction, Reuse, and Recycling

In order to minimize the amount of solid waste that goes into landfills and incinerators, a concerted effort between government, the local community, and businesses needs to become standard practice. This involves the diversion of solid waste to alternative ways of dealing with the refuse. It involves a change of thinking by all three sectors in which a large proportion of the waste ceases to be considered waste but instead as raw materials. The life cycle of the refuse is studied and instead of analyzing it as a "cradle-to-grave" waste disposal problem, it becomes a "cradle-to-cradle" materials-handling issue. The solutions to waste management cease to be "end-of-pipe" solutions and become a life-cycle assessment (LCA). The three major components of this approach are the so-called three Rs: reduction, reuse, and recycling.

The reduction component entails the minimization of the actual amount of waste generated. A significant fraction of the waste generated by households comes from the packaging of purchased goods. When the manufacturers work at reducing

the amount of packaging, a concomitant reduction of the amount of waste is observed. Examples of other reductions can be the streamlined redesign of the product and the restructuring of the production process to generate less unwanted by-products. This is often referred to as green manufacturing.

The reuse component refers to the life span of the product. Returnable bottles are a well-known example, a practice that dates back many decades with the payment of a deposit for the bottle when a bottled drink is bought and the receipt of a refund when the empty bottle is returned to the store. In addition, a product that is replaced by a household can be used by another. This is the type of service provided by thrift stores that take in (frequently donated) goods such as older appliances, furniture, and clothes. These are then bought by other individuals, resulting in the extension of the life span of many goods. This is a common phenomenon in lower-income communities, both in advanced and in developing economies.

The third component, recycling, is the better-known and more controversial one. Composting of organic materials is frequently considered part of recycling. Many materials are recycled, including plastics, paper, newspaper, mixed paper, cardboard, and metals (such as aluminum, iron, and steel). The process of recycling starts with the collection of the sorted material either at the curbside or at collection stations. The materials are then transported to transfer stations, and the various types of material are redirected to the appropriate processing centers (known as materials recovery facilities, or MRFs). Finally, the processed, recycled material is sold to manufacturers.

The composting of organic waste, such as yard waste and food scraps, is similar to recycling because the materials are diverted from the landfills and incinerators into composting facilities. The material is processed in various ways over a period ranging from weeks to months, obtaining significant reductions in its volume and turning it into a different material, which is useful either as fertilizer or as a capping material for the surface of landfill cells.

Criticisms

Both composting and recycling have been subjected since the mid-1990s to scrutiny by economists, some of whom allege that these two alternatives are not economically viable when compared to landfill disposal or incineration. A relatively large series of factors enters into the elaboration of this economic picture. These economists argue that the costs of recycling are greater than the costs of simply disposing of these materials in the landfill, even after accounting for the sale of the recycled materials and the extra storage space that is saved at the landfill facility by keeping the recyclables out of the landfill. The reasons cited for this disparity are that the market for recycled materials is too small (and the prices exacted too little) because there are not enough manufacturers with the technology or the (financial) willingness to acquire the technology to accept recycled materials into their processes. In addition, the inconsistent supply of recycled materials scares manufacturers away from these materials.

Promotion Policies

In order to address these difficulties, local governments have enacted a series of ordinances and implemented economic regulations to favor the generation of recyclable materials and enhance the demand side of the economic picture. To enhance the rate of collection of recyclable materials, local government officials have conducted extensive campaigns to educate the population about the benefits of recycling. They have instituted curbside collection of recyclables. They have also used economic compulsion by instituting a fee per bag of solid waste collected to encourage households to reduce their landfill-destined solid waste through recycling, thus reducing the number of trash bags for which they have to pay for. On the enhancement of demand, governments have enacted ordinances requiring a minimum content of recycled materials on new products. In Germany, the Green Dot program requires manufacturers and distributors to take responsibility for their packaging. Businesses are required to collect, process, and recycle the packaging from their products. This is referred to as the "responsible entity" approach to solid waste management.

Business-oriented economists deride these responsible entity programs, but from the sustainable waste management point of view, this makes perfect sense since the power to change their pro-

cesses and waste practices resides at the point of production and not at the point of consumption. This approach coincides with the goals of sustainable waste management in more than one way because it also generates new jobs. For example, if 10,000 tons of computers are processed to recycle their components, 300 jobs can be generated, while the disposal of these 10,000 tons of computer refuse in a landfill produces just one additional job.

Recycling programs have matured since the 1990s, and the EPA's Office of Solid Waste asserts that the range of costs of efficiently run curbside recycling programs matches the range of costs of trash collection and landfill disposal programs, with room for improvement. Furthermore, citizens have consistently expressed a willingness to pay more to cover the costs of recycling programs to guarantee their continuity, a phenomenon that puzzles economists. However, from the standpoint of sustainable waste management, this makes sense. These are efforts to guarantee a healthier environment, which also lead to the generation of additional jobs. When local governments began charging for the new garbage collection and disposal programs in the 1960s and early 1970s (in rural areas), it came as a surprise to many citizens. However, in the early 21st century, few would dispute the necessity of garbage pickup and proper disposal and the need to cover its cost. The same kind of reasoning should be applicable to recycling and composting programs, for the many benefits that they bring.

Partnerships

There are innovative approaches that perform a systems analysis of the inputs and outputs that are generated by various businesses in which solid waste (concomitantly with the patterns of energy consumption/generation) is simply examined as one of many materials streams flowing from one type of business to another. This is termed *industrial ecology* (IE) because it tries to mimic the natural processes that take place in ecosystems in which the waste of some organisms merely becomes the feedstock of others. This approach requires interfirm cooperation and entails, as of 2010, voluntary compliance. Since businesses, beyond the public relations value that green branding has acquired, will only engage in practices that do not negatively impact their bottom line, they become attracted to IE practices because of the savings generated by implementing ecological efficiencies.

Thus, economists who question the costs of recycling programs not only ignore the urgency of expanding the cited benefits but also ignore in their analyses the fact that the production of virgin materials is subsidized by the state in the form of a variety of tax breaks. These virgin material subsidies have the effect of cheapening the virgin materials. Hence, subsidies to recycling programs act to level the field. Leaving the issue of how to better manage solid waste to the mercy of the vagaries of the market is a deficient strategy. For example, the market for recycled cardboard paper suffered a major setback during the recession of 2008. Thousands of tons of post-consumer cardboard were shipped from the United States to China every year, where it would be processed into new packaging for the goods that China exported to the United States. But as a result of the recession, Americans reduced their consumption of Chinese goods. This compelled the Chinese to stop importing cardboard for recycling, resulting in the generation of mounds of cardboard collected for recycling accumulating in warehouses in the United States. On the other end of the spectrum, during the recession of 1990, the collection of commercial solid waste dropped by 20 percent in New England, resulting in less material being available for recycling.

In order to reduce the impact of market fluctuations, a significant degree of participation by the local community is required. This participation includes a respect by the authorities and businesses of the input of the community in all aspects of solid waste management. This is the essence of sustainable waste management. When landfills and incinerators are placed near poor communities with a large composition of racial or ethnic minorities—vulnerable communities with lesser economic and political resources to resist these placements—the practice is termed *environmental racism*. This is the opposite of sustainable waste management. Communities began to fight back starting in the 1990s, when the harmful health effects of prevalent waste management practices became evident to community members. For example, the people of South Bronx (New York) formed a coalition with public interest

lawyers and various environmental justice groups to forge a sustainable waste management plan that would have compelled all of New York City's boroughs to become self-sufficient. The South Bronx was plagued by having become the transfer station for the solid waste of several boroughs. Eventually, the community of South Bronx and its allies were victorious in having legislation enacted that compelled each borough to handle its own solid waste.

Local governments, recycling businesses, and grassroots organizations have learned the lessons of partnership. The Penn South housing cooperative (in New York City) has a leadership with strong roots in the community and is able to successfully manage 2,820 apartments with 6,500 residents, oversee a staff of 150 people, run an active recycling program, and manage facilities that cogenerate electricity, heat, and hot water. All of these are performed with the explicit trust and acceptance of the community. On the other hand, Recycling Solutions, a New Jersey recycler of construction and demolition debris, that despite its mission to hire at-risk, inner-city youth, is barely able to stay afloat because it has not been able to find community support.

The benefits of sustainable waste management, particularly recycling, are many: energy savings (for example, 95 percent energy savings in recycling aluminum compared to mining and processing it), a reduction in the release of global warming–causing gases, air-quality improvements, resource conservation, job growth, and economic development. In 1998, the city of Edmonton, Canada, sent 85 percent of its solid waste to a landfill. By 2010, Edmonton had North America's largest collection of modern, sustainable waste processing and research facilities, with 81 percent of its citizens participating in the curbside recycling program. The Edmonton Waste Management Centre, in a 233-hectare site, has an MRF that processes 40,000 tons of recyclables annually, a composting building the size of 14 hockey rinks, an electrical and electronic waste recycling facility, a residential waste drop-off station, a construction and demolition recycling operation, a landfill, a leachate treatment plant, a landfill-gas recovery system, biosolids lagoons, and paper and glass recycling and biofuels facilities under construction. With this type of integrated solid waste management, the city of Edmonton is pointing the way toward a sustainable future.

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See Also: Archaeology of Modern Landfills; Composting; Economics of Waste Collection and Disposal, U.S.; Incinerators; Industrial Waste; NIMBY (Not in My Backyard); Recycling; Sustainable Development.

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Swimming Pools and Spas

The swimming pool, and to a lesser extent the spa, has long been a symbol of affluence and a critical amenity for hotels and resorts. Swimming for fitness is common at schools, health clubs, and military installations. According to the U.S. Census Bureau, swimming is the second most popular recreational activity—behind walking—in the United States. Residential swimming pools were a $6.9-billion industry during the first decade of the 21st century.

Many people believe that the ancient Romans invented the swimming pool, but they were actually latecomers to the idea. The earliest known sacred baths date to about 3000 B.C.E. in the Indus Valley,

and the ancient Greeks built swimming pools near their gymnasiums. Although "taking the waters" at fashionable spas had long been an activity for the affluent, modern swimming pools were introduced to the Western world by the British, who during the 1800s had experienced public baths in India and the Far East.

In many coastal cities, floating baths provided swimming facilities. These were simply barges moored alongshore with open bottoms. Changing rooms, benches, and diving boards surrounded the swimming area. In the polluted harbors of the era, exposure to floating sewage limited their popularity. Nonetheless, Boston, Massachusetts, operated 14 such facilities in 1901, along with 10 municipal beaches and two swimming pools. The first municipal swimming pool in the United States was in Brookline, Massachusetts, in 1887. During the 1890s, a hygienic reform movement in the United States encouraged cleanliness through regular bathing and exercise through swimming. Swimming as a sport gained popularity after the first modern Olympic Games in 1896. By the 1920s, there were several thousand public swimming pools in operation; about two-thirds were operated by Young Men's Christian Associations (YMCAs), colleges, schools, Boys' Clubs, and the remainder were commercially operated.

If swimming pools are drained into ponds or lakes, the chlorinated water can harm aquatic ecosystems. Almost all sterilizing agents must be disposed of as hazardous wastes. Chlorine can react with organic materials in drinking water to form carcinogenic compounds.

Prior to World War II, private, in-ground pools were reserved for the wealthy. A typical 20-by-40-foot residential pool cost at least $8,000 on the West Coast and more in the eastern states. The technology to apply concrete pneumatically was introduced in 1940 and cut the cost of a residential pool by as much as 75 percent. By 1963, advances in construction techniques lowered the price of a residential pool to an average of $4,000. By the mid-1980s, there were 2.6 million in-ground residential pools in the United States and an additional 2 million above-ground pools. Twenty years later, 8 million families owned a swimming pool, and there were an additional 5 million spas.

During the first decade of the 21st century, the average size of residential pools declined by 14 percent. In the early 1990s, 40 percent of new pools were 30,000 gallons or larger, and fewer than one-third were 20,000 gallons or smaller. However, as house sizes increased, the available land for pools and other outdoor amenities decreased.

Sterilization

Since an artificial pool has no source of freshwater, it is necessary to remove bacteria and foreign matter so that the water remains safe and pleasant for human contact. While chlorination emerged as the most popular form of sterilization, ozone, ultraviolet light, electrolytically generated silver ions, and a combination of alum and sand filtering were also in use. In the absence of other sterilization methods, water was simply filtered often and changed frequently.

The first recorded use of chlorine to sterilize a pool was at Brown University's Hoyt Pool. John Wymond Miller Bunker, a graduate student, applied "hyperchlorite of lime" to the pool in 1910. The results were spectacular; bacterial counts dropped by 94 percent in only 15 minutes.

By 1963, chlorination was used to sterilize 95 percent of U.S. pools. The active sterilizing agent is hypochlorous acid (HOCl). Hypochlorous acid is formed when diatomic chlorine reacts with water. The optimum chemical equilibrium for this reaction is found in slightly acidic conditions. However, since

acids would damage concrete swimming pools, most pools are maintained at a pH of 7.4–7.6. A number of materials release chlorine into water and have been used as a source of hypochlorous acid. One of the earliest was bleach, which is a 10–15 percent solution of sodium hypochlorite. Other substances used for sterilization include calcium hypochlorite, chlorine gas, and a number of chemicals made from chlorine and cyanuric acid. Sodium or potassium dichloroisocyanurates and a cyanuric acid stabilizer can be pressed into slowly dissolving tablets. Since hypochlorous acid can be destroyed by sunlight, most modern chemical formulations include an ultraviolet-absorbing additive. "Shock" treatments are used for short-term increases in sterilizing capacity. Those that lack the ultraviolet-protection additives are designed for use at night. Chemically similar brominated compounds are typically used for spa treatments.

The "chlorine demand" of a swimming pool is the amount of oxidizing agent required to destroy impurities present when the sterilizing agent is first added. What sterilizing agent remains after this occurs is called the residual chlorine. Most swimming pools are maintained at a residual chlorine level of two to five parts per million (ppm). The distinctive chlorine odor experienced in many pools is caused by chloramines—compounds consisting of chlorine and nitrogen. This is a symptom, not of excess chlorine in the pool, but an indication that there was not enough oxidizer to completely destroy the dissolved, nitrogen-containing organic matter.

In addition to sterilizing agents, typical categories of pool chemicals include pH control compounds, algaecides, stabilizers, and flocculating agents. Algaecides are usually copper sulfate or quaternary ammonium compounds. The former had an unfortunate tendency to turn swimmers' hair green under the right conditions. Injuries from the misuse of pool chemicals are common. These include skin burns, accidental poisoning, and splashes in the eye. The first signs that pool chlorination might have more serious adverse effects on human health and the environment came in 1974 when it was discovered that chlorine could react with organic materials in drinking water to form carcinogenic compounds. While the concentrations of these compounds are low in pools, this discovery created consumer demand for chlorine-free pools.

A popular alternative to conventional chlorination is the use of a saltwater-chlorine system, which electrolytically generates a small amount of chlorine gas to be fed into the water. While this is not a chlorine-free system, it does eliminate the need to handle large amounts of potentially hazardous chemicals. Ultraviolet light, ozone, and silver/copper ion generation systems have also been sold in response to this concern. In Europe, a number of pools have been constructed with a secondary basin filled with aquatic plants, which purify the water. This system requires pumping water between the swimming and purification basins, and it also requires occasional chemical treatments.

The principle adverse environmental effect of swimming pools and spas is that if they are drained into ponds, lakes, or rivers, chlorinated water can harm fish and other aquatic life. Almost all sterilizing agents are oxidizers and must be disposed of as hazardous wastes.

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See Also: Cleaning Products; Household Hazardous Waste; Pollution, Water; Water Treatment.

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Switzerland

A financial and geographic center in western Europe (and European Union member state), Switzerland borders several (France, Italy, Germany, Austria, and Liechtenstein) of the most developed

nations on the continent. The United Nations' Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was opened for signature in the Swiss city of Basel in 1989. Beyond that important milestone, consumption and waste patterns in Switzerland are representative of wealthy nations.

Per capita income rates are among the highest in the world. Differences between high and low salaries are, however, also significant. Differences regarding wealth ownership are even more staggering, with 3 percent of the population owning 54 percent of wealth. The savings rate is very high in Switzerland (about 14 percent of net income), meaning a considerable part of income is saved and not spent. Accordingly, the Swiss are rarely in debt, and when they are, it is frequently because of real estate purchases.

Prices and Consumption

Switzerland is a high-priced zone. Living costs are high compared to other European countries. Average Swiss consumers are not very price sensitive but are rather more concerned with the quality of goods. Even discounter retailers feature items with "premium" and "organic" labels. At the same time, consumption is not supposed to be ostentatious. It is common that brand labels are cut off from clothes after purchase and signs indicating the motor specifications on luxury cars are removed at the sale of a vehicle. Preference for quality cars and also for the best available configuration makes the Swiss car fleet one of the dirtiest. The average fuel consumption per vehicle is higher than elsewhere.

Due to changing demographic composition and lifestyle, Swiss consumption patterns are gradually adjusting toward the rest of Europe. Many of the protection measures making Switzerland a high-price islet had already fallen as of 2010, and others are bound to disappear; for example, Switzerland will introduce the Cassis de Dijon principle in the early 21st century. But the discussion on how to preserve high-quality standards in produce for Swiss consumers, especially in relation to food products and domestic agriculture, is lively. Swiss consumers do not want to abandon their standards concerning genetically modified organism (GMO)-free foods, local and organic produce, and labor rights. The market for edibles is especially sensitive and needs to be very transparent and correct. Swiss consumers are easily spooked by health scandals and rumors, and affected products need months—if not years—to recover sales.

The main energy sources in Switzerland include oil, natural gas, coal, nuclear power, water power, solar power, wind energy, bio-energy, garbage and industrial wastes, and ambient heat. In the summer energy is exported, and it is imported from neighbors in the winter. Since the 1980s, Switzerland's energy consumption has been increasing at a rate of 2 percent. The highest energy consumption is for transportation and households, making the Swiss high energy consumers. However, because of the weak economy and warm weather of 2009, energy consumption fell by 2.5 percent. There is an increase in the use of renewable forms of energy, especially with the government's two main energy policy priorities to promote the use of renewable resources and encourage efficiency.

Garbage Collection and Recycling

Switzerland produces about 1,587 pounds (lbs) of garbage per person in a year. The garbage is collected in bags or containers. By federal law, the producer of garbage is responsible for its safe disposal. This means that each municipality sells a color-coded garbage bag on its territory, which is to be used for garbage disposal. Hence, during garbage collection, only regular bags are collected. The sale price of garbage bags must thus cover the costs of garbage disposal. The application of this principle has led to a formidable drop in garbage collected. The collected garbage is burned in special furnaces at garbage disposal plants, mostly owned by intercommunal confederations. Only the residues of the burned garbage are deposited. The deposition of household garbage is no longer permitted.

Garbage separation is strongly recommended in Switzerland. Of the 1,587 lbs of garbage collected per person per year, only 772 lbs are collected as household garbage for burning. The rest is separated for recycling. Paper is collected for free, usually about once per month. For glass and metal, there are collection points where glass bottles and tin as well as aluminum cans are collected for recycling. Electric appliances and electronics are sold

with a precollected disposal fee. Once their life cycle is over, these items can be brought back to any shop that sells similar items. The fee for the disposal has already been paid at the purchase. PET bottles are also specially collected by shops that sell them.

Organic waste is collected in some municipalities, while others mainly rely on composting. They deliver the means to compost and provide instructions. In the early 21st century, collected organic waste is much sought after by biogas plants. Bulky waste is collected by municipalities, sometimes for free but sometimes for fees. The separation of waste into different components has been very successful in Switzerland, but it also causes problems. Because garbage collected is usually completely devoid of paper, it does not burn on its own. In order to process it in a waste burning plant, fuel has to be added to permit proper burning.

Waste burning plants are generally connected to distant heating systems. The plant produces steam, which is then used to heat facilities and/or households. Most of the garbage disposal plants belong to public utilities or cooperatives uniting different municipalities for this purpose. There are some private actors in garbage collection, but the bulk is collected and disposed of as part of the public sector. Garbage and waste have to be treated in Switzerland. It is illegal to move garbage out of the country for disposal.

Contaminated sites that were formerly used for waste disposal have been mapped and registered. If they are to be used again, they have to be decontaminated beforehand. A contaminated site cannot be built-over before decontamination, even if it is a deposit of inert materials. Much effort has gone into the decontamination of heavily polluted sites dating to the 1950s and 1960s. These very costly procedures had to be financed by the former polluters. Public pressure was needed in order to make various industries move forward with decontamination of their former deposition sites. The process is ongoing, and there remain concerns about sites contaminated by industrial waste, putting drinking water resources in danger.

Littering and Education

Cleanness is a highly valued etiquette in Switzerland. The propriety of roads and public spaces is often discussed, and resources are used to keep them considerably clean. In fact, sometimes the Swiss are said to be "obsessed with propriety." Public littering has, however, become a problem, and larger municipalities are engaged in an uphill battle to keep their public sphere in a reasonable state. Cities have already given up trying to return to former levels of cleanness. They try with education, posters, containers, and accelerated cleaning as well as anti-littering fees to combat the phenomenon.

Switzerland includes teaching about issues of waste and garbage into the school curriculum. Schoolchildren are invited to visit garbage disposal furnaces and water-cleaning facilities. They are accompanied by their teachers and specially informed tutors made available through an association. The program is financed through the garbage disposal cooperatives. It is deemed very important to educate children from the youngest age in the issues of garbage avoidance and correct disposal.

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See Also: Consumption Patterns; Economics of Waste Collection and Disposal, International; Incinerators; Recycling.

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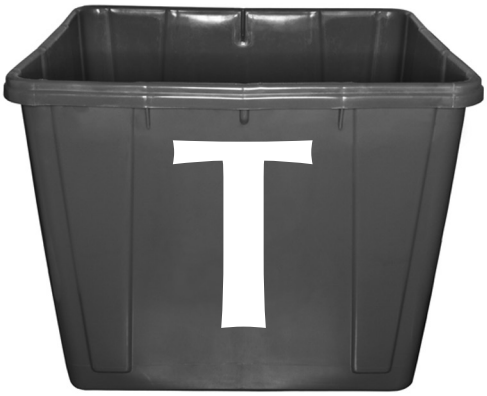

Television and DVD Equipment

Television encourages waste through its constant stream of advertisements, urging viewers to buy the new best thing. In order to make room for new products, consumers must waste old products. Installed into people's homes where domestic decisions are made, television is the most driving force in culture encouraging the cycle of consumption and waste. However, few people stop to think about the waste of the television sets themselves or the DVD equipment once viewers have moved on to the bigger, newer, high definition (HDTV), or 3D technology. With few options for recycling, televisions and DVD equipment are often disposed of in landfills, where hazardous chemicals can leach into the soil, air, and water as well as affect workers. Some U.S. states are taking action, creating programs and initiatives aimed at consumers and manufacturers to encourage recycling. Much of the television waste is illegally traveling overseas to developing nations, causing serious environmental hazards.

In a *Consumer Reports* survey, consumers in the United States who replaced their televisions in the past year gave the following reasons: (1) one-third replaced a television that had stopped working, (2) one-quarter replaced a television because the screen was too small, (3) one-quarter wanted an additional television, and (4) one-fifth wanted an HDTV for higher picture quality.

These are all legitimate reasons for procuring a new television, all of which illustrate desire inherent in a culture of consumption. According to the Environmental Protection Agency (EPA), 25 million televisions are disposed of in the United States each year.

Television and DVD equipment are a subset of electronic waste (e-waste). E-waste includes unwanted electronic devices that have been disposed of, such as computers, cell phones, printers, and televisions. Unwanted electronics are amassing in landfills at an alarming rate because of the rapid progression of technology and the need to replace older technological items. Television and DVD equipment are a global e-waste and environmental concern, with processing plants, recycling facilities, and landfills in developing nations filled with the TV waste from developed nations throughout the globe.

The cathode ray tube (CRT) in televisions contains five to eight pounds of lead, which can pose serious health hazards to sanitation workers and

the air, soil, and water in and around landfills. However, people are phasing out older CRT televisions in favor of newer and lighter liquid crystal display (LCD), plasma, and light-emitting diode (LED) televisions. CRT, LCD, plasma, and LED televisions and DVD equipment can contain hazardous chemicals such as mercury, arsenic, cadmium, chromium, beryllium, and brominated flame retardants (BFRs), while also posing the environmental problem of the massive amount of nonbiodegradable plastic that is sitting in landfills.

Technological Advances

In 2009, the United States transitioned to digital television, meaning that analog signals were no longer sent through the air—only digital signals. Roughly 15 percent of television viewers in the United States still receive their signals through free, over-the-air broadcasts. Approximately 19 million analog, CRT television sets were still in use as of 2010. For those who received their signals via cable, satellite, or the Internet, no change was needed. However, for that 15 percent watching over-the-air signals, either a converter box or a new television set was required. This prompted a rise in sales of new televisions and an increase in CRT televisions in landfills.

In 2009, consumers spent more than $25 billion on 30 million HDTVs. Similarly, high-definition Blu-ray players prompted the replacement of older DVD players and DVDs, amassing more players and discs in landfills. 3D technology threatens to replace these newly acquired HDTVs, discs, and players soon after they were bought. 3D televisions were beginning to enter the marketplace in 2010. ESPN broadcast the 2010 FIFA World Cup in 3D. If consumers want to view such broadcasts, they must have a 3D television. If they want to watch their new 3D Blu-ray discs on their 3D television, then they must buy a new 3D Blu-ray player.

New audio-visual (A/V) receivers will also need to be purchased, as existing A/V receivers do not work with the new 3D technology. The continuing cycle of electronic disposal and acquisition fuels sectors of the U.S. economy. However, it poses serious environmental and waste issues, as the 3D transition will fuel a large amount of hazardous e-waste. As much of the developed world has few channels set up to allow or encourage recycling of e-waste, this waste often ends up in landfills.

Recycling and Disposal

About 97 percent of television contents can be recycled or reused. Nonetheless, the EPA estimates that only 15–20 percent of e-waste is recycled, with approximately 80 percent of televisions disposed of in the trash. The infrastructure for recycling is small to nonexistent, often making it difficult for well-meaning citizens to find ways to recycle their television and DVD equipment.

There are no federal regulations in the United States forbidding the disposal of television and DVD equipment in landfills as household waste. Some states are passing regulations on recycling televisions, and some are aimed specifically at CRTs. They take two different forms to fund the programs: fees for the consumer, or fees for the manufacturer. The first law of its kind was instituted by Maine in 2004. It requires manufacturers to pay fees based on the waste generated by its products, which encourages manufacturers to produce products with less waste. Cities and towns are required to provide a system for residents to drop off televisions and computer monitors at a centralized location. Roughly 60,000–100,000 televisions and monitors are collected each year.

California requires buyers of televisions and computers to pay a small recycling fee, which helps pay for an electronics recycling program. In 2006, California became the first state to ban the disposal of electronics in household trash, including televisions and DVD equipment. Massachusetts, Minnesota, and New Hampshire banned the disposal of CRTs in landfills, incinerators, or both.

Transportation and Bans

Once televisions and DVD equipment are collected—and very few are collected for recycling—the question is raised as to what really happens to the items. Developing nations recycle televisions and DVD players, mostly for the metals that may be inside them, such as copper wiring. TVs and players may contain circuit boards and microchips, which contain toxic chemicals such as cyanide, or use open smelting processes in order to break down and access the individual metals. These release even

Cities and towns are required to provide a system for residents to discard of unwanted televisions and computer monitors at a centralized location. Some municipalities require residents to pay a recycling fee, which helps pay for the program. Once recycled, about 97 percent of the contents of a television can be recycled or reused. Although about 60,000 to 100,000 televisions and monitors are collected in the United States each year, only a minority of televisions ever make it to a recycling center; approximately 80 percent are put in the trash.

more toxins into the surrounding environment. A landmark 1992 agreement signed by 170 countries—the Basel Convention on the Control of the Transborder Movement of Hazardous Wastes and Their Disposal—bans the transport of hazardous wastes, including televisions and DVD equipment, across national lines. Violations are commonplace even by nations that have signed. For example, in 2006, Canadian federal agencies seized 50 containers of e-waste bound for China at the Port of Vancouver. Canada is a strong proponent and signatory of the Basel Convention.

The United States has refused to sign the agreement. By 2010, CRTs were the only e-waste that the EPA considered hazardous and forbid transport across national lines. All other forms of e-waste can be legally exported from the United States. Nonetheless, during testimony before the U.S. House of Representatives Subcommittee on Asia, the Pacific, and the Global Environment in 2008, John Stephenson testified that in an undercover operation posing as buyers from Hong Kong, Singapore, India, and Pakistan, he found 43 U.S. electronics recyclers who were willing to export to him broken or nonworking CRTs, which would violate the EPA's rule.

The United States and United Kingdom are the two largest producers of e-waste in the world. The European Union created a directive that laid out the responsibilities of manufacturers in the collection, disposal, and recycling of e-waste. It is called the Waste Electrical and Electronic Directive. The Restriction of Hazardous Substances (RoHS) directive, however, has begun to change the game worldwide.

The RoHS requires manufacturers to comply with agreed-upon levels of hazardous chemicals in new electrical and electronic products. For example, new televisions are required to have much less lead in them. Since manufacturers had to comply with RoHS for the European market, they released compliant products in other markets as well, lowering

the amounts of hazardous chemicals in televisions worldwide. RoHS began in 2006, and now electronics worldwide were compliant as of 2010. Still, further progress can be made, but the resolution has helped create global progress.

Two prominent television manufacturers, Sony and Samsung, have pledged to phase out the use of hazardous chemicals in televisions. However, there are no agencies to monitor compliance or pressure other companies to find more environmentally friendly technological solutions.

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See Also: Audio Equipment; Consumerism; Household Hazardous Waste; Toxic Wastes.

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Tennessee

Tennessee is a state in the southern United States. The eastern half is largely mountainous, as the Appalachian Mountains run through it and the Mississippi River forms the state's westernmost border. With 42,143 square miles and a 2010 population of 6,346,105, its density is 19th among American states. Tennessee's economy includes agriculture, tourism (based in part on the scenic mountains of the east and in part in the rich musical heritages of the cities of Nashville and Memphis), and transportation. The Memphis International Airport in the southwestern corner of the state serves as an important transit center for air cargo as it is a hub for the FexEx Corporation.

Tennessee generates approximately 13.5 million tons of solid waste per year. Where does all this waste go? Tennessee's westernmost city, Memphis, is notable for important developments in U.S. waste history in the 19th and 20th centuries. The city was plagued by yellow fever epidemics during the 1870s, losing one-tenth of its population to the disease in 1873 alone. Five years later, an epidemic reduced the population by 75 percent due to deaths and residents fleeing, and the city lost its charter temporarily. In response, the National Board of Health brought investigators in to develop a modern sewage system, developed under the principal investigator Col. George E. Waring. This began a series of improvements in the city's public sanitary systems over the following century, including the development of garbage collection services through the Department of Public Works.

The department grew substantially after World War II, hiring primarily African American men to collect the city's garbage. Due to declining work safety conditions and the mayor's refusing to recognize the workers' right to organize, the Public Works Department went on strike in early 1968. Dr. Martin Luther King Jr. joined the strike, attracting international attention. While the strike is most famous for King's assassination (which was quickly followed by the city's offering a contract to the workers), it also marked an important linking of the civil rights movement and the labor movement over waste issues. In the past, Tennesseans largely relied on burning waste in backyard piles or dumping in rural zones, creeks, or unofficial and city dumps. As the population rose, so did solid waste disposal. The ever-expanding convenience packaging associated with throwaway, one-serving items significantly heightened the degree of waste.

By the mid-1980s, the waste stream was overflowing. City and county governments were managing their waste in a myriad of ways, some providing removal services to landfills that lacked liner systems, leading to seepage into groundwater. Many cities and counties did not provide any services to their citizens. Even as of 2000, only 29 of Tennessee's 95 counties offered collection services. Of the 13.5 million tons of trash that Tennesseans produced in 2008, about 6.5 million tons were disposed of in Class I (sanitary) landfills and seven million tons were recycled. This means that individual Tennesseans are producing about one ton of trash every year. While the numbers are outstanding, managing

waste in Tennessee has improved, down from 1.3 tons of waste per person in 1995.

Improvements and Reduction

Federal mandates to improve waste management have led to improvements in landfilling. Since 2000, over 50 of the state's public landfills have been closed. Those closed lacked modern liners designed to prevent seepage of contaminated liquid into groundwater. As of 2009, there were 35 Class I (sanitary) landfills in the state of Tennessee, 19 of which were publicly owned. These landfills all contain the federally mandated liner systems and can manage an increased volume of waste.

Despite improvements to landfills, over 90 percent of Tennessee's municipal solid waste still ends up in one of the state's 35 Class I landfills, in one of 68 operating Class II and IV (construction and demolition) landfills, or in one of the two incinerators in the state (one in Nashville, one in Sumner County). This disposal figure represents post-recycling and reduction techniques, which divert 21 percent from the waste stream. The millions of tons of materials that could be recycled each year but are instead buried, represent unrealized jobs and lost tax revenues for local governments.

In 1989, the Environmental Protection Agency (EPA) set a national waste reduction and recycling goal. Tennessee followed suit with its own 25 percent reduction goal to be achieved by December 31, 1995. This reduction goal was part of the 1991 Tennessee Solid Waste Management Act (TSWMA), which was the first comprehensive solid waste planning legislation in Tennessee history. The TSWMA mandated long-term solid waste planning, with an emphasis on reduction and recycling. Its passage transformed a prior emphasis on disposal as a primary strategy to a last resort by introducing a $0.75–$0.85 surcharge on every ton of solid waste disposed of, a $1 predisposal fee on new tires, and disposal plans for special wastes, including household hazardous wastes, motor oil, and tires. County convenience centers for citizens to bring waste and recyclables were established throughout the state.

Unfortunately, Tennessee did not meet its waste reduction goal. Some would argue that the state's inability to meet its goal is because its citizenry is slow to achieve an ethic of conservation and resource stewardship. Jack Barkenbus of the Institute for a Secure and Sustainable Environment at the University of Tennessee, Knoxville, cites two examples of the lack of this ethic. First, unlike many states across the nation, Tennessee has yet to adopt a ban on the disposal of yard waste to landfills. Second, by 2006, only two communities (0.5 percent of all communities in the state) had adopted a pay-as-you-throw disposal system, where households pay on a sliding scale depending on the amount of waste they produce. Conversely, more than 7,000 U.S. cities have adopted some variation of pay-as-you-throw. In October 2010, the City of Memphis joined this small percentage, implementing a volume-based pricing solid waste management program. Additionally, while convenience centers were established in the 1990s, there were only 506 operating centers located across the state as of 2010, thus remaining few and far between.

Recycling

Tennesseans recycle approximately 1.3 tons of material in the top four commodity groups (fiber/paper, plastic, glass, and metals). About half of all Tennesseans compost their yard waste, and 67 percent recycle. Recycling behavior in the state has drastically improved from the late 1980s, when only about 40 percent of Tennesseans recycled. One effort to increase recycling is the proposed Tennessee Bottle Bill, which would introduce a $0.05 deposit on beverage containers. Shelby County heavily endorsed the bill, which saw no action in the House or Senate in 2010. Proponents of the bill argue that its passage would lead to an increase in recycling behavior to 80 percent. Increased recycling has positive environmental and economic impacts. In 2008 alone, more than 44 trillion Btus of energy were saved as a result of recycling in Tennessee. Further improvements to statewide recycling initiatives would result in new revenue streams and localized jobs, a dire need for a state with an average unemployment rate of 10.4 percent.

Programs

Since 2000, a number of state-level programs and initiatives have been introduced to further reduce waste. The following five are a selection of contemporary efforts. First, Development District

grants are available to assist local governments in upgrading their solid waste programs, systems, and facilities and to establish composting and recycling programs. Second, the State Employees Recycling Program (SERP) has recycled over 16,000 tons of mixed office paper since 2000, generating well over $150,000 in revenues that were diverted from landfill disposal costs and into purchasing new equipment for solid waste management. Third, the Tennessee State Park system has recycling programs in over 75 percent of its parks. Fourth, the Tennessee Solid Waste Education Project (TNSWEP) offers educational workshops and training sessions for students, teachers, and local officials on the topics of recycling, reduction, conservation, environmental protection, and solid waste management. Fifth, the Tennessee's Social Chemical Cleanout Campaign (SC3) coordinates cleanouts to inventory and to remove potentially hazardous materials from K–12 schools.

Hazardous and Industrial Waste

Hazardous waste disposal is a critical issue in Tennessee at both household and industrial levels. The average home in the state of Tennessee produces 20 pounds of household hazardous waste each year. Residents of Chattanooga, Knox, Nashville, and Shelby counties have permanent collection sites for hazardous waste; residents of other counties must rely on Tennessee's Mobile Collection Service. Since the program's establishment in 1993, there have been over 975 one-day collections, servicing 301,000 households and collecting more than 20 million pounds of hazardous waste. In rural parts of the state, open burning remains common. Open burning of vegetation, paper, and cardboard is permitted in all counties except Shelby, Davidson, Hamilton, and Knox, if waste collection service is not available. While permitted, backyard burning has health consequences because the smoke from open burning can cause breathing difficulties, especially to those who suffer from asthma and other respiratory conditions. Moreover, backyard burning releases more pollutants than municipal incinerators because they operate at lower temperatures (400–500 degrees Fahrenheit [F] compared to more than 1800 degrees F).

At the industrial level, Tennessee is burdened with ash and sludge waste from its eastern mines. Ash and sludge toxic waste contains uranium, mercury, arsenic, and other heavy metals. In December 2008, more than one billion gallons of toxic sludge spilled into the surrounding rivers and land in the Tennessee Valley Authority (TVA) ash spill disaster in Kingston, Tennessee. Gregory Button's research on the spill shows how the disaster is a contemporary example of environmental injustice in waste management and cleanup. The EPA did not conduct a complete and meaningful justice review, which would have considered a host of factors, including public health, social costs, and welfare impacts. Instead, the TVA underreported the magnitude of the spill, declaring the situation safe despite the hazardous nature of ash and without any scientific studies conducted to assess the imminent harm to public health or the environment. Button's work led to a successful petition drive to have the Agency for Toxic Substances and Disease Registry (ATSDR)—a federal agency in the Centers for Disease Control and Prevention under the Department of Health and Human Services—conduct a long-term assessment of the impact of the spill.

Environmental Justice

Of the nine regional environmental justice coordinators of the Sierra Club, one is located in Memphis, Tennessee, a testament to the degree of polluting industries in the western region of the state. Memphis has a majority African American population (approximately 62 percent of the city's population). The majority of the Sierra Club's "2010 Terrible Ten" report for Memphis found the worst industrial polluters to be located in minority populations and low-income neighborhoods. In addition to chemical pollutants, these neighborhoods suffer from the siting of wastewater treatment facilities and must bear the burden of a decreased quality of life associated with foul odor. There is also a concern with seepage into the groundwater.

Central Tennessee has also struggled with environmental injustice. For example, in 2007, Sheila Holt-Orsted of Dixon filed a class action lawsuit against the county's contaminated landfill for lack of notification that their water was contaminated with cancer-causing agents. While major improvements in solid waste management and recycling behavior have occurred, statistics on consumption suggest that Tennessee should focus on reduction. The Consumer

Price Index, a statistic that captures consumption of food, clothing, shelter, fuels, transportation costs, medical services, drugs, and several other goods and services that individuals purchase on a daily basis, rose by 0.2 percent in the south over the course of 2010. Consumer education programs that emphasize the 3Rs (reduction, recycling, and reuse), combined with efforts to incorporate sustainability into both K–12 and higher education curriculum, are essential to truly decrease the waste stream.

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See Also: Coal Ash; Open Burning; Recycling; Solid Waste Disposal Act.

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Texas

The history of the state of Texas' natural resource protection has evolved from protecting surface water rights to protecting public health and conserving natural resources for future generations of Texans.

Texas is the largest state in the contiguous United States, measuring 268,581 square miles; it is second to Alaska in area, and second to California in population. As of the 2010 census, over 25 million people lived in Texas. The state has several major population centers and a varied geography. Natural resources are diverse; agriculture and fresh- and saltwater, wind, minerals, and wildlife have all played a part in shaping the environment. From early ranching and cattle drives, railroad expansion, and development of coastal counties along the gulf, rural Texas has increasingly become urban. In tandem with developments in the rest of the country, environmental efforts in Texas have broadened to include the regulation of hazardous and nonhazardous waste.

Waste Expansion

Texas grew with the west after gigantic oil strikes in the southwest and California at the turn of the 20th century led prospectors to vast oil fields in Texas. The city of Houston in east Texas grew steadily from its founding in 1836, primarily as a railroad hub for exporting cotton. Growth accelerated rapidly after prospectors discovered a rich deposit of oil under Spindletop Hill in Beaumont. They quickly developed the Spindletop oil field, triggering a wave of speculation, drilling, and investment in Texas. The energy industry has dominated the state's economy and environment ever since; oil production averaged 3 million barrels per day at its peak in 1972. The transportation of millions of barrels of petroleum through the state's wells and refineries has produced significant air and water pollution problems, as well as vast amounts of wealth. As early as the 1920s, oil spills into the state's waterways attracted the attention of other industries that relied on water transportation, and, ultimately, the attention of the U.S. government. The U.S. Bureau of Mines conducted a survey in 1922 and 1923 that found the waters near Port Arthur and Houston to be the most polluted with oil of any waterway in the United States. While oil produced significant growth throughout the state in the early 20th century, the state's economy grew during World War II as federal funding of military bases and infrastructure sparked industrial investments that subsequently included steel fabrication and natural gas production.

Major Cities

The start of the oil boom in 1901 had immediate effects on the state's largest city. Houston's population doubled between 1900 and 1910, reaching

78,800, with one-third of the residents African Americans. Both the population and geographical size of the city continued to grow over the next century, and by 2010, the city was the most populous in Texas, with more than 2 million people living on over 600 square miles. Tthis development was largely unplanned, and Houston is the largest city in the United States that did not adopt zoning practices. In the post–World War II era, the sprawling city had half the population density of Los Angeles. The metropolitan area, incorporating the surrounding suburban sprawl, hosted almost six million people, making the region the second most populated region in the state.

Other major cities in the state include Dallas, San Antonio (bolstered by military development), Austin (the state capital and also a center for the software industry), and El Paso, which shares the Rio Grande with the bordering Mexican city of Ciudad Juárez. The most populated region in Texas is the Dallas–Fort Worth metroplex in north Texas, home to almost 6.5 million people in 2009. The largest city in the area is Dallas, long a banking and finance center and home to about 1.3 million people. As is true of most of the state's metropolitan areas, sprawl dominates the Dallas–Fort Worth area and automobile traffic on I-20, I-30, and the area's other major roads clogs often enough that they are notorious for being the worst in the United States. In a December 2010 ranking of U.S. metropolitan traffic congestion, Dallas ranked last among 90 metropolitan areas for length of commute, averaging 28 minutes each way to work; Austin ranked 82nd. In the same survey, the Houston metropolitan area ranked 88th. Environmental problems in Houston represent many of the waste issues in this large and diverse state. As a center for oil production and refining, Houston not only faced significant levels of oil in its waters as early as the 1920s but also problems relating to the introduction of tetraethyl lead (TEL) in gasoline that same decade. TEL levels were not conclusively measured until the 1960s, by which time high levels were found throughout the Houston area.

Environmental Justice

Houston also has a troubling civil rights history relating to waste. Between 1920 and 1980, the growing city situated garbage dumps and incinerators in its largely African American neighborhoods. In 1979, residents filed the *Bean v. Southwestern Waste Management Corp*. lawsuit, the first in the United States to use civil rights law to challenge racial siting of waste. That movement sparked the careers of lawyer Linda McKever Bullard (the lead attorney) and sociologist Robert Bullard (her husband). Discussing local waste-siting patterns of the 1970s, Robert Bullard characterized Houston as replacing NIMBY (Not in My Backyard) with a PIBBY (Place in Blacks' Backyards) policy. In the years after the lawsuit, Bullard became a leader in the emerging environmental justice movement, noting similar developments in both urban and rural areas, publishing the landmark book *Dumping in Dixie*, and advising the Clinton administration in drafting environmental justice guidelines as the 1990s began.

Energy and Enron

In the 21st century, environmental challenges in both urban and rural Texas endure as the state's economy continues to grow. The state continues to be a powerful force in the energy industry, as indicated by the rise (and, due to systemic fraud, sudden fall) of Enron. Before declaring bankruptcy in December 2001, Enron owned or operated 38 power plants in the United States and its territories, United Kingdom, Central America, South America, European Union, India, and the Philippines, as well as natural gas pipelines across North America. One year before the company filed for bankruptcy, Enron traders began deliberately encouraging electricity suppliers in California to shut down plants for maintenance, resulting in dozens of blackouts and economic chaos. Despite Enron's collapse, Texas remained a center of energy, including some investments in renewable energy. Wind farms in Texas, while growing, represent a tiny fraction of the state's energy consumption, as fossil fuels continue to power Texas industry. Environmental challenges relating to water, air, and land pollution continue to plague the state.

Water, Air, and Land

Water issues in Texas range from the vulnerability of the Gulf Coast to petroleum refining and transportation (as became internationally known after the Deepwater Horizon disaster in 2010) to severe trans-

boundary pollution (including arsenic, mercury, chlordane, and human waste) of the Rio Grande.

Geographical variations cause large disparities in water sources in Texas; there are shortages in the western region of the state and an abundant amount of water in the east. Assuring adequate supplies of water for irrigation, industrial, and municipal needs is largely a regional issue.

Historically, water rights defaulted to the Texas landowners on whose land the water source was found. In 1967, the state legislature passed the Water Rights Adjudication Act, consolidating all surface water rights into a unified system by transforming previously held Spanish and Mexican grants, riparian water rights, and claims into "certificates of adjudication." In Texas, more than 90 percent of surface water had been adjudicated by 2010, and some rivers, like the Rio Grande, were actually overappropriated.

Air pollution in Texas is a serious issue. Texas has 60 percent of U.S. petrochemical production, 25 percent of the nation's refining capacity, and nearly 30 million cars on Texas roads.

Air quality levels in every corner of Texas consistently rank at the top of federal air toxic emissions lists, reflecting the state's large amount of petrochemical production sites. Houston and El Paso, cities on opposite sides of the state, are both "nonattainment" cities that do not meet federal standards for clean air. El Paso is the only city in Texas in violation of national standards for both respirable particulate matter and carbon monoxide. A 1990 joint study by the Environmental Protection Agency, Texas Air Control Board, El Paso City/County Health Department, and Mexican authorities found that the highest concentrations of particulate matter occurred in the highway along the international border and the densely populated, urban Mexican city of Juárez, Chihuahua. Houston has its own combination of pollution sources: an abundance of chemical industry and power plants, an expanding population in the millions, and high motor vehicle use. Since 1999, Houston has competed with Los Angeles as having the most polluted air in the United States, defined by the number of days each city violates federal smog standards.

Texans dispose of approximately 21 million tons of municipal solid waste (MSW) per year and pay more than $1 billion each year for the management of MSW. A study conducted for the Texas Commission on Environmental Quality showed that only 37 percent is commercial or institutional waste, and 63 percent of the MSW generated in Texas is residential waste. An average Texan generates about 5.6 pounds per day of MSW, compared to the national average of 4.3 pounds per person per day.

In Texas, landfills have been the predominant method of MSW disposal. Texas imports more MSW from other U.S. states and Mexico than it exports. Statewide landfill capacity is predicted to be adequate through 2050, though federal regulations to protect groundwater sources lead to higher landfill costs.

Texas is one of the worst states for soil erosion rates. Of the 32 million acres of cropland in Texas, more than 40 percent are classified as highly erodible. This contributes to the danger of groundwater being contaminated by agricultural chemicals or other types of pollution from landfills.

Environmental Action

The Texas Commission on Environmental Quality (TCEQ) is the agency responsible for enforcing state and federal environmental regulations, granting air and water operating permits to businesses. These permits define the types and maximum amounts of pollutants a permit holder may legally discharge into the air or state waterways.

The agency's 2010–11 Strategic Plan states goals such as increasing the percentage of polluted-site cleanups and decreasing the average time taken to respond to natural disasters.

The Texas Campaign for the Environment (TCE) is a nonpartisan, nonprofit citizens' organization that focuses on local and state issues. TCE works to inform and mobilize Texans to become environmental advocates, with actions such as helping pass a producer take-back law for computer equipment in 2007. TCE's focus is innovative recycling strategies, including programs to encourage manufacturer-based recycling; zero waste, which aims for product design that is either fully recyclable or fully and safely biodegradable; and evaluating the impact of poor landfill operations in Texas.

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See Also: Culture, Values, and Garbage; Economics of Waste Collection and Disposal, U.S.; Pollution, Air.

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Thailand

Thailand, encompassing a large part of central continental southeast Asia, shaped by a mountainous north, the plateaus and valleys of the Mekong and Chao Phraya rivers, and extending over the Kra Isthmus toward Malaysia, has a rich biological and cultural heritage. The country, which is a constitutional monarchy, prides itself on being the only southeast Asian country never to have been colonized; it is also one of the few countries in the world that could legitimately be considered Buddhist. These aspects are not often considered in international public discourse, but they shape lifestyles, and hence consumption, to this day in ways that are relevant to the deeper discussion of development and (or versus) ecological sustainability.

Brief History

Since 2010, Thailand has mainly been in the news because of its political turmoil. Even so, it has experienced strong economic growth of around 5 percent between 2002 and 2007. It is reminiscent—without being noticed nearly as much, though—of the 1990s, when Thailand was a leader among the Asian Tigers. These countries' economies were ostensibly showing the potential of economic globalization to increase gross domestic product (GDP) and modernize, that is, industrialize, the economies of countries that had been underdeveloped, a rise that was seemingly cut short by the Asian financial crisis of 1997–98 (in which Thailand again played a prominent, this time negative, role). Already in 2001, however, export-led growth resumed, buoyed by a weak currency, and combined with Keynesian state spending on large projects in an approach known after Prime Minister Thaksin Shinawatra as Thaksinomics. Growth continued (albeit, less strongly) despite the subprime crisis and the following recession in the United States and Europe. China's rise, however, overshadowed all others so that less international attention has been given to the continuing development of smaller countries such as Thailand.

Where "globalized" parts of the economy are concerned, then, Thailand has emerged as one of the centers for turning both local and imported resources into goods to be fed into the world economy. Textiles and footwear, jewelry, electrical appliances, computers, and even cars are produced in Thailand, predominantly for export (which accounts for two-thirds of GDP). Thailand also gained importance as an anchor economy supporting growth in its neighboring countries.

Economic activities based on local resources, presenting a direct consumption of land and productivity, continue to form major elements of the Thai economy. The two most noteworthy cases are

agriculture, in particular, production of rice, and tourism. Although they have lost their predominant position in the economy, they are integrated into aspects of the global economy and interact with traditional culture in ways that are highly interesting. They arose out of Thai cultural contexts and have given rise to major discussions about the meanings of development and have brought awareness to the tension between development and conservation, both natural and cultural.

Agriculture

The agricultural sector still employs 49 percent of the Thai labor force (down from 70 percent in 1980); major products are rubber, rice, and fishery products, especially shrimp. Thailand is, in fact, the world's largest exporter of rice, and it is the cultivation of this crop, in particular, that shows tensions. On the one hand, like all of Thailand's agriculture, rice growing has shifted from labor-intensive to mechanized, input-intensive agriculture. As recently as 2008, however, there had been reports of Thai farmers returning to the use of water buffalo for cultivation of rice fields, as rising gasoline prices cut into the earnings from rice sales. In 2010, however, according to the *Bangkok Post*, Thailand's stock of water buffalo had fallen from 6 million to only 1.3 million, as farming machines were (again) favored and consumption of buffalo meat was on the rise; but officials and Her Majesty the Queen Sirikit of Thailand urged farmers to use water buffalo more, in order to favor resilience against economic disruptions over short-term increases in yield.

The promotion of subsistence goes against the commercialization of agriculture that had its roots in the 1920s when farmers began growing more and more for the market, rather than for themselves. Now, the description of the population as engaged in either farm work or factory jobs is, to a considerable extent, misleading. Much farming is not for subsistence anymore, but (contract) farming for sale of the produce, and many people are also engaged in factory work or manufacturing (home) work, at least during part of the year. Through this commercialization of farming and deagrarianization of rural areas, the link between wealth and possession of land has been broken, if not even reversed. Furthermore, rural residents are not just the victims of new global forces, as they are often portrayed, but also actively shape their interaction with them. Nonfarm work offering higher wages, better opportunities for advancement, and less exertion is often taken over agricultural employment, for example. Not least for young women, who are usually the preferred factory workers, such work gives better chances for becoming "modern," with all the trappings of consumption that entails. In the case of contemporary rural Thailand, that still means televisions, refrigerators, and motorcycles.

At the same time, however, farming is traditionally upheld as an honorable way of life, at least in theory. In school, farmers are presented as the backbone of the nation, and (as in other countries) rural people are seen as living in community and

Rice growing in Thailand, which is the world's largest exporter of the grain, has shifted from the traditional labor-intensive system to mechanized, input-intensive agriculture. However, there have been recent reports of farmers using water buffaloes to save fuel costs.

more closely hewing to (other) traditions, whereas urban residents are modernizing and losing their traditions. Chatthip Nartsupha's *The Thai Village Economy in the Past* (Sethakit mubaan Thai nai odiit, 1984; English translation 1999) presented a favorable—if (re-)interpretative, rather than factual—view of Thailand's rural past, and a critique of the (particularly rural) present.

These descriptions of rural village life in communities with few modern problems had been taken up, for example, in the calls for a self-sufficient economy (*sethakit phor piang*) that were announced during the time of the Asian financial crisis and continue, as in the example of water buffaloes, to exert their influence.

Countryside Colonization

According to research, the combination of nostalgia for the rural life with the higher affluence of urban citizens has led not to a revival of farming (let alone subsistence farming) but rather to a colonization and gentrification of the countryside. Especially in the periphery of cities, housing estates presenting themselves as new kinds of old-style villages have re-created (or rather, invented) an imagined form of traditional country living. The intermingling of housing developments and rural factories with farming areas meanwhile has been leading to problems for the remaining farmers (where such remain), as land prices rise, drainage is changed, and waste effluent pollutes rice paddies and fish ponds.

The conflict between the desire for a good life (including economic growth and personal consumption similar to perceived Western standards) and what are argued to be better, more traditional, and authentically Thai lives is especially apparent in tourism. Authenticity is a highly prized—if not essential—asset, especially when it comes to tourist visits to the "hill tribes" of the mountainous northern parts of the country. Development and deagrarianization are also desired and occurring in these parts, however—and with them, changes in lifestyles as well as the rural countryside. Thus, tourists' consumption of the countryside rests on an authenticity that the very nature of tourism changes, and that has been changing for decades with economic development. The problem may be even more striking when it comes to the well-known side effects of tourism in Thailand. People are not only consumers but also human resources of a country—and here, they have come to form a significant part of the national economy through prostitution and sex tourism. Estimates from the last two decades suggest that income from the sex trade was responsible for about 3 percent of the national economy.

Buddhism

Changes in rural life and the countryside, as well as increased consumerism in the average Thai lifestyle, have not gone without critique. Given the state of Thailand as a predominantly Buddhist country—Theravada Buddhism is the defacto national religion, with 94.6 percent of the population belonging to it—it is not entirely surprising that such critiques, as well as calls for conservation of nature and a return to traditional modes of living, have also come from this religion. The engagement ranges from socially engaged Buddhism, a widely recognized representative (and initiator) of which is Sulak Sivaraksa, recipient of the Right Livelihood Award in 1995, to the work of Thailand's "ecology monks" (*phra nak anuraksa*).

This development within Buddhism is noteworthy because the religion has, for a majority of its lay adherents in Asia, been a matter of faith and tradition, rather than the rational alternative to Christian belief it is seen as in the United States and Europe. As such, it has not necessarily been very engaged, particularly in rather-more-political contexts. However, its tenet that attachment to and desire for things is at the root of human suffering has found some interest in anti-consumerist circles, and it finds particular (though by no means resounding) resonance in the Thai context, where it is a tradition that young men spend at least some time in a Buddhist monastery, and where it fits in only too well with the nostalgia for older, authentic Thai lifestyles founded in subsistence agriculture.

Buddhist "spiritual ecology" plays a role not only in development discourse and associated discussion about consumption, but especially in the more down-to-earth issue of conservation. Thailand's rapid deforestation and the effects public policy and environmental degradation associated

with it have had on rural people and their livelihood have been at the root of the practice of the "ecology monks." Upholding the sanctity of all living beings and the traditional role of forests in Theravada Buddhism as places of meditation, these monks have, through the "ordination" of trees, among other practices, given impetus to forest conservation and the larger environmental movement.

More recently, the 2004 tsunami strengthened the discussion of conservation for coastal areas, with the observation that areas that had not been cleared of mangrove forests in favor of shrimp farming had suffered less impact. As everywhere, though, it remains to be seen how the country's economy and society will develop in the future. As the Thai example shows, the intermingling of cultural traditions, perceived tradition, modernity, and development will probably form the particular context in which growth will take place, not a unified global form of development.

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See Also: East Asia (Excluding China); Garbage, Minimalism, and Religion; Sustainable Development.

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Thallium

Thallium (Gr. *thallos*, a green shoot or twig, Tl; at. wt. 204.3833(2); at. no. 81) is treated as a hazardous substance. Sir William Crookes discovered thallium spectroscopically in 1861. The metal is very soft and malleable and can be cut with a knife. Forty-seven isotopic forms of thallium, with atomic masses ranging from 179 to 210, are recognized.

It is not a rare element—for instance, it is 10 times more abundant than silver. In natural deposits as ores, thallium is found together with other elements. One of the biggest natural deposits is located in Macedonia. The element is widely dispersed in potassium minerals, such as sylvite and pollucite. Thallium minerals are rare, but a few are known, such as crookesirte and lorandite. Man-made sources of thallium pollution are gaseous emissions of cement factories, coal-burning power plants, and metal sewers. The leaching of thallium from ore-processing operations is the major source of elevated thallium concentrations in water. Thallium is a trace metal associated with copper, gold, zinc, and cadmium. Thallium does not long persist if released to water, but does have a strong tendency to accumulate in aquatic life. If released to land, it may bind to alkaline soils but may otherwise migrate to groundwater. Thallium occurs in small amounts in almost all living organisms.

World production of thallium compound is around 30 tons per year. Thallium has not been produced in the United States since 1984. There has been no assessment of the size of reserves.

Consumption and Health

The greatest use of this metal is in specialized electronic research equipment (electronic devices, switches, and closures, primarily for the semiconductor industry). It also has limited use in the manufacture of special glass and for certain medical procedures.

Thallium is toxic and does not have any positive effect on people's health if consumed through food and water or absorbed in larger quantity from the atmosphere. Recent research in China, for instance, shows that thallium concentration in plants exhibits species-dependent preferences, decreased from green cabbage toward corn. The highest level of Tl

in green cabbage is up to 500 milligrams (mg)/kilogram (kg) as dry weight, surpassing the values of Tl in the soils in which the green cabbages grow.

The Maximum Contaminant Level Goals (MCLG) for thallium in water set by the Environmental Protection Agency (EPA) is 0.5 parts per billion (ppb), while the enforceable standard called a Maximum Contaminant Level (MCL) is set at 2 ppb. Short-term health effects of the thallium consumed above MCL may include gastrointestinal irritation and nerve damage, and long-term changes in blood chemistry, damage to liver, kidney, intestinal and testicular tissues, polyneuropathy, visual impairment, hair loss, and even death.

The Occupational Safety and Health Administration (OSHA) has set an exposure limit of 0.1 mg per cubic meter (0.1 mg/m^3) for thallium in workplace air. The National Institute for Occupational Safety and Health (NIOSH) has recommended that 15 mg/m^3 of thallium be considered immediately dangerous to life and health. This is the exposure level of a chemical that is likely to cause permanent health problems or death.

There are medical tests available to measure levels of thallium in urine and hair, as well as in the blood. The antidote for thallium poisoning is Prussian blue, which increases the elimination of thallium in urine and feces. A case study points to fully reversed hair loss during a two-year follow-up after poisoning. Polyneuropathy in the lower extremities was improved substantially, but residual and visual impairments remained. In the United States, thallium has been restricted from use in rodenticides and depilatory cosmetics.

Pollution, Waste, and Disposal

Thallium enters the environment primarily from coal-burning and smelting, in which it is a trace contaminant of the raw materials. It stays in the air, water, and soil for a long time and is not broken down. Some thallium compounds are removed from the atmosphere in rain and snow. It is absorbed by plants and enters the food chain, and is known to build up in fish and shellfish.

Eating food contaminated with thallium, breathing workplace air in industries that use thallium, and smoking cigarettes are among the major sources of exposure to this hazardous substance for most people. Living near hazardous waste sites containing thallium may also result in higher than normal exposures. It is dangerous for children to touch or eat soil contaminated with thallium. Recommendable methods of disposal are solidification and landfill, and it is not recommended for thermal destruction.

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See Also: Environmental Protection Agency (EPA); Toxic Substances Control Act; Toxic Wastes.

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Thompson, Michael

Born January 28, 1937, Michael Thompson is a British social anthropologist who has published over 50 books and articles on topics including cultural theory, material culture, human interaction with the environment, and environmental politics. His most important contributions to the study of consumption and waste are related to his intellectual development of rubbish theory and subsequent related works.

Education and Career

Thompson began his college education at the Royal Military College of Science in Shiverham, UK, where he studied chemistry, mathematics, and statistics from 1960 to 1961. In 1962, he entered the University College of London, where he earned a bachelor's of science in anthropology. From 1965 to 1968, Thompson studied social anthropology at Corpus Christi College Oxford, graduating with a bachelor's of literature. In 1973, he returned to the University College of London and received a doctoral degree in anthropology in 1976.

Upon completion of his advanced education, Thompson began a career as a professional researcher. Since 1979, he has been employed as a senior research scientist at the Institute for Policy and Management Research in Santa Monica, California (1979–80); at International Institute for Applied Systems Analysis in Laxenburg, Austria (1980–85); and at the University of Warwick Business School's Institute for Management Research and Development (1985–87). Since 1987, Thompson has been serving as the self-employed director of the Musgrave Institute in London, which has numerous contracts with other research firms around the world. In 1995, he also took on the positions of professor II at the University of Bergen in Norway and senior researcher at the Norwegian Research Center in Management and Organization.

Rubbish Theory

In relation to the sociology of garbage, Thompson is best known for the introduction of rubbish theory and his continuing work with these ideas. His 1979 book *Rubbish Theory: The Creation and Destruction of Value* was the seminal work on this topic. In it, he made a strong argument for the need to focus more attention on unvalued, or "rubbish," objects in order to understand how objects are defined and altered with regard to value. Understanding how societies value their material goods is important for social scientists because it is recognized that all cultures distinguish between the valued and the unvalued. Further, a certain degree of social consensus regarding these values is key to maintaining social order.

Rubbish theory states that there are three types of objects: transients, durables, and rubbish. Transients are durables that are socially visible objects with agreed-upon values. However, transients decrease in value over time and have finite lifespans because their value will eventually reach zero, while durables continually increase in value and have an infinite lifespan. The values of these objects are typically determined by the powerful within society. Rubbish, by comparison, is socially invisible and deemed unvalued.

Thomspon argued that the rubbish category is a medium for the potential rediscovery of a past transient object and its subsequent reappearance as a durable. An excellent example of this are automobiles that decline in value until they are discarded as worthless, but several years or decades later are rediscovered and labeled as "antiques" or "classics." This is significant not only for explaining how items of declining value can eventually become objects of great worth but also for illustratig a means of bypassing the control of the powerful in society as to the determination of what is valued or not.

Other Contributions

In addition to his work with rubbish theory, Thompson has also produced and contributed to several books and articles focusing on environmental topics such as human decision making and policy, sustainable development, and climate change. Given the 21st-century attention on environmental issues, these topics are important areas of consideration for a better understanding of the sociology of consumption and waste.

Much of Thompson's work with these topics is based on research conducted in the Himalayan

mountain region of central Asia. In 1987, he contributed to the publication of a major work on the subject, *Uncertainty on a Himalayan Scale: An Institutional Theory of Environmental Perception and a Strategic Framework for Sustainable Development of the Himalaya,* detailing the challenges and possible solutions to sociocultural and ecological issues associated with efforts to develop the Himalayan region.

Thompson is also known for his work with cultural theory and published a 2003 article using rubbish theory as a framework to explore and better understand the wide variety of interactions between social agents. In its simplest form, individuals and groups experiencing upward social mobility are equated to objects transitioning from rubbish to durables, while individuals and groups experiencing downward social mobility are compared to objects declining from transients to rubbish. Thompson argues that since social agents are always experiencing changes in status and power—and that these agents cannot simultaneously be experiencing both upward and downward social mobility—then understanding these transitions will illustrate how modern class-based societies are able to perpetuate their existence.

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See Also: Garbage in Modern Thought; Rubbish Theory; Sociology of Waste, Sustainable Development.

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Tianjin, China

Tianjin is a city and small province in northeastern China that has become internationally known as one of the world's largest importers of waste products, bought largely from European Union (EU) countries and the United States. Tianjin is an economically important entity, and its waste imports play a major role in China and have a global impact. Environmental challenges surround the waste imports, and programs are being put in place to tackle them.

Brief History

Tianjin borders Hebei Province and Beijing Municipality and is bounded to the east by the Bohai Gulf portion of the Yellow Sea. Its geographic position at the confluence of the Hai River and the Grand Canal has made it a leading international port of China and a strategic collection and distribution center for the north China plain. It is an important manufacturing center, its major industries being petrochemicals, textiles, car manufacturing, mechanical industries, and metalworking.

Tianjin was called Zhigu (meaning "straight port") until 1404, when the new Yongle emperor renamed it Tianjin (meaning "heavenly ford"). Agreements exacted from China by the British and French in 1860 made Tianjin a treaty port and conceded parts of it for foreign settlements and garrisons. These Treaties of Tianjin opened it up to foreign trade. Between 1895 and 1900, Britain and France were joined by Japan, Germany, Russia, Austria-Hungary, Italy, and Belgium in establishing self-contained concessions in Tianjin. In 1937, as part of the Sino-Japanese War, Tianjin became partially occupied by the Japanese. This lasted until 1945, when Japan surrendered in World War II. The foreign concessions within Tianjin were abolished in 1946, when Tianjin was restored to Chinese sovereignty.

Along with other coastal provinces, Tianjin was designated a Special Economic Zone in 1985, part of the second wave of Deng Xiao Ping's so-called opening up policies in order to increase foreign trade and investment. Special Economic Zones are allowed to utilize an economic management system especially conducive to doing international busi-

ness. They gain tax incentives for foreign investments and have greater independence in international trade activities.

In the 21st century, Tianjin is governed as a directly controlled municipality, one of four such designations. It therefore comes under direct administration of the central government. Tianjin City is the sixth-largest in China, and the municipality had a population of approximately 12 million in 2009. Almost 10 million of these inhabitants were permanent residents in Tianjin, of whom around 6 million were urban and almost 4 million rural. Most were from the Han Chinese majority.

Tianjin's Waste Industry

China has been developing economically at an astounding rate since the "opening up" policies of the late 1970s. This growth has been based on the manufacturing industry and therefore requires high levels of raw materials, making China reliant on imports. Data from Chinese customs statistics for 2004 reveal that China imported 4.1 million tons of waste plastics, 12.3 million tons of used paper, 10.22 million tons of scrap iron, 3.95 million tons of copper scrap, and 1.2 million tons of aluminum scrap that year. These materials are melted down and used by Chinese manufacturers to make new products. The waste industry is therefore crucial to the continued success of China's manufacturing-based economy. In fact, many container ships bringing goods to the United States and Europe return to China carrying waste from those countries.

Because Tianjin is one of China's major ports, much of this waste is processed in the city, making recycling a major industry there. For example, according to statistics from Tianjin Customs of China, from January to July 2010, Tianjin imported 402,000 tons of waste plastics (241,000 tons from the EU and 105,000 tons from the United States). The major proportion of this waste was imported by private enterprises. These enterprises are often small, informal companies whose economic and environmental practices are difficult to measure and whose employees are frequently migrants from other provinces and are therefore difficult to trace.

Although China needs to import waste, its reputation as "the world's dumping ground" has also caused regular incidents of illegal dumping at ports across the country, including Tianjin. For example, in October 1995, 14 containers of medical waste from the United States were refused entry into Tianjin, and in December 1997, uncleaned plastic waste and scrap from France and Korea was turned away. The flows of foreign garbage into China and the incidents of refusing entry tend to occur in two main ways. First, there are consignments that are imported without passing through customs—they are smuggled in. Second, there are cases of prohibited imports being falsely labeled in an attempt to avoid detection.

The Chinese government is well aware of the problems associated with importing waste and is therefore keen to promote higher levels of consumption domestically in order to generate good-quality waste and save the costs involved in bringing it in from other countries. Until the end of the 20th century, Chinese consumers had only been able to afford low-quality goods, which did not provide waste materials of the quality necessary for reuse. However, the better the quality of goods consumed, the longer they last and the slower they are disposed of, so a higher level of consumption does not in itself provide the answer to China's need for raw materials.

A series of policy changes have been implemented by the Chinese government in order to remove urban discrimination against rural migrants in the areas of employment, welfare, and social security, giving rural migrants equal rights to urban residents and harnessing their spending potential. These policies also reflect the concern for maintaining demand for Chinese products in the wake of the global downturn. With export growth shrinking and industrial output falling precipitously, the government is hoping that domestic demand will keep the economic growth rate from falling below 8 percent, which is, according to government economists, the level necessary for the Chinese economy to create enough jobs to absorb the growing workforce.

Environmental Challenges

Because of the speed at which the city is industrializing and because of its intake of waste materials, Tianjin faces a range of environmental challenges associated with resource use and waste management. These challenges include water scarcity, air

pollution, disposal of municipal and industrial liquid and solid wastes, and associated health problems. These problems tend to have particularly negative effects in Tianjin compared to other industrializing cities in the world because of the proximity of residential areas to industrial areas. Many people are living and working very close to sources of pollution. Also, in comparison to other large cities, much of Tianjin's industry is made up of enterprises that are small and often informal or hidden, and so they are difficult to trace and regulate.

Tianjin has responded to its environmental issues by putting in place a series of regulatory measures to manage the urban environment. For example, to reduce emissions and waste, Tianjin has teamed up with the EU to fund one of China's first "industrial symbiosis" programs. This involves a company in the United Kingdom sharing its knowledge and experience of reducing waste with one of China's largest industrial companies.

Furthermore, Tianjin Economic-Technological Development Area aims to reinvent itself as the Silicon Valley of low-carbon technology. In the initial four-year stage, it aims to bring 800 companies together to reduce landfill waste and carbon emissions. The hope is that by identifying and sharing needs, the waste of one firm can become the fuel or recycled raw materials of another. For example, chimney steam can be diverted to heat greenhouses.

Finally, a joint Sino-Singapore enterprise is funding the creation of the new Tianjin "ecocity" that will better balance high-density urban living with environmental protection. For example, some 60 percent of the ecocity's waste will be recycled, and organic waste will be used to generate heat and power.

The district government has attached great importance to the development of recycling practices as part of an attempt to become a national model of best practice. These practices are part of China's Circular Economy Law, which was introduced in 2009. Among other environmental stipulations, the law requires that government departments promote recycling and improve waste-reutilization standards and that enterprises recycle and make comprehensive use of all waste materials.

The Circular Economy Law can be seen as replicated traditional practices at play within Chinese culture. For example, the Chinese belief in frugality and the total use of resources has been evidenced in the past by the recycling of human and household wastes. While the importing of waste and its reuse as raw materials is an increasingly high-tech operation, it is based in older, more primitive practices.

Conclusion

Because of its strategic geographic position and infrastructural links, Tianjin has become a major importer of waste materials into China. By 2010, despite attempts to encourage internal consumption (and therefore disposal), China was still highly reliant upon imports of waste from the developed world. Therefore, the waste industry in Tianjin is crucial to the whole country's continued economic success.

However, the success of China's waste import industry has caused some importers to attempt to smuggle or dump large quantities of illegal waste and has been detrimental to some extent to China's international reputation.

Furthermore, the importing of waste does not come without environmental consequences, and these are aggravated in Tianjin by the density of the population and housing. Industrial pollution from recycling companies and small factories is a significant problem that is difficult to trace because of the informal nature of many of these companies. However, there is a high level of both domestic and international investment in green technologies in China and a strong emphasis on the recycling of waste.

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See Also: Beijing, China; China; Economics of Consumption, International; Industrial Revolution; Post-Consumer Waste; Shanghai, China.

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Tires

A tire is a collection of materials that are built up on a drum and then cured in a press under heat and pressure. The process of manufacturing a tire is energy consuming. Energy efficiency is particularly important for this sector because almost all processing uses heat. Heat facilitates a polymerization reaction that cross-links rubber monomers to create long elastic molecules. These polymers create the memory of the tire—the elastic quality that permits the tire to be compressed in the area where the tire contacts the road surface and spring back to its original shape under high-frequency cycles.

Composition

The materials and composition of tires vary depending on the uses. Natural rubber or polyisoprene is the basic elastomer used in tire making. But rubber is soft and sticky. Vulcanization of rubber is one the main processes of tire manufacturing. It strengthens regular rubber by adding sulfur and complex organic compounds to speed up the process of solidification. Activators like zinc oxide assist the vulcanization. Styrene-butadiene copolymer (SBR) is a synthetic rubber that is often substituted in part for natural rubber based on the comparative raw materials cost. Polybutadiene is also used in combination with other rubbers because of its low heat-buildup properties. Carbon black, one of the original ingredients for tires, forms a high percentage of the rubber compound. It gives reinforcement and abrasion resistance.

Most tires have some amount of halobutyl rubber mixed with additives to decrease air permeability. They also have one or more layers of reinforcing fabric such as rayon, nylon, polyester, and Kevlar. Additives used in sidewall compounds include antioxidants and antiozonants. The beads are bands of high-tensile-strength steel wire encased in a rubber compound. Bead wire is coated with special alloys of bronze or brass. Coatings protect the steel from corrosion. Copper in the alloy and sulfur in the rubber cross-link to produce copper sulfide, which improves bonding of the bead to the rubber. Bead rubber includes additives to maximize strength and toughness. The tread (the thick extruded profile that surrounds the tire body) compounds include additives to impart wear resistance and traction, in addition to environmental resistance.

Production Waste

Producing a tire is normally a controlled process with respect to the production and disposition of its derived waste and levels of toxicity. The International Agency for Research on Cancer (IARC) has found that there is nonconclusive evidence for the carcinogenicity of carbon black to humans. Silica is used together with carbon black in high performance tires as a reinforcement. It has been documented that silica can cause silicosis, a disabling, nonreversible, and sometimes fatal lung disease caused by overexposure to respirable crystalline silica. Silica exposure is currently a serious threat to nearly two million U.S. workers.

Most of the environmental concerns in tire manufacturing and recycling are related to air emissions and solid waste management. The Environmental Protection Agency (EPA) has proposed several recommendations to reduce waste in rubber-related manufacturing companies. Chemicals should be received in closed docks in sealed containers or in bulk rail or truck shipments with a minimal history of spills. Chemical piles should be stored inside the facility to ensure that any fugitive emissions can be contained within the facility.

Sealed containers should be provided for all open materials. Sealed containers should have air space between the chemical and the container cover to minimize "puffing" losses when the container is opened. A computerized inventory-control method should be used to minimize the amount of stock purchased. Automatic dispensing and weighing equipment should be used whenever possible. Automatic dispensing minimizes waste due to spills from manual dispensing and provides quality control. Protocols for cleaning up spills and sweeping should be provided to ensure the proper segregation of waste.

Scrap Tires

Tires are made to last. It is not completely clear when a tire fulfills its life cycle, but it is certain that whenever the tire is replaced, it has concluded its planned obsolescence period and becomes a scrap tire. On average, one tire is discarded per person per year in

the United States. Retreading saves millions of scrap tires from being disposed of as scrap each year.

In the past, most scrap tires took up space in landfills or provided breeding grounds for mosquitoes and rodents when stockpiled or illegally dumped. The curved shape of a tire allows rainwater to collect and creates an ideal habitat for those host species. Disease-carrying pests may breed in tire piles. Mosquitoes can also breed in the stagnant water that collects inside tires. Several varieties of mosquitoes can carry deadly diseases, including encephalitis and dengue fever. Asian tiger mosquitoes—a vector for encephalitis and dengue fever, among others—first came into the United States in a shipload of used tires from Japan. In the 21st century, many states have cleaned up large numbers of tire stockpiles. Minnesota, Wisconsin, and Maryland are three states that report having cleaned up all scrap-tire stockpiles. Most states have passed scrap-tire regulations requiring proper management. By 2010, 48 states had laws or regulations specifically dealing with scrap tires.

An occupational study in a Taiwan scrap-tire shredding plant identified volatile organics and particulates in the air that were "frame shift" mutagens. While the report cited epidemiological studies of rubber workers showing acute and chronic respiratory effects—including reduced lung capacity and increased risk of laryngeal, bladder, lung, and skin cancers—no health studies had been done of workers in tire-shredding plants. With the exception of the more volatile solvents, similar types of chemicals are found in shredding facilities and manufacturing plants. The volatile organics found include styrene, benzothiazole, phthalate esters, and naphthalene.

Over the years, tires have been used more creatively. They are bound together and used as different types of barriers, such as collision reducers, erosion control, rainwater runoff, wave action barriers to protect piers and marshes, and sound barriers between roadways and residences. Entire homes known as "Earthships" can be built with whole tires by filling them with soil and covering them with concrete. In the 1970s, some experiments to evaluate the use of scrap tires to build artificial reefs resulted in very negative environmental endeavors. The most publicized case happened in Florida's Osborne Reef, an artificial reef off the coast of Fort Lauderdale constructed of concrete jacks in a 50-foot-diameter circle. In the early 1970s, approximately 2 million disused tires were dumped at the Osborne Reef over 36 acres of the ocean floor at a depth of 65 feet. Most of the discharged tires were bound with steel clips. Corrosion, storms, and water movement finally made the steel restraints fail. The resulting mobility of the reef destroyed any marine life that had thus far grown on the tires and prevented the growth of any new organisms. Furthermore, the tires were now easily subject to the tropical winds and storms that frequent the east coast of Florida and continue to collide (at times with tremendous force) with other natural coral reefs only 70 feet away. The result was not only uselessness of the tires but also environmentally damaging side effects.

On average, one tire is discarded per person per year in the United States. Retreading saves millions from being discarded. Once in landfills or open dumping grounds, the stagnant water in old tires becomes a breeding ground for disease-carrying mosquitoes.

In 1994, the estimated number of scrap tires in stockpiles in the United States was 700–800 million. Since that time, millions of tires have been removed from stockpiles, primarily because of aggressive cleanup through state scrap-tire management programs. A flourishing market exists in the United States for 80 percent of scrap tires, up from 17 percent in 1990. According to the Rubber Manufacturers Association of the United States, the market of recycling and beneficial use for scrap tires continues to grow. Many uses have been found for recycled tires, including whole tires, tire chips, shredded tires, and ground rubber. As of 2003, about 233 million tires went to the scrap-tire market. Approximately 45 percent were used as fuel, 19 percent were recycled or used in civil engineering projects, and 12 percent were converted into ground rubber and recycled into products or rubber-modified asphalt. Approximately 7 percent were exported, recycled into cut/stamped/punched products, or used in agricultural and miscellaneous uses. More than 16 million scrap tires are retreaded. The remaining scrap tires (more than 23 million) are either stockpiled; landfilled; illegally dumped in ravines, woods, deserts, and empty lots; or burned under inadequate environmental conditions. In spite of the efforts and campaigns against dumping, a significant amount of scrap tires end up in landfills each year.

Tires in Landfills and Tire Fires

Landfilling scrap tires can cause problems because of their uneven conformation and propensity to rise to the surface. An additional problem is that a tire is basically 75 percent empty space, which quickly consumes valuable space in the landfill. Tires can easily catch methane, causing them to become buoyant, or "bubble" to the surface. This bubbling effect can damage landfill liners that have been installed to help keep landfill contaminants from polluting local surface and groundwater. To minimize these problems, many states require chipping or grinding of tires prior to disposal. Sometimes scrap tires are also incorporated into the landfill as part of daily cover, or in a landfill cap. In the early 21st century, the placement of shredded scrap tires in monofills—a landfill or portion of a landfill that is dedicated to one type of material—has become more common. Monofills may be used where no other markets are available and municipal solid waste landfills do not accept tires. Monofills are preferable to above-ground storage of tires in piles because of fire hazards and human health hazards. A tire's physical structure, durability, and heat-retaining characteristics make these stockpiles a potential threat to human health and the environment.

Stockpiled tires are prone to heat retention and can ignite, creating tire fires that are difficult to extinguish and can burn for months. Tire fires generally start either as a result of arson or accident. Tire fires release thick, black smoke, generating unhealthy smoke and toxic oils, which contaminate the soil with an oily residue. For example, in 1999, lightning started a tire dump fire in Westley, California, which burned for 30 days. Pyrolitic oil flowed into a nearby stream and also ignited. Scrap tire piles are not treated as hazardous waste. However, once a tire fire occurs, tires break down into hazardous compounds including gases, heavy metals, and oil, which may then prompt Superfund cleanup status.

Regulation, Reuse, and Recycling

Scrap tires, as a solid waste, are regulated primarily by state governments. Based on a survey of state agencies conducted by the Rubber Manufacturers Association in 2001, 91 percent of all scrap tires stockpiled in the United States were concentrated in 11 states.

The main use of scrap tires is as fuel because tires are a very good source of hydrocarbons (carbon and hydrogen). For example, using tires for combustion in a cement kiln produces 25 percent more energy than coal, and it can also result in lower emissions. Because of the extremely high temperatures (greater than 3,000 degrees Fahrenheit), cement kilns burn materials quickly and extremely efficiently. Tire-burning at low temperatures generates pollutants like benzene, toluene, methylene chloride, polychlorinated biphenyls (PCBs), dioxins, and furans. Burning waste at extremely high temperatures destroys chemical compounds and disease-causing bacteria. Another product derived from tires is rubber mulch, which consists of either waste-tire buffings or nuggets of rubber from tires that are ground up whole,

after having their steel bands removed. Buffings are produced from recycled truck tire tread when the remainder of the worn-down tread is removed from the tire prior to retreading. Rubber mulch provides several advantages over plant material–based mulches. For landscaping and gardening purposes, both nuggets and buffings insulate soil from heat, allowing a higher soil temperature difference over wood mulches. Rubber mulch is beneficial for soil moisture as rubber is nonporous and does not absorb water on its way through to the soil. It also reduces fungus growth and plant growth, and it becomes a weed barrier as weed seeds dehydrate in the mulch before reaching the soil. Another advantage over plant-material mulches is its elasticity, which gives it a springy quality when used in a fairly thick layer. This makes it a natural choice for playgrounds, where the extra springiness provides additional safety for children when they fall off playground equipment.

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See Also: Automobiles; Car Washing; Emissions; Engine Oil; Gasoline; Rubber.

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Tokyo, Japan

Tokyo is the capital of Japan and the most populous metropolitan area in the world, with over 36.7 million people according to the 2009 United Nations World Urban Prospects report. Since its founding in 1603, Tokyo has been the center of Japanese politics and commerce, maintaining a high population density. The most common practice of waste management in Tokyo is incineration for volume reduction, followed by final disposal of combustion products to landfills. Some of the larger landfills are located in Tokyo Bay and are continuing to reclaim land from the sea. It is estimated that residents of Tokyo generate about 807 pounds (lbs) of solid waste per person per year, which is less than the industrialized countries average of 1,279 lbs per person per year and less than half of the United States, average of 1,676 lbs. Since the peak in the late 1980s, this number has declined steadily under the central planning of the Tokyo Metropolitan Government, which aims to transform Tokyo into a sound material-recycling society. Source reduction, reuse of products and materials, and thermal recycling are encouraged. Two key features of Japanese waste management practice, the proximity principle and the top-down decision-making process, have added an extra layer of complexity to waste management in Tokyo.

Tokyo is not a city. The term *Tokyo* refers to the Tokyo Metropolis, one of the 47 prefectures in Japan. It is also used to describe the Greater Tokyo Area, an urban planning unit including three other prefectures around Tokyo Metropolis: Chiba, Kanagawa, and Saitama. The Tokyo Metropolis prefecture houses 13 million people, or 10 percent of the total population of Japan. The Tokyo Metropolis is further divided into three regions: the Twenty-Three Special Wards Region, the Tama Region, and the Island Region. In Tama and Island regions, there are 26 cities, five towns, and eight villages. As specified in Article 5 of the Waste Management and Public Cleansing Law, the Tokyo metropolitan government has the authority to establish a Waste Management Plan in line with basic policy set by the Ministry of Environment. Each municipality is responsible for formulating a Municipal Solid Waste Management Plan under the central planning of the Tokyo metropolitan government. However, the Twenty-Three Special Wards Region has autonomy to control and administer waste collection and processing operations independently.

History

Human settlement in the area around Tokyo began as early as 7500 B.C.E. Early settlement consisted of

a hunter-gatherer lifestyle in which the population was dependent on the benevolence of the ocean. As of 2010, more than 600 shell mounds had been found from these early settlements. Shell mounds are dumps of remaining food and refuse, which provide archaeological information about the life of the ancient populations. In the next millennia, Tokyo was known as Edo, only hosting remote fishing villages. The development of the city was started when Tokugawa Ieyasu, the first shogun of the Edo period, claimed the city as his base and Edo City became the center of his nationwide military government in 1603. The population in Edo City boomed as it secured its position in commerce, politics, and culture. By the 18th century, Edo City grew into one of the most populous cities in the world, with 1 million inhabitants, supporting even more people than London or Paris during this same period. Waste management during the Edo period was centered around material reuse and recycling. Night soil was collected and sold to farmers in nearby areas, while ocean dumping of solid waste was used as a means to reclaim land from the sea.

Edo City remained the capital of Japan even after the Tokugawa military government collapsed in 1868 and the name was changed to Tokyo. International commerce resumed, and Japan quickly converted to a modern industrial society. Incineration of waste was started in 1929, when the Fukagawa Refuse Waste Disposal Plant was established. Utilization of night soil was continued and even encouraged during World War II in order to enhance food production. The collected night soil was transported by train to nearby farmland. This practice was gradually phased out as sewer system coverage was expanded in the late 1960s to the early 1970s.

Solid waste management gradually increased except during World War II. In 1964, the regular collection of refuse was fully implemented. In 1965, a massive outbreak of flies in the Yumenoshina landfill in Tokyo Bay created a public outcry, which motivated the conversion of open dumps to sanitary landfills with daily soil cover. It was also at this time that solid waste generation skyrocketed as all of Japan went through a phase of rapid economic growth and Tokyo was in a crisis-like state as some special wards could not treat all the solid waste generated within their limits. The War on Waste was declared in 1971 and improvement of waste collection efficiency and material recovery through recycling was encouraged. The catalyst for this change was also a reaction to the oil shock in 1973, but later became connected to environmental movements.

The curbside collection of recyclables started in the early 1990s in two special wards and gradually spread to the rest of Tokyo. In the same period, the transfer of authority of sanitary operations to Twenty-Three Special Wards took place to enhance decentralization under the Local Autonomy Act. In 2000, the local government of the Twenty-Three Special Wards established a social governmental body called the Clean Association of Tokyo 23 to jointly manage intermediate waste processing, such as incineration, pulverization, and sewage treatment. Twenty-Three Special Wards, the Clean Association of Tokyo 23, and the Tokyo metropolitan government then cosigned for the operation of final disposal sites. The Basic Law for Establishing Sound Material-Cycle Society and other recycling regulations were enacted in the first decade of the 21st century and the Tokyo metropolitan government continued to establish ordinances to improve material and thermal recycling.

Solid Waste Management in the 21st Century

Approximately 4.9 million tons of municipal solid waste (MSW) is generated within Tokyo Metropolis every year. Of this, 90 percent is collected by public entities and the remainder is collected by private waste haulers with permission granted by local municipalities. MSW is classified into combustible, noncombustible, large-size waste, and recyclables. The recycling rate of Tokyo is 23.2 percent and is relatively high compared to the national average of 20.3 percent.

Almost all the nonrecyclables go through an intermediate waste-processing step for volume reduction prior to the arrival at final disposal sites. Like the rest of Japan, incineration is the most common practice in Tokyo. There are 58 incinerators in Tokyo that treat 3.6 million tons of MSW each year. Approximately 445,000 tons of incineration ash are sent to landfills annually. There are 10 landfills located in Tokyo, eight of which

are smaller landfills on land serving the Tama and Island regions. The two larger landfills, the Outer Central Breakwater Landfill Disposal Site and the New Sea Surface Disposal Site, accept refuse from the Twenty-Three Special Wards Region and are literally filling in Tokyo Bay. The Tokyo metropolitan government is the operating entity of these final disposal sites, employing the sandwich method in which every three meters of waste is covered with 50 centimeters of soil.

Another 24 million tons of industrial waste is generated in Tokyo, of which 63.8 percent go through intermediate waste treatment processes such as incineration and chemical treatment, while 1.2 million tons are sent to the final disposal site. Only 75 percent of intermediate treatment and 18.8 percent of the final disposal takes place within Tokyo, creating conflicts with surrounding municipalities.

Human waste is managed separately from the rest of the solid waste. As of 2008, 96.8 percent of people living in Tokyo have flush toilets, and almost everyone has a connection to publicly owned sewer lines and a centralized wastewater treatment facility. Fewer than 5 percent of the population are served by septic tank treatment systems or utilize vault toilets. There are 13 wastewater treatment plants in Tokyo, and most are equipped with advanced treatment systems. The collected sewage sludge is stabilized and sent to final disposal sites. About 70 thousand tons, or 10 percent, of the waste is sent to landfills as sludge from water and wastewater treatment plants.

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See Also: Incinerators in Japan; Japan; Osaka, Japan; Recycling; Sustainable Waste Management.

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Tools

That tools contribute to the increasing amount of waste characteristic of advanced societies seems somewhat unlikely. Tools are useful; personal tools allow for fabrication, repair, and maintenance in the domestic sphere, while industrial tools produce material for both domestic consumption and export. Nonetheless, tools—both personal and industrial—significantly contribute to the rising tide of waste.

Personal Tools

Personal tools contribute to waste in several ways. One largely overlooked wasting of potentially useful tools occurs because of tool redundancy. Enormous numbers of domestic utensils, hand tools, and power tools lie either unused or underused. In this state, such tools do not enter the formally recognized circuits of object disposition or disposal but remain idle or little used.

A number of factors can be seen to contribute to such wasting and redundancy of personal tools. First, there has been a marked proliferation, through duplication, of simple tools. Functionally identical tools are increasingly styled to appeal to differing consumer preferences. Changes of color, shape, surface decoration, packaging, and advertising are the bases of such differentiation. There are simply too many very-similar tools compared

to the distribution of ownership. While many in the world have few tools, in affluent societies, it is not uncommon for households to own multiple unused duplicates of many personal tools. Second, the overdesign of functionally simple tools is apparent. Function-driven design and manufacture of tools has somewhat given way to the form-driven imperatives associated with consumerism. When styling predominates over ease of use, tools are often abandoned, either through domestic redundancy or disposal. Third, increasing tool differentiation is also apparent. The range and configuration of tools with very similar functional purposes has gradually expanded. For example, there are many different types of devices to remove corks from wine bottles, each working in a different way and each employing differing technological approaches. Such differentiation is not new. In the past, model differentiation predominated, for example, offering a range of pocket knives with a family resemblance but differentiated through the functions on offer, such as more blades. In the 21st century, conceptual differentiation is instead emphasized as manufacturers offer a range of families of devices with similar functions (such as pen knives, multitools, and pocket assistants).

The household accumulation of such tools can be marked. Tool redundancy is obvious in such cases; one can only use one tool to open a bottle of wine, one hammer when a nail needs to be driven, one Allen wrench to tighten a bolt, and so on, but many households own multiple versions of each. Finally, increasing tool specialization is apparent. Many traditional hand tools have been redesigned as power tools, and this technological elaboration is usually the basis of a promise of increased functionality and ease of use. While often welcome, such technological elaboration is often unnecessary. For example, powered screwdrivers can easily overtighten screws, damaging the head of the screw. Specialization is also apparent as new tools with novel, specific functions are developed. Such tools are often matched to new products such that there is a seeming symbiosis between the two. For example, many goods are built from bodies to which access is only possible through the use of specific and specialized tools. A corollary of such specialization is the discouragement of adapted use or functional improvisation in relation to tools; for example, there are a number of gadget catalogs offering very specific solutions to problems seemingly discovered or invented for the sole purpose of offering the solution. Very many of these tools remain unused, underused, or add to the quantity of items to be disposed of.

In a more abstract sense, in a culture that offers a range of ready-made commodified solutions for simple problems when free time is often curtailed for the majority of the working population, the use of personal tools for the autonomous creation of useful goods is both discouraged and undermined.

Industrial Tools

Many of the same points can be made in relation to industrial tools; whole industries have developed that aim to convince the owners of industrial tools that their tools are outdated, functionally obsolescent, or inefficient. The replacement of industrial tools can thus generate very large amounts of problematic waste matter. However, the domain of industrial tools also has its specific wasteful dynamics. The most significant comes about from the reliance of the owners of industrial tools on the performance of the market economy. Industrial tools are used to make items, such as other tools, components, and finished goods. The fortunes in the markets for these intermediate and finished goods profoundly affects the fortunes of the originating industrial tools. Factories and workshops of industrial tools often lie idle or partially decommissioned while scrap heaps bear witness to an enormous wastage of industrial tools and productive potential. In this sense, industrial tools are often employed in both highly inefficient and irrational ways.

Solutions and Alternatives

Interesting initiatives that aim to alleviate the widespread wasting of such socially useful goods have been developed. Various enabling solutions, including tool libraries, tool banks, and the micro-leasing of tools, are seen as alternatives to mass, duplicated ownership of similar but redundant tools. Similarly, many tool charities take in old, unwanted, or about-to-be-disposed-of tools, refurbish them where necessary, and redistribute them to "tool-poor" societies. Such remedies, with their stress on neighborhood and community organization,

sociality, collaboration, self-organization, and environmental benignancy, can themselves be seen to be allied to what Ivan Illich has called "convivial tools"—social devices that enable individuals and groups to use them in a manner of their choosing and toward variable and adaptable ends.

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See Also: Consumerism; Garden Tools and Appliances; Overconsumption; Post-Consumer Waste.

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Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was introduced in the U.S. Senate by Senator John V. Tunney of California in March 1976 and signed into law by President Gerald Ford in October 1976. It allows the Environmental Protection Agency (EPA) to regulate existing chemicals when they pose an unreasonable risk to individual health or to the environment, new commercial chemicals before they enter the market, and their distribution and use.

Regulations

Chemical substances regulated by the the TSCA include "Any organic or inorganic substances of a particular molecular identity including any combination of such substances occurring, in whole or in part, as a result of chemical reaction or occurring in nature and any element or uncombined radical." Those substances not regulated by the TSCA include (1) pesticides regulated by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); (2) tobacco and tobacco products regulated by the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF); (3) radioactive materials regulated by the Nuclear Regulatory Commission (NRC); and (4) foods, food additives, drugs, cosmetics, or devices regulated by the Food and Drug Administration (FDA).

Laboratories engaged in research must consider the implications of TSCA to their operation. There are, however, research and development (R&D) exemptions, which include those that are imported, produced, or used in small quantities; used solely for purposes of noncommercial scientific, experimentation, or analysis of research; and under the supervision of a technically qualified person. Laboratories must also comply with other TSCA requirements, such as certifying TSCA status of imports of R&D substances, notifying receiving countries of exports of certain R&D substances, documenting prudent laboratory practices, creating and maintaining records of any allegations of effects to human health or environment potentially caused by R&D substances, and documenting and recording any significant risks associated with these substances.

Among the chemicals EPA regulates under Section 6 authority are asbestos, chlorofluorocarbons (CFCs), lead, and polychlorinated biphenyls (PCBs). Asbestos tends to break down into a dust of microscopic fibers, which can easily penetrate body tissues after being inhaled or ingested. The fibers can remain in the body for many years, and symptoms of diseases sometimes appear 10–30 years after exposure. The EPA banned the manufacture of lead-based paint and related products in 1978, after it was shown that exposure to this substance can create long-term health effects, especially in children.

PCBs are mixtures of synthetic organic chemicals. Because of their nonflammability, chemical stability, and electrical insulating properties, they were used in several industrial and commercial applications, such as electrical, heat transfer, and hydraulic equipments. They have significant ecological and human health effects, including carcinogenicity, neurotoxicity, reproductive and developmental toxicity, immune system suppression, skin irritation, and endocrine disruption.

Proposed Changes in the TSCA

The world changed dramatically after the TSCA was passed in 1976. Companies are now using nanotechnology to create chemicals and materials that

may have additional hazards not covered by the existing law. Because of a confluence of knowledge and technology, there is a general consensus from a myriad of federal agencies such as the National Institute of Environmental Health Sciences (NIEHS) and the National Toxicology Program (NTP), as well as other stakeholder groups, about a need for a fresh perspective on chemical evaluation.

Research has shown that the normal development of the fetus, infant, and child can be disrupted by even low doses of certain chemicals, including toxicants and newer hormonally active agents. Other research has linked breast cancer in adults to exposure of mammary glands to environmental agents. The NIEHS also encourages research on the origins of diseases such as obesity, diabetes, and metabolic syndrome and the role of toxic agents and environmental chemicals in accentuating them. The NTP, in partnership with the National Human Genome Research Institute and the EPA, have devised new quantitative methods to test a large range of products simultaneously, dramatically increasing the speed with which problematic chemicals can be tested for additional testing.

In April 2010, Senator Frank Lautenberg of New Jersey introduced the Safe Chemicals Act of 2010, which would revamp the Toxic Substances Control Act of 1976. A similar measure was also introduced in the House by Representatives by Bobby Rush and Henry Waxman. Among the measures, the proposed legislation would require chemical manufacturers to provide a minimum amount of safety data, as well as give the EPA the full authority to request additional safety information. The legislation would also put the burden of proving a chemical is safe on manufacturers, a reverse from the 1976 law, which put the burden on the EPA.

The legislation has support from Safer Chemicals, Healthy Families, a broad coalition of health and environmental groups. However, many industry groups have expressed concerns, including the lack of transparency in how the EPA would select the priority chemicals that would be the first to be subject to safety determinations and the absence of provisions for judicial review of agency decisions.

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See Also: Acid Rain; Aerosol Spray; Environmental Protection Agency (EPA); Hazardous Materials Transportation Act; Household Hazardous Waste; Industrial Waste; Medical Waste; Organic Waste; Waste Disposal Authority.

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Toxic Wastes

Toxic waste is a liquid, solid, or sludge that can cause fatality or serious permanent bodily damage to humans or animals at low doses. When released into the air, water, or land, toxic wastes pose a long-term risk to health and environment.

The Environmental Protection Agency (EPA) defines four major types of hazardous wastes: F, K, P, and U. The F list includes wastes from various industrial sources, such as spent solvent and waste by-products from wood preserving, metal production, petroleum refinery wastewater treatment sludge, and multisource leachate. The K list emphasizes the most common sources of waste, including pharmaceuticals manufacturing, petroleum refining, iron and steel production, wood preservation, and manufacturing of explosives and chemicals. The P list and the

U list include commercial chemical products that are hazardous when they are discarded, such as commercial chemical products and container and spill residues. The P list chemicals are acute hazardous wastes and those on the U list are defined simply as toxic wastes. The EPA categorizes toxic wastes that are mixed with radioactive waste (wastes originating from the production of nuclear energy and nuclear weapons) as its own category of waste.

The EPA relies on scientific evidence when defining the harm and toxicity of particular substances, although toxicity and risk are debated among scholars, government officials, businesses that created the waste, workers in factories producing the waste, and citizens living near toxic sites. Often, environmental activists define particular chemicals or sites as toxic before government officials. Sometimes government officials, citing the need to wait for clear scientific evidence, have been initially reluctant to define particular sites or toxins as hazardous or toxic. The amount of government funds given for cleanup and the definitional thresholds for waste, hazardous waste, and toxic waste vary with political administration. For example, in November 2010, the Obama administration announced that it was pushing tougher EPA regulations that would force cleanup of thousands of formerly ignored dioxin sites across the country. The difference between legal waste, hazardous waste, and toxic waste often is less a matter of objective measurement of risk and more a matter of historical and political perspective.

Common Toxics

A common toxic waste is low-toxicity waste (for example, leaded soil). This type of waste is unlikely to migrate and thus it is placed under the ground, hard coverings are placed around it, and it is used for public, commercial, or industrial purposes,

A worker in a hazardous-material (hazmat) suit sprays a toxic sealant on a concrete wall during construction. The U.S. Environmental Protection Agency (EPA) must wait on clear scientific data before categorizing a toxic waste from an industrial or common source or from a commercial chemical product. In the meantime, the risk posed by these substances is debated among scholars, government officials, environmental activists, companies creating the substances, and citizen who live near toxic sites.

such as parks, athletic fields, or shopping malls. EPA statistics from the National Toxics Inventory show that this is one of the fastest-growing types of toxic waste.

DDT was discovered in 1939 and is one of the best-known synthetic pesticides. It controlled malaria during World War II and was subsequently used as a popular commercial and agricultural insecticide. Some claim that DDT is not toxic, while others note carcinogenic or lethal properties. DDT was central to Rachel Carson's 1962 *Silent Spring*, a book that helped motivate the modern environmental movement.

Another common toxic is dioxin. Dioxins are by-products of industrial processes, including chemical manufacturing, chlorine bleaching of pulp and paper, smelting, and cigarette smoke. Dioxin is also released through incineration of hazardous waste, municipal solid waste, medical waste, and sewage sludge. Dioxins exist primarily in fatty tissues and take at least eight years to be metabolized, so even small exposures may eventually reach dangerous levels. The EPA reports that dioxins are a probable carcinogen, but notes that noncancer effects (such as reproduction, sexual development, nervous system, and immune system malfunctions) may pose an even greater threat to human health.

Businesses that produce dioxin by-products, such as Dow Chemical, DuPont, and Monsanto, typically argue that dioxin is not toxic, sometimes in response to lawsuits from plant workers and those living near plants. Dioxin exposures caused large-scale evacuations, such as in the Niagara Falls neighborhood of Love Canal and the town of Times Beach, Missouri. The U.S. military used dioxin in an herbicide campaign during the Vietnam War. Dioxin contamination may have occurred at the site of the September 11, 2001, attacks in New York City.

Responding to Toxic Wastes

As stakeholders in the community cleanup process, scientists, citizens, and activists demand accountability. By implementing legislation to remediate toxic sites, the government protects citizens. By producing everyday chemicals, companies that produce toxic waste make society more efficient. The stakeholders' competing interests create a social situation likely to induce toxic controversies.

Emergence of a Social Problem

In the United States, the danger of toxic waste existed long before public understanding about the danger of toxic waste. In the 1950s and 1960s, the federal government increased environmentally focused legislation, but the development of an enforced anti-toxics policy did not happen until the 1970s. The coordinated reaction to toxic waste was not due to a spike in exposure to toxic wastes but rather was the outcome of a widespread public understanding about their risks. This public understanding was created largely through heightened environmental activism, which often is attributed to a book about the dangers of toxics.

In 1962, American biologist Rachel Carson published *Silent Spring*, a scientific account of how widespread use of DDT was causing environmental damage. Carson provided scientific evidence about DDT's environmental dangers and wrote rhetorically and speculatively about future dangers, exemplified in the book's image of a dead river. The book sparked years of debate among scientists, producers in the chemical industry, users in the agricultural industry, government officials, and environmental activists.

Added to this new politicized awareness was a catalyzing moment that was distributed around the country in newspapers and television programs: a river in Ohio was so polluted with toxic sludge that it caught fire. The combination of this surprising image and the sensitivity from the *Silent Spring* controversy created a great opportunity seized by the environmental movement in 1970 to create Earth Day and to push legislators to create the EPA.

Ecuador

From 1964 until 1992, the U.S. oil company Texaco contaminated waterways in Ecuador by dumping billions of gallons of toxic sludge. Texaco abandoned nearly 1,000 toxic waste pits throughout the region, filled with crude and sludge that—plaintiffs claim—continues to seep into the groundwater. In the 1990s, after spending just $40 million, the polluter received a release of environmental liability from the Ecuadorian government. In a class action lawsuit filed on behalf of Amazonian villagers who claim that the sludge was poisoning the groundwater, an Ecuadorian court

could impose a legal penalty of up to $28 billion to be paid for by Chevron, the owner of Texaco.

September 11

Since 2001, at least half of the 9,000 9/11 first responders have reported respiratory problems. In the days and weeks after the attack, the EPA tested for only a few toxins and erroneously said the air was safe. Activists and journalists discovered that there were many chemicals for which there were no government safety limits. There were also government reports confirming that the White House shaped EPA press releases by convincing the EPA to add reassuring statements and to delete cautionary ones.

First responders who were told the air was safe fear that they are facing long-term health problems and thus have joined lawsuits against the city and against the group that owned the World Trade Center; settlement offers were $712.5 million, and $47.5 million, respectively. As of November 2010, the offers were not yet accepted by enough plaintiffs to be validated by the courts. Many plaintiffs complained that the amounts were not even close to covering their medical costs.

Government officials, scientists, and activists disagree about the distance the toxins traveled, and some citizens in nearby cities worry that their homes, schools, and workplaces are contaminated with toxic dust. As of 2010, the U.S. Congress is considering more economic support to clean nearby communities and to pay the medical bills and lost wages of exposed citizens.

Vietnam

During the Vietnam War, between 1962 and 1971, the U.S. military sprayed millions of gallons of chemical herbicides (such as Agent Blue and Agent Orange) in Vietnam, Laos, and Cambodia. The goal was to deprive enemy armies of crops and cover and to force them into the cities. Millions of acres of land were made unusable, and in some cases, the concentration of the toxics was far greater than legally allowed.

Hundreds of thousands of Vietnamese were maimed, killed, or suffered birth defects from exposure. Birth defects can be deformities of the face or body, extra limbs or appendages, and mental disabilities. Skin and genetic diseases and cancers still emerge anew in exposed populations. Similar conditions are reported by Vietnam veterans who delivered and stored the chemicals and also by others who served on bases or missions where the defoliant was used.

Once home, Vietnam veterans suspected that personal health problems, miscarriages, and birth defects their families were experiencing were due to exposure to Agent Orange. Exposed veterans with health problems associated with exposure are assumed to have contracted the problems through exposure and are provided with medical coverage for symptoms through government disability payments. In 1984, a class-action suit on behalf of exposed veterans against the chemical producers was settled out of court for $180 million. Many veterans were angry about the low amounts of payment they received. Monsanto continued to claim that Agent Orange did not cause serious long-term injury. The United States (through presidential, congressional, and EPA action) continues to measure and clean Vietnamese toxic sites.

Bhopal

On December 3, 1984, tons of toxic gas escaped from an insecticide plant in India that was owned by the U.S. firm Union Carbide. The toxic gas quickly spread over neighborhoods around the plant, killing 15,000–20,000 people. Soil and water contamination are blamed for continuing sicknesses among hundreds of thousands of survivors, including respiratory problems, eye irritation, blindness, birth defects, and other ailments. Plaintiffs claim that the company cut corners in both the creation and running of the plant and that they had poor contingency plans in case of disaster.

In early 2006, Indian activists began a hunger strike. In response to these protests and pressure in the courts, the Indian government agreed to fully clean the site as well as to provide fresh drinking water for local residents. In June 2010, eight former senior employees of Union Carbide's Indian subsidiary were convicted in an Indian court of "death by negligence." The former employees faced up to two years in prison. The Indian government unsuccessfully requested U.S. extradition of the former CEO of Union Carbide.

New Wastes

New toxics are not only objectively produced but are also dependent on societal and government acknowledgment that a well-known chemical is toxic. One example is drinking-water contamination from farming industries. Activists and journalists suggest that birth defects in the community may be tied to toxics like the pesticide atrazine, which is common in drinking water—especially in agricultural communities. Some activists and journalists claim this evidence demonstrates that the system of water purification in U.S. cities is insufficient for removing new chemical wastes and that the EPA has insufficient measurement and regulation of new wastes. Although atrazine is highly regulated in Europe, in the United States and many other countries around the world, atrazine is a common—and largely unregulated—herbicide. Some scientific reports suggest that atrazine causes birth defects, endocrine damage, and cancer, but after extensive scientific testing of 100 atrazine-exposed community water supplies, the EPA concluded that there was no threat to the population.

International Trade

Because disposals of toxic and radioactive wastes are so expensive in highly regulated industrialized nations, there is a lucrative trade in the transportation of toxic wastes to countries where regulations are limited and disposal is relatively cheap. Businesses sometimes seek to save money by exporting the toxic waste. Because the monetary offers can rival their country's annual gross domestic product (GDP), governments of developing nations often think they must accept the money. In one case, U.S. smelting firms sent their waste to Bangladesh, where it was used as fertilizer. In another case, Congolese officials were accused of receiving millions of dollars in kickbacks for receiving one million tons of toxic waste. Some Somali pirates have cited the international toxic waste trade as a rationale for their violence; for example, in 2008, one group demanded $8 million for years of dumping toxic waste in their coastal waters.

Some evidence suggests that trade deregulation such as the North American Free Trade Agreement encouraged increased international trade in toxic waste. Still, many poorer countries will not accept toxic waste from more developed countries. Barges filled with toxic waste travel the world looking for dumping places, often without success. In one infamous case, a toxic load from the United States was accidentally dumped in the ocean after being turned away from ports around the world for several years. Recycling is big business, and U.S. waste companies can increase profits by avoiding expensive U.S. regulations and selling toxic products, such as computers, to unethical recycling companies that export the toxic waste to countries with lax regulation.

Regulation of international toxic waste typically respects the sovereignty of receiving nations. The 1989 Basel Convention is an international treaty that states that toxic waste shall not be exported either without notice or without permission of the receiving nation, depending on the circumstances. Critics suggest that this did little more than encourage careful recording of toxic trade between exporting and importing nations. Some people suggest that the international trade in toxic waste provides poorer countries needed economic resources, while others suggest that it results in richer people displacing environmental costs onto poorer people. The latter argument is sometimes extended to issues of race: toxic waste trade is usually from white countries to non-white countries, thus suggesting environmental racism on an international scale.

Environmental Racism

Like other environmental harms, there is a correlation between toxic waste sites and race. The challenge for scholars is to isolate the causal relation between exposure to toxic waste and race. In many cases, scholars have been able to show causality, while other studies suggest that other variables (such as community income, industrial base, or geography) have proven more important than race.

The EPA acknowledges that environmental racism has been an unintended pattern in exposure to toxic waste. Recent analyses have shown that the U.S. military tended to place the most dangerous testing sites in rural areas, and that these areas happen to be much closer to Native American communities than to other ethnic communities. Other analyses show a general concentration of municipal toxic waste sites in communities with large numbers of ethnic minorities.

Some of the most visible examples of toxic exposure have had disproportionate influence on minority communities. In Pennsylvannia, there is a majority-black county that is overwhelmingly African American and also houses a disproportionate number of polluting industries. In Chicago, the predominantly African American Altgeld Gardens community housing project was built on top of an abandoned landfill and was surrounded by pollutants such as heavy metals, DDT, and PCBs. Similar stories of toxic siting in poor, minority communities occurred in Houston, Texas; Institute, West Virginia; Alsen, Louisiana; and Buttonwillow, California. There are many other examples throughout the United States.

While the causal link between toxic sites and racial communities is tentative, the correlation between the two is well documented. Whether race is the cause is beside the point; the real harm is the unequal distribution of negative environmental consequences.

Love Canal

The Love Canal disaster is often called the "worst toxic waste disaster in U.S. history." The New York neighborhood within Niagara Falls was built around an abandoned canal where, in the two decades following World War II, the Hooker chemical and plastics plant dumped toxics, including tens of thousands of tons of carcinogens such as PCBs and dioxin. After the company closed and the land was deemed safe, it was given to the city of Niagara Falls, which used it for new neighborhoods. In 1978, journalists began writing stories about the history of the neighborhood, and citizen-activists pressured state officials to address concerns that they may be living on top of a toxic waste site. Some residents began reporting seepage of toxic waste into their basements.

Lois Gibbs, a Love Canal housewife and mother of a child with lung problems and epilepsy, believed that her son's illnesses were due to his playing at the school playground. She began to petition to have the school closed, and in the process of going door-to-door around her community, she learned that many of her neighbors also suffered from unexplained illnesses and birth defects. She enlisted support from neighbors, and they presented their findings and signatures to state health officials, who responded by closing the school and suggesting that all pregnant women leave the area. About a week later, President Jimmy Carter declared the area around the school an emergency area, a declaration that helped allocate funds for relocation of homes near the school.

The EPA and government officials, following scientific uncertainty, were reluctant at first to acknowledge the full harm posed by the toxic site. In early 1980, tensions rose when the EPA finally admitted that the Love Canal residents were exposed to carcinogens such as dioxin; the report also said that residents may have contracted chromosomal damage. Angered at years of inaction by the federal government, Love Canal activists took two EPA officials hostage. The hostages were released without harm, but Lois Gibbs gained national media attention for the cause. Gibbs then appeared on national television talk shows and described the struggle as a presidential campaign issue. Carter agreed to set up a fund to clean up other toxic waste sites around the country. This became known as the Superfund.

Regulatory Responses to Toxic Waste

Concerns over dangers posed by toxic wastes have spurred regulatory approaches in several industrialized nations. The widest global agreement on toxins is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal. The Basel Convention is intended to regulate the trade and dumping of toxic wastes across international boundaries, but it lacks enforcement provisions for trafficking in illegal hazardous waste. It was opened for signature in 1989 and, as of the end of 2010, had 175 member nations throughout the world (the United States was one of the few nations that had not signed the agreement). In 1994, the parties of the Basel Convention agreed to the Basel Convention Ban Amendment, immediately banning (without enforcement provisions) the export of hazardous wastes from Organisation for Economic Co-operation and Development (OECD) to non-OECD countries.

Within the European Union, Council Directive 91/689/EEC, on December 12, 1991, set controls on hazardous waste management, specifically, requirements related to traceability, forbidding the mixing of hazardous waste with other waste, and the obligation to inform the commission of waste that has hazardous properties but is not listed as such. That

directive was replaced on December 12, 2010, with Directive 2008/98/EC of the European Parliament and the European Council (passed November 19, 2008). This directive establishes a legal framework for the treatment of waste within the European Community. It aims at protecting the environment and human health and provides guidelines to member states that they establish practices to store and treat dangerous waste in conditions that ensure the protection of health and the environment.

Within the United States, the major regulatory tools are the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly called the Superfund) and brownfield programs. Enacted in 1980, CERCLA provides a regulatory mechanism in response to threats from abandoned, accidentally spilled, and illegally dumped hazardous wastes. Through penalties and taxes on hazardous substances, CERCLA provides funding and guidance for cleaning up abandoned sites. CERCLA directs the EPA to analyze, prioritize, and oversee remediation of toxic waste sites, even when the responsible party is unknown or unwilling to pay for cleanup. The program officially seeks widespread participation by the public through stakeholder meetings, but the stark contrast between participation and power is noted by many stakeholders who challenge government authority.

The EPA established the Brownfields Program in 1995. The EPA defines a brownfield as a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. The agency estimates that more than 450,000 such sites exist in the United States. The program began with the EPA providing seed money for a variety of two-year pilot programs at the state and local levels and was expanded under Public Law 107-118 (H.R. 2869), the Small Business Liability Relief and Brownfields Revitalization Act. The act, passed in 2001, provides relief for some small businesses from Superfund liability and, alternately, provides financial assistance for the cleanup and reuse of brownfields. As of September 2010, the EPA claimed that its Brownfields Program had leveraged more than $14 billion in brownfields cleanup and redevelopment funding from the private and public sectors and leveraged approximately 60,917 jobs.

The fastest-growing program is CERCLA's redevelopment initiative in which Superfund sites are developed into airports, shopping malls, sports fields, and wildlife refuges. While redevelopment has cost much more time and money than simple cleanup of past Superfund sites, it has increased community and business involvement. Environmental activists question the safety of cleanup methods—especially incineration and redevelopment. Environmental activists protesting Superfund sites have also focused on the lack of accountability and transparency. In late 2009 and early 2010, new EPA policies promised to increase transparency in Superfund cleanups.

At the 25th anniversary of the Superfund, construction work had been completed at 966 sites, or 62 percent, and work had begun at an additional 422 sites, for a total of 1,388 sites on the National Priorities List. By the beginning of 2010, 1,320 toxic waste sites were on the National Priorities List. Despite decades of measuring and responding to toxic waste by governments, scientists, activists, and citizens, toxic waste remains a pervasive part of modern life.

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See Also: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Environmental Justice; Love Canal; Resource Conservation and Recovery Act; Sociology of Waste.

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Toys

Purchase and ownership of toys has long-term implications for children, parents, and the environment. While much has been written regarding the effect of certain toys upon gender-identity development and exposure to toxic chemicals, such as PVC, lead, and cadmium, there is little information available about the afterlife of toys once they leave the hands of their owners and land in recycling bins, landfills, or illegal dumps. Toys and their baggage—multiple layers of packaging of various types that accompany them—interact with all segments of society. U.S. children consume more than 40 percent of the world's toys, though they only comprise 4 percent of the world's child population. Though toys were originally manufactured for and marketed to children in the 1960s, the toy market expanded to encompass teenagers in the 1980s. Adults also collect action figures, Beanie Babies, and other toys for display and as investment opportunities. As a nation of animal lovers, Americans also purchase toys for dogs, cats, horses, reptiles, and other small animals.

Beginning as early as the 1980s, when Care Bears entered the marketplace, the plush-toy manufacturing industry ramped up production to offer competing products. In 1982, over 65 million units were sold. In 1984, over 17 million Care Bears were sold in the United States. By 1987, that number nearly tripled to 193 million units.

Recycling Habits

Some families teach their children to recycle their toys. Single-stream recycling makes the practice easier for people because it ends the hassle of sorting. For example, instead of separating cardboard from plastics, all recyclables go into one bin. The numbers of people recycling increase, and less trash is being hauled away from neighborhood curbsides. Toys are sorted with other plastics and sold to facilities handling that particular material.

Disposal Habits

Overconsumption of toys and their resultant disposal is an international burden that each country bears. In the United Kingdom, statistics reveal that the mean age of toys discarded between 1993 and 1998 was 4. While most consumers wish that their items be reused or repurposed, only about 35 percent of toys are donated or sold for reuse, which leaves 65 percent of the total amount of cast-off toys lying in landfills where they may never degrade entirely and may leach chemicals such as lead, cadmium, and PVC into the soil and groundwater tables. When toys are recalled by companies in the United States, they follow U.S. government guidelines in the disposal of the recalled toys and are usually destroyed.

For example, Fisher-Price never refurbishes recalled toys. Customer service supervisors at Manhattan Group of Minneapolis, Minnesota, have no idea what happens to recalled toys that their company manufactures or distributes. This lack of knowledge at the corporate level may indicate that recalled toys are illegally dumped or destroyed, or it may be an instance of corporate ignorance.

Hazards

In 2008, Walmart, Target, and Toys "R" Us recalled about 25 million toys made in China and sold in the United States because they contained lead or other heavy metals and chemicals that cause medical and developmental problems in children. While China bears the brunt of Americans' ire over lead-contaminated toys, other countries manufacture cheap toys that end up in landfills. Six toy production centers in India produce approximately 2,000 stuffed toys each day—4.4 million toys a year.

Baby chew toys, rubber duckies, and plastic bejeweled necklaces oftentimes contain polyvinyl chloride, phthalates, and lead, especially when toys are produced overseas where manufacturers do not comply to the same environmental, health,

and safety standards as in the United States. Lead is only one of many toxic elements found in children's toys, causing parents to toss them into the garbage in greater numbers than in the past. Toxic toys are often imported from other countries to the United States. For example, Mattel recalled many of its popular toys when they were found to contain lead; they were made in China.

Devaluation

In 2010, an ecofriendly children's brand launched at FAO Schwartz. GREENZY'S plush toys are made from soy fibers and nontoxic dyes to reinforce environmental responsibility, but they did not address the waste issue the toys create when they grow old, unstylish, or children tire and dispose of them. Children may grow up faster in part because they are exposed to sex and violence in the media. U.S. childhood has a smaller window for play with toys before tweens abandon traditional toys for electronics like mobile devices and handheld video game devices.

The proliferation of both plastic and plush toys, coupled with Americans' impulse buying of these low-value items with discretionary income, has resulted in the devaluation of toys from special, cherished heirlooms to disposable commodities. The availability of cheap items at Dollar Stores and other retail outlets is merely a symptom of the throwaway society created by an abundance of toys. Consumers are prey to faddish and whimsical impulses with no thought given to the carbon imprint they leave behind with such thoughtless, acquisitive compulsions driving their purchases. The play value of such mass-produced and -marketed toys is low. Children become bored with their toys. Many toys are manufactured to reflect economic status, and possession of trendy toys increases children's standing among peer groups. The consumption patterns of children from countries outside the United States have increased to mimic U.S. toy consumption. Chinese families spend 85 percent of the family's income on their children. Those expenses include food, toys, and other items. While the cost of toys is cheap, their indirect costs of waste disposal, hazardous materials handling costs, environmental effects, and damage to health are steep.

Environmental Impact

Children's toys are often illegally dumped, along with other unwanted waste. Once a child accumulates several years' worth of cheaply produced toys given away as treats or for promotional distributions—like toys given away at fast food restaurants such as McDonald's and Burger King—the child disposes of them into the trash to clear space for new toys.

Project Kaisei was formed to extract large items, such as large toys, from the Great Pacific Garbage Patch, an international garbage dump floating 1,000 miles north of Hawaii that was discovered in 1997. Toys comprise a portion of its estimated 3.5 million tons. Once smaller parts of children's toys fall into the ocean, they kill seabirds. Approximately 66–80 percent of marine litter is plastic, which takes hundreds of years to degrade.

Before a child plays with a toy for the first time, it must be removed from extensive packaging that both protects the item during shipping and prevents its theft from store shelves. Besides the hard plastic and cardboard boxes that toys are shipped in, some feature packing peanuts and foam for cushioning and insulation. At some point, the toy and its packaging become junk.

Adult Toys

Adults must dispose of their sex toys. The adult industry pioneered an environmentally friendly way in which to dispose of vibrators, dildos, plugs, and other sex toys. Dreamscapes launched the Sex Toy Recycling Program in 2008 and offers an alternative to dumping adult toys in a manner that might be hazardous to the environment. As a Green Certified Business, Dreamscapes (a Tampa, Florida, firm) cleans and disassembles sex toys once they receive them via the postal service. Parts unfit for traditional landfill are sent to recycling facilities, which process or sell the raw materials such as silicone, rubber, plastic, meal, electronic waste, motorized parts, and batteries for reuse. The Sex Toy Recycling Program attests that 90 percent of items they receive are recycled by material-specific recycling centers. They suggest that consumers buy and use green sex toys that are made from 100-percent surgical silicone, glass, or metal. Green sex toys are recyclable, safe, hypoallergenic, and chemical free.

Conclusion

The Environmental Protection Agency (EPA) does not collect and report data specific to toys in its collection of annual municipal solid waste generation, recycling, and disposal in the United States. While 2008 figures reveal that Americans generated 250 million tons of trash and recycled and composted 83 tons of material, it is not known what proportion of those measurements include toys. However, the EPA reported 30 million tons of plastic, 7.41 million tons of rubber and leather, 12.37 million tons of textiles, and 16.39 million tons of wood waste. Toys are constructed from a variety of materials, including the aforementioned categories from the EPA report. Undocumented statistics estimate that 13 million toys are dumped into landfill sites each year. Promoting the recycling of toys, whether by donating them to a second hand retail store or reselling them at yard and tag sales (or online via eBay), is promising for reducing their numbers in landfills. Americans could take note of toy libraries in the United Kingdom that collect and loan out a wide range of toys to children.

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See Also: Baby Products; Children; Ocean Disposal; Public Health; Recyclable Products; United States.

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Transition Movement

The term *transition movement* refers to affiliated groups of citizens and organizations that are in the process of creating so-called transition towns or transition initiatives worldwide, especially in the United Kingdom and the United States. The term *transition* in this case refers to the move from the current economic system to a "post-carbon" society. This is because transition organizers are motivated by two principal concerns: global peak oil and climate change. Global peak oil is the idea that global oil reserves have reached their peak and that—while global demand for oil is on a steady increase—cheap, readily available sources of petroleum will henceforth be on the wane. Peak oil will have ramifications for nearly all sectors of industrial society, impacting not only transportation but also food systems, the production and distribution of goods (especially plastics), and the organization of towns and cities.

The second concern, climate change, refers to the probability of significant climate disruptions caused by increased greenhouse gases in the atmosphere, which will most likely significantly alter weather and climate patterns worldwide in the 21st century. These shifts may cause—or may already be causing—extreme weather events, rising sea levels, and even the mass migration of animal and human species seeking to adapt. A third concern for transition organizers is the threat of economic collapse or crisis, such as the global economic meltdown that began in 2008.

Goals

Transition initiatives seek to respond to such challenges both by relocalizing communities and their economic and social systems and by building resilience and joyful or exuberant futures into those local communities. As of 2010, most communities in the industrialized world are organized to be part of giant, transnational, or globalized networks of production and consumption. Consumer goods are manufactured, shipped, and consumed all over the world. People—especially those in large cities—rarely work in the same vicinity where they live. Most food is shipped massive distances. Rapid societal changes, particularly in areas such as communi-

cation technology, make it easy for people to isolate themselves from neighbors.

Transition aims to counter these phenomena by fostering creative forms of problem solving, organizing, and production at the local level. For example, some towns or regions have adopted local forms of currency that may be robust in the face of global economic collapse. This provides citizens with a system for trading goods independent of the global economic system, over which individuals seem to have little control. Other transition towns are in the process of promoting local agricultural and sustainable food practices so that citizens might grow more of their own food and be less dependent on national or international food systems and shortages. Still others are proposing transportation initiatives that promote walking or biking. Most are focused on fostering connections between individuals with similar environmental and economic values; many feel that such connections have been severely compromised by the extreme individualization fostered by postindustrial society.

Origins and Growth

The origins of the transition movement are generally credited to Rob Hopkins, a UK citizen teaching permaculture (sustainable land use design) classes in Kinsale, Ireland, in 2005. With two of his graduate students at the Kinsale Further Education College, Hopkins wrote an "Energy Descent Action Plan," an effort to transition the town of Kinsale to a post-carbon economy. The students, Louise Rooney and Catherine Dunne, presented the plan to the Kinsale Town Council, where it was eventually approved and, as of 2010, was in the process of being implemented. Hopkins went on to replicate the plan in his hometown of Totnes and cofounded the Transition Network, one of the lead organizational arms of the international transition movement.

There are hundreds of transition initiatives existing worldwide, with strong U.S. hubs in California, New England, and Colorado. Unlike many other environmentalist or sustainability-oriented organizations, transition has resisted hierarchical structures of organization, preferring instead to operate on a "cell" model in which Hopkins's Transition Network functions in an advisory role, providing resources but not dictating programmatic goals for individual transition initiatives. In fact, in training materials, the network encourages transition organizers to plan for their own obsolescence, handing over power to communities. The goal is not to build the organization but rather to empower communities to build and have ownership of their own initiatives, dependent upon local contexts, needs, and strengths. As a result, funding for transition initiatives frequently varies by location, but Transition US has received funding from the Post-Carbon Institute, a nonprofit organization aiming to study and facilitate society's transition away from oil dependence.

Effectiveness

Given the tremendous uncertainties inherent in peak oil and climate challenges, it is difficult to evaluate the effectiveness of transition initiatives as responses. It is possible that these crises may not be as severe as some predict, in which case the transition movement may seem irrelevant. Or, these crises may prove so severe that no amount of relocalization or community empowerment will matter. The reality will most likely lie somewhere between these extremes, in which case the transition movement will prove to be both prescient and useful.

It could be seen as a part of a growing interest in what philosopher Kate Soper calls "alternative hedonism," seeking the good life not through consumerism but through community and local consumption and production practices. Seen in this light, rebuilding communities, strengthening local ties, and increasing joy and resilience are practical—if somewhat utopic—goals, regardless what the future holds.

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See Also: Consumerism; Consumption Patterns; Economics of Consumption, U.S.; Food Consumption; Material Culture Today; Zero Waste.

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Trash as History/Memory

Throughout the 20th century, trash has been appropriated as one of the key figures through which to contest traditional, scholarly understandings of history. The term *trash*, understood in its broadest sense as something deemed of no value, has been located as a telling figure, capable of highlighting all that 19th-century forms of history have too readily dismissed in their faith in objectivity, progress, and development.

Walter Benjamin and Early Theory

Walter Benjamin is one of the early theorists to have adopted this optimistic view of trash for the revision of conventional forms of history. In his treatise, *The Arcades Project*, Benjamin undertakes a critical evaluation of 19th-century conceptions of modernity and history, drawing upon the seemingly trivial, minuscule items of detritus left to decay in the dilapidated shopping arcades of 19th-century Paris. Writing from the vantage point of the 20th century, these obsolescent commodities held allegorical significance for Benjamin, gesturing to the failure of history and modernity under 19th-century industrialization. Outdated commodities were vital runes of modernity at large. They were telling for the way they undermined the foundational tenets of development and illuminating for the way they highlighted the contradictions inherent in 19th-century conceptions of progress. Benjamin thus imbued the arcades' junk and refuse as symbolic for the redundancy of modernity's ideals of civilization and social betterment. When framed through trash, the definitive experience of urban modernity was far from an encounter with the new but was rather the experience of repetition—endless sameness. The arcades and their detritus stood as cathedrals of the commodity fetish, offering up the appearance of a long-awaited better world in order to still any real sense of actual historical change.

The ruined arcades, and their outmoded clutter, therefore held the potential to open up a different understanding of history and modernity, prizing open the lines of closure through which traditional narratives of history maintained their cohesion. Derelict objects could offer a radical critique of history's myth of universal progress, illuminating the way history becomes stagnant and derelict when driven by the supposedly innovative power of capitalism and technology. By apprehending the modern as the already-old—the ancient dressed up as the new—Benjamin held that this consciousness was also capable of realizing the actually new. The trivial scraps of urban life therefore offered a fundamentally different way of understanding modernity and history, not only by allowing for different representations to emerge, but also by fundamentally reconfiguring historical methodology. Trash therefore eschews conventional historical methodologies based on transcendence, progression, and linear narrative models in which the past only exists to confirm the dominance of the present. Trash exceeds official scholarly knowledge grounded on the separation between public and private, heritage and the contemporary.

Later Conceptions

Benjamin's reading of the viability of trash in staging a critical and transformative encounter with the past takes on a new urgency in the 21st-century cultural milieu, given that the value of trash has changed in the contemporary commodity culture. The insatiable desire for endlessly new outdated "retro" objects in postindustrial commodity cultures has come to suture the historical consciousness, such that the coveting of trash may no longer hold the rupturing capacity it was once believed to possess. Trash has become tainted with the aura, not of heritage, but of vintage or retro. As a coveted commodity, it may no longer hold the critical potential Benjamin once ascribed to it. Critics like Fredric Jameson and Hal Foster argue that trash epitomizes the limitations of historical thinking in postmodern culture. Trash has been written into the canon of postmodernism's

theory of history—history has become trash—such that it no longer resides as a figure through which to rupture traditional models of history, but the very figure that signifies the crisis of history in late capitalism. Trash embodies the perpetual repetition and recycling that purportedly sutures the postmodern present. In Jameson's view, it is the latest symptom of postmodernism's facile interest in micronarratives that do little to displace the presence of the present, so much as confirm the ubiquity of late capitalism. Trash therefore embodies the logic of *posthistoire*, or as Jameson notes, the disappearance of the weightiness of history—the incapacity of society to "retain its own past," prompting the perpetual amassing and aestheticization of past fragments that Jameson terms *pastiche*—a form of history that has become little more than a dusty set of spectacles or a series of perpetual presents.

The term trash *once denoted items of no use, yet in modern research, it embodies the question of how to imagine historical change. To 19th-century philosopher Walter Benjamin, trash was symbolic of the redundancy of modernity's ideals of progress.*

History is reduced to the endless recycling, pastiche, or bricolage of outdated objects, finally embodying the postmodern dictate that there is no outside from which to rupture the status quo or the dominant teleology of history. This form of history as trash is a highly conservative force because the resuscitation and renovation of aesthetics and styles from the past offers a seductive image of change that functions to stall real historical alterity. Hence, the resuscitation of past, outmoded forms does not displace history, as Benjamin argued the appropriation of trash could do. It merely confirms the dominant late capitalist system that gives the surface appearance of change to allow society and culture to remain the same. Or, as Jameson notes in *The Seeds of Time*, ". . .what begins to emerge as some deeper and more fundamental constitution of postmodernity . . . at least in its temporal dimension—is that henceforth, where everything now submits to the perpetual change of fashion and media image, nothing can change any longer." Late capitalism is not displaced by trash; rather, it is perpetuated by the recycling of outdated styles and forms. The thorough dismantling of historicism's presence and the celebration of fragmentation, difference, and obsolescence looks more like a collusion with late capitalism's dominance, rather than an unsettling engagement with the alterity of the past. History is most dead when it is paralyzed in an interminably fragmented and discontinuous present—when its gravity is purportedly reduced to the endless recycling of junk moments and retro styles.

Conclusion

Trash has therefore become a highly loaded figure in postmodern debates about the representation of historical difference within commodity culture at large. Trash signifies the utter fragmentation of history in late capitalism, embodying the very problematic facing postmodern theory broadly: the question of how to imagine historical change, the new, or the truly modern. *Trash*, in other words, is a key term around which the crisis facing history in postmodern culture is played out—the key issue at stake regarding its very futurity.

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See Also: Commodification; Consumerism; Culture, Values, and Garbage; History of Consumption and Waste, U.S., 1950–Present; Overconsumption; Politics of Waste; Post-Consumer Waste; Recycling; Recycling in History; Rubbish Theory; Shopping.

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Trash to Cash

The expression *trash to cash* refers to either (1) the exchange of objects considered garbage for money or (2) the gaining of monetary profit through the service of garbage removal. Historically, however, money was often not involved in either of these exchange processes. During World Wars I and II, for example, collecting and returning different kinds of wastes, such as coffee grounds or metallic consumer products, were in many countries regarded a national duty and did normally not involve monetary transactions. Neither is the exchange of trash for cash a phenomenon limited to capitalist societies. It can rather be regarded a characteristic of monetary economies in general. For example, between the 16th and the 19th centuries in precapitalist Japan, city dwellers could sell their excrement. Another example is the communist German Democratic Republic, where governmental agencies bought different kinds of scrap material from the population. The case of the German Democratic Republic also shows that the two different versions of creating money out of garbage—the increase of value of a material and the service of removal—cannot always be clearly distinguished in practice. In the 1950s, officials discussed whether the population was being paid for the service of collecting their garbage for the state, or if people were compensated for the actual material. While the difference does not seem important in a capitalist economy, it was in German communism where the allocation of resources was equipped with higher funds than the provision of services.

Cash Through Recycling Trash

The exchange of trash for cash is most importantly owed to the fact that garbage is not intrinsically worthless, but is—in dependence of the context—attached to a certain value. Through the change of its owner or user, an object's value can increase. Something that is regarded as garbage and thus as valueless by one person in a particular context, may be regarded of a higher value by another person in another context. For example, industrial waste products of one factory can be used as a resource in other industrial contexts. Similarly, household waste can be grouped into different material categories such as paper, aluminum, or plastic, conditioned and sold as a resource for production. Since an aura of having no value still adheres to the waste material, a somewhat mystic dimension has often been attached to the ability of creating value out of it. In this respect, "trash to cash" particularly refers to a narrative that became popular in capitalist countries between the late 19th century and the 1920s.

Its main idea is reflected in numerous publications titled *Wealth From Waste* (1908), *Millions From Waste* (1920), and others. These argue that modern garbage is a waste and hides resources that only need to be made accessible. The narrative can be regarded as an outcome of changing consumption habits of the time that consequentially led to an ever-increasing amount of garbage. Entrepreneurs started to become interested in filtering out products of value on a large scale. Throughout Europe, several recycling factories opened. For example, Budapest introduced sortation in 1895, Munich in 1898, and Berlin in 1907.

Turning trash into cash by that time had been practiced for hundreds of years. "Rag men" and "rag pickers" on a much smaller scale collected and sold waste material. Up to the 21st century, the rag-picking business exists in developing countries at the bottom of the social ladder.

In contrast to the rag pickers, the systematic sortation and recycling that had established in the late 19th century rapidly declined again because of economic problems. These problems have stayed the same ever since. Recycled garbage in capitalist economies is traded in a relatively free market. As such, the former competes with raw materials withdrawn directly from nature. The scrap's quality as well as its price is thus constantly compared to that of raw materials. The physical necessity of sorting waste into accurate fractions of paper or metal, for example, requires personnel and cost-intensive activity. The technological developments of cutting-off machines as well as the introduction of separate waste collection in households support the recycling industry in the early 21st century. The latter has to do with a perception of waste as an environmental problem that needs to be solved on a societal level through different measures of removal and avoidance. Subsequently, an industry of waste removal emerged.

Cash Through Removing Trash

"Trash to cash" also refers to the service of waste removal and disposal. In this case, the value ascribed to garbage does not change, but the producer of garbage or society pays another party to remove it. Whereas, typically, systems of waste removal are established during urbanization processes, only since the 1970s was garbage removal transformed into an extraordinarily profitable business in Western capitalist countries. As an effect of ever-rising amounts of garbage and its increasing toxic components, garbage removal was restructured according to a new ecological paradigm. Regulations called for the use of technologies such as sanitary landfills and, later, incinerators in order to keep toxic garbage separate from the natural environment. Together with a neoliberal economic paradigm of the late 1970s and 1980s, the removal was assigned to private companies. They, in turn, started to form an industrial complex yielding profit out of waste, not only by selling valuable materials extracted out of garbage, but also through collecting fees for the service of adequate ecological removal.

At the beginning of this new system, the regulations were undermined by the illegal dumping of waste aside from ecological regulations. Often, this was only possible because officials tended to bend the rules in favor of business and to the disadvantage of the natural environment. Similarly, the illegal export of garbage to countries with less-strict ecological regulations has been regularly reported ever since. Both illegal activities have led to a Mafia-like image of waste industries. However, regulations and inspections have been imposed much more strongly since the 1990s so that the profit margins of the waste industries have scaled down considerably and illegal dumping and export have become less frequent.

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See Also: Capitalism; Crime and Garbage; Culture, Values, and Garbage; Waste Management, Inc.

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Trashed

Trashed is a 2007 documentary film directed by Bill Kirkos. The film focuses on the growing business of waste disposal and addresses the myriad

consequences that result from overconsumption and waste. The film begins with mention of a 2000 Environmental Protection Agency (EPA) study that linked global climate change and solid waste management. Since that time, Americans have continued to produce increasing amounts of garbage, with the average American producing 4.5 pounds every day, for a total of 400 million tons of garbage. According to the filmmaker, this stems from a society that places higher value on things that it buys and throws away, rather than on conservation, recycling, reuse, and meaningful reductions. In addressing this social problem, *Trashed* uses the case study of the landfill and its relationship to economics, the environment, and social issues.

Case Studies

Like many states, Indiana imports a large amount of garbage—some three million tons of out-of-state garbage. Combined with this statistic is the fact that between 2000 and 2004, the number of curbside recycling programs dropped by 50 percent. The film discusses the politics surrounding the Mallard Lake Landfill, a 256-acre landfill located in Anderson, Indiana. Residents have been battling to keep the landfill out of their community, in part due to its size, concerns about leachate and the effects on aquifers, and its close proximity to an elementary school. While many residents have expressed concerns about the impact of the landfill, landfills like Mallard Lake can make millions of dollars per year.

The next case study is the state of Michigan. Since 2004, 10 million tons of domestic and international garbage have been brought into the state, with 400 garbage trucks arriving from Toronto every day. Michigan offers one of the cheapest rates for the importing of garbage and some state legislation attempting to change this tendency has been unsuccessful. In some cases, medical waste has leaked from the garbage trucks. Using the state of Michigan as a case study, Kirkos emphasizes that more and more landfills are private, money-making operations.

Alternatives

The film then turns attention to the contrast of the landfill—recycling. During World War II, there was a massive effort to recycle and conserve precious resources for the war effort. However, following the war, an explosion of commerce and waste resulted in greater threats to the environment. The spirit of recycling has been difficult to inculcate, in part because there is more money to be made in landfills than in recycling. Three successful examples of recycling and reuse are then offered. The first is Urban Ore Ecopark in Berkeley, California, a household supply store that includes various items, such as old bathtubs, doors, and consumer electronics. The store functions as a reuse market in which old items can be turned in and then resold to consumers. The second is Interface, Inc., the world's largest commercial carpet manufacturer. According to its CEO, Ray Anderson, while reading Paul Hawken's *The Ecology of Commerce*, he had an epiphany that he was a plunderer of the Earth, and this led him to transform his company into being restorative and sustainable. Using a reclamation program, old carpet is turned in and reused, essentially replacing a linear production process with a cyclical one. The third example considered is that of New York freegans—individuals who salvage food from trash and express an anti-consumerist ideology.

The film concludes with case studies on composting and the effects of plastics in the world's oceans. In the first case, the examples of Toronto's successful green-bin wet-waste program and San Francisco's restaurant composting programs (in which, in some cases, up to 90 percent of garbage is either composted or recycled) are detailed. In the second, the impact of plastics in the oceans is addressed by discussing the plight of seabirds resultant from the 3.5 million tons of plastics in the world's oceans. According to the film, there is six times more plastic than marine life on the surface of the North Pacific Gyre.

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See Also: *Garbage! The Revolution Starts at Home*; Landfills, Modern; Recycling.

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Turkey

Turkey, as of 2011 a candidate state in the European Union (EU), has been an important economic power for centuries, in part because it links Europe and Asia. The information on hand regarding the amount and composition of wastes generated in Turkey is substantially limited. Garbage was historically regarded as a problem to be resolved and taking the garbage away from sight was assumed sufficient for the solution of this problem.

The garbage figuratively "swept under the carpet" in Turkey for a long time has become questionable in administrative and legal platforms since the comprehension of waste as an economic value in the 1990s, and the adoption of a solid waste management approach that is still valid in the early 21st century. The legislation on waste management in Turkey has been revised within the EU harmonization process and the basis to be followed has been defined in detail; however, substantial deficiencies exist in the implementation of these regulations.

Statistics

According to 2008 data of the Turkish Statistical Institute, which is in charge of establishing municipal waste statistics in Turkey, the total amount of annual municipal solid waste collected by 3,129 municipalities out of 3,225 that provide waste collection service was calculated at 24.36 million tons. Annual average waste amount per capita is about 2.5 pounds. The only regular data regarding household solid waste composition in all of Turkey belongs to 1993. According to this data, as much as 68.87 percent of the household waste in Turkey was organic in nature. The composition of household solid waste has also changed together with the increase in population, urbanization, industrialization, and transformations in the consumption field in Turkey since the 1990s. More up-to-date data regarding waste composition was obtained in 2006 by determining seven cities that could represent the general profile of Turkey and conducting solid waste characterization studies in these cities within the framework of the Solid Waste Master Plan Project of the Ministry of Environment and Forestry. According to this study, which aims to anticipate changes in the amount and composition of the wastes, the ratio of biodegradable waste (including kitchen waste, paper, cardboard, voluminous cardboard, park and garden wastes, and other flammable and other voluminous flammable wastes) had the highest level in all cities and its ratio was 55–65 percent. Kitchen wastes had the highest share in this ratio at 32–44 percent. The share of recyclable wastes was 18–37 percent. Where 17.11 percent of the population live below the limit of poverty in Turkey, the wastes of recyclable nature are more intensely collected in large cities and from those regions of these cities with high income levels.

Consumption and Waste Practices

Consumption practices of poor people mainly consisted of using their own resources, such as preparation of basic sustenance materials at home or bringing them from villages at certain time intervals; purchasing of loose products without packaging; or obtaining clothes from acquaintances, decreasing the amount of packaging wastes. In Turkey, proximity of some slum regions to dump sites is another issue that is prominent in the relation of the poor with waste and produces various dangers, as experienced in 1993 in the Hekimbasi waste yard in the Ümraniye district of Istanbul. In the field where garbage had been dumped for approximately 20 years, drift occurred because dumping was not well managed; 39 people were killed by the garbage fallout caused by methane gas accumulation under pressure, leading to an explosion. Rapid increase in population, together with urbanization, have changed the outlook of waste in Turkey. While in 1945, 4.7 million people (approximately one-fourth of the total population) lived in the cities, as of 2010 approximately 55 million people lived in the cities, with a total national population of approximately 73 million.

Another factor effective in the change of waste amount and composition in Turkey is the change in consumption patterns. In the 1930s, when the first industrialization period had started in Turkey, the country closed its economy to the outside and a period of national industrialization was initiated. In this period, with the establishment of the National Economy and Saving Society on December 12, 1929, and its public relations activities, citizens became accustomed to saving and consuming

domestic goods, rather than foreign imports. However, this discourse has lost its validity, especially after the 1980s.

This transformation was shaped by the economic policies brought into force on January 24, 1980, which were assumed to be extensions of neoliberal economic policies applied around the world. With the economic transformation of January 24, liberalization was provided in the financial system in Turkey, and the Turkish economy became open to global markets. This liberalization process helped the development of consumer society in Turkey. Thus, product variety increased after the 1980s, and there has been a transformation from scarcity toward abundance in products and services. Turkey's integration into global markets within the context of consumption has caused changes in waste amounts and composition. Moreover, the changes in Turkey's economic policies have affected the administrative regulations about garbage.

Conceptions of Garbage

Turkey's relationship with its garbage has historically evolved from an approach considering garbage as a problem related to public health. toward an approach where the relationship of garbage and environmental destruction is built and garbage is framed as a part of environmental problems and environmental health, and finally to an approach where garbage is regarded as an industrial service area to be managed along with the environment. This latter approach has led to a point where operations regarding garbage are no longer a public concern, and garbage is redefined as an economic element that should be utilized. In parallel with the historical changes in processes regarding wastes, the institutions regulating and auditing operations related to garbage have also changed.

In the 1930s, when garbage was defined as a part of public health, all operations regarding garbage were defined as services of municipalities and auditing of these services was under the responsibility of Ministry of Health. In some regulations brought into force beginning from the mid-1960s as a consequence of the practices conducted by the Ministry of Health, the emphasis on environment has become more prominent. Starting from the 1980s—with the environment-centered approach—issues related to garbage were defined as one of the fundamental government policies with the establishment of undersecretary of environment and then the establishment of the Ministry of Environment in 1991. The view of garbage also went through revisions with the impact of globalization.

Garbage was redefined as waste during that time and the regulations in this area were systematized as solid waste management. Economical and commercial purposes related to waste have gained importance with the solid waste management approach, and all processes that used to be defined within the scope of municipalities had restructured so that they could be handed over to the private sector.

Regulation and Management

The solid waste management approach could be regarded as a consequence of the reverberation of the globalization process on waste management in Turkey. The Solid Waste Control Directive that was brought into force in 1991 and revised several times constitutes the legal provision of solid waste management. Moreover, the Directive on General Principles of Waste Management, which came into effect in 2008, determined the basic principles of waste management.

In Turkey, action plans are established by the Ministry of Environment and Forestry in order to solve the problems encountered in waste management services and determine strategies for implementation of regulations, which are prepared within the framework of EU harmonization programs. Although comprehensive legislative regulations regarding wastes are set in Turkey, there are still problems in the implementation. In Turkey, wastes are generally deposited in unregulated dump sites in an uncontrolled way. As of 2010, there are 46 sanitary landfills in Turkey and approximately 2,000 small-scale and 50 large-scale uncontrolled dump sites.

There is an unregistered industry about recycling of packaging materials arising from the deficiencies of implementation. Street collectors, the number of whom is not known but estimated to be 20,000 in the capital city of Ankara alone, realize an important part of recycling in Turkey because waste segregation at the source is not well devel-

oped in Turkey. However, their situation is difficult because of the latest regulations on packaging waste in 2004 and 2007. So-called recycling workers, who earn their living from garbage and regard garbage as a living area, gathered and founded a Recycling Workers Association in 2005 and publish a journal, *Katık,* with the motto "Do not throw capitalism in the junkyard of history, it is not worth a cent." It is perhaps the first organization of its kind in the world.

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See Also: Developing Countries; Recycling; Slums.

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Typology of Waste

Industrial waste is defined as any substance not required by a generator and is therefore to be discarded from the site at which the substance is located. This definition can be applied more broadly to commercial waste, such as from hotels, offices, hospitals, retail stores, and residential properties. In such cases, the occupier of the premises is construed to be the generator. The definition can be extended further if the concept of "site" includes entities such as modes of transport, in which cases the corresponding generators are the people who operate them. A definition might describe a unique, immutable relationship or phenomenon, such as the area of a circle in relation to its radius, or it may indicate a group of phenomena that is to be considered for a specific purpose. Definitions of waste are examples of the latter category, some formulated for purposes that might produce unintended consequences. A case in point is the all-inclusive definition of industrial waste formulated by some agencies as the basis of strategies for protecting the environment. Such definitions may facilitate regulatory action but they might also inhibit the use of waste in practice, to the detriment of the environment. A typology of waste may help to mitigate this and similar difficulties in relation to the consumption of waste.

The notion of "want," as expressed by the phrase *not required*, is the defining criterion of waste, from the perspective of its generator. The notion of want is also a criterion for this typology but from the perspective of a potential user, as implied by the concept of demand. If waste is wanted by a user for a beneficial purpose, then the notional status of that substance may change accordingly, even though the substance might remain physically or chemically unaltered. Notwithstanding that waste may be wanted by a potential user, it may remain unused because the costs of supply, such as handling, storage, and transport, may be prohibitive. The significance of cost is represented by the concept of "tradability," which correlates demand with actual use. Waste is deemed to be traded when some form of consideration is made for the cost of its supply to the user. The consideration may be in cash or in kind, according to the relationship between the generator and the user and may be made by one to the other or by a third party to either. The user may pay nothing for the waste, or may even be paid to receive it. In such cases, the generator is usually the payer, although subsidies might be available from government or other third parties.

Types of Waste

Untradable waste has no known potential for—or possibility of—being used, given the technologies currently available. This category includes waste that is processed specifically for ultimate disposal, such as dumping, indefinite storage, or incineration, other than for waste-to-energy.

Potentially tradable waste could possibly be used, given the technologies currently available, but it is nevertheless dumped.

Narrowly traded waste is supplied to an established market comprising a few users, or even only one user. The trade has to be subsidised in some way—often by the generator—but there is at least a use for the waste that avoids dumping.

Widely traded waste is supplied to an established market comprising many participants. Although such waste might have intrinsic value, it may not be sufficient to cover the cost of supply so the trade has to be subsidised, as with narrowly traded waste.

A by-product is waste for which there is a continuous demand and for which the price paid by the user exceeds the cost of supply. The trade in by-products does not have to be subsidised in order for it to take place.

This classification applies to *voluntary waste*, the creation and disposal of which can be controlled by the generator, as distinct from *involuntary waste*, which the generator cannot prevent from escaping into the environment. Examples of involuntary waste include noise and heat emitted by internal combustion engines, degradation of protective coatings, tire rubber on roads, and the results of accidents such as explosions and spills. It may be possible to use some involuntary waste, but the circumstances would likely be highly specific and hence beyond the scope of this typology.

A corollary to this classification of waste is one of use. The following is suggested on the basis of (manufacturing) processes in which waste might be used:

Recycling occurs when waste in an unchanged chemical form is used in the same process that created the original product. Examples are crushed glass containers (cullet) used to make new glass containers, and scrap metal used in foundries.

Reuse occurs when waste in an unchanged chemical form is used in a process that did not create the original product. Examples include crushed glass containers (cullet) used to manufacture glass wool insulation or manufactured sand, and various forms of waste polypropylene used to make clothing.

Use occurs when the chemical form of waste is changed either before or during the process into which it is introduced. Examples include carbohydrate waste used to produce ethanol, and effluent used as a soil conditioner.

Nonuse occurs when waste cannot be used in any form and is consequently dumped in landfill or is stored indefinitely until an alternative means of permanent disposal is arranged.

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See Also: Environmentalism; First Principle of Waste; Politics of Waste.

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Underconsumption

The term *underconsumption* is used in very different contexts, making an unambiguous definition difficult. On one hand, it is a historically and culturally placed concept based on specific premises developed in the classic Western European liberal economic theories of the 16th, 17th, and 18th centuries. Consumption is therein primarily understood as part of a gigantic market mechanism, and underconsumption as a sign of an undesirable development of the system. On the other hand, economic anthropology questions the universal validity of such an approach. From observations in marketless societies, it became evident that economic relations are embedded in the social system to a much greater extent. A comparative analysis shows that the market economy model also has its limits with regard to industrialized societies.

The term *underconsumption*, therefore, has to be scrutinized against the background of anthropological and sociopsychological reflection on the material world in order to gain a better understanding of consumption patterns and their function in society as a whole.

In the neoclassical economic theories of the 19th century, the premise is that the market economy has self-regulating forces. Hence, a practice of laissez-faire (of nonintervention) can be differentiated, as in the free market the quasi natural level of prices, wages, profit, and production establish themselves, according to Adam Smith's theory of the "invisible hand." Thereby two basic phenomena—production and consumption—are viewed as reciprocally dependent, as they are decisive in the explanation of the economic and social balance of development forces. In this model, it is assumed that production serves the satisfaction of existing needs of the domestic market, whereby, ideally, all goods produced are consumed. If this balance is perturbed due to external causes (such as wars, ecological disasters, or epidemics) and the domestic market collapses, it is crucial that this is evened out by trade and adequate export.

The interplay between national production and global consumption is thus of great importance. In this context, one needs to distinguish between use values (the goods to satisfy the actual needs of the domestic market) and exchange values (the goods for export), as the production cannot be maintained by consumption on the local market alone but additionally by global trade.

One of the first to reject economic liberalism was the Swiss economist Simondi de Sismondi

(1773–1842). In his theoretical approach, the concept of underconsumption was of central relevance, as the question arose of what happens if the produced goods are not consumed. Following de Sismondi, industrialization and the resulting uncontrolled growth lead not only to a constant increment of production but also to an impoverishment of a constantly growing part of the working and consuming population (workers, artisans, and peasants) and to an increase in the number of unemployed. Consequently, de Sismondi radically questions the equation of unlimited growth and common wealth.

Karl Marx (1818–83) regarded de Sismondi to be the father of crisis theory. In his own theory of the connection between production and productive resources, Marx adopted de Sismondi's understanding of underconsumption. Marx recognized that the contradiction inherent in a capitalist system must inevitably lead to an economic crisis. Accordingly, the market is not regulated by an interplay of supply and demand alone but also by competition. The latter secures prices commensurate with production costs and maintain or raise the rate of profit (the "surplus value") by keeping wages low or by decreasing them. Hence, general gluts can occur, caused by overproduction of goods and commodities. The result of this is that the working class continually gets poorer and is less able to consume.

Key Differences and Commonalities

The main difference between supporters of the theory of the self-regulating market and its many critics is the fact that the former see the market as a force contributing to the welfare of a society and the latter consider it as a dangerous, uncontrollable force. Both sides, however, do not question the basic premises: people are rational actors, economic events are effects of individual optimization, and underconsumption is a market mechanism.

In economic anthropology, however, the seemingly inseparable connection of money, trade, and market is scrutinized. The self-regulating market is regarded as a model distant from reality, as, for example, Karl Polanyi (1886–1964) shows in his critical analysis of classical economic theories. Additionally, it is criticized that the significance of goods for the satisfaction of needs, their functional patterns, and groupings are mostly ignored.

Nevertheless, one is confronted again and again with a mechanistic explanation of consumption as part of a model of market forces. John Maynard Keynes (1883–1946), for example, tried to show with his "function of consumption" as relative ratio between income and consumption how, consumption occurs at a domestic level, but from a predominantly economic perspective. It proves, however, that the higher the income, the relatively smaller is the share of expenses for consumer goods. A comparably greater part of the income gets economized. Even though this argument breaks with a pure mechanistic neoclassic point of view, it does not include sociopsychological factors of consumption.

In general, a neoclassic analysis leads to a mechanistic and quantifying view of consumption, as all services and expenses—even the ones for the correction of environmental damages that are effects of production—are included into the gross national product as income.

Social Factors

However, if one regards consumption as a sociopsychological and complex social phenomenon, as Jean Baudrillard (1929–2007) did in his book about the consumer society in 1970, these costs have to be considered as social costs with a negative impact on general social development.

Following Baudrillard, prodigality, visible overconsumption, is a feature of many societies. Therewith, he conforms with many cultural and social anthropological researches about precapitalist economic systems because consumption is not only an economic but also a sociocultural category. He talks about a *civilisation de la poubelle* (civilization of dumpsters), which has in common with the potlatch of North American natives that goods in the sense of a "wasteful expenditure" are destroyed. The potlatch as ceremonially regularized destruction of valued objects is a social act, which aims to demonstrate and elevate social prestige.

Analogous is the underconsumption of rich people in consumer societies, which can be regarded as a way of distinguishing oneself from others; for example, if a rich person drives a small, inconspicuous vehicle instead of a big and expensive one.

Consumer goods become less and less a marker of social status in postmodern society, whereas the form of property and the access to resources like education and power become more important. In a consumer society they are regarded as differentiators. On the other hand, there is a philosophy of "consuming less, consuming waste." This is evident in some 21st-century alternative social movements, such as the freegans, who recuperate from dumpsters consumable food that is thrown away, particularly in the cities, even though they are not compelled by financial means.

The underconsumption of poor people, however, is a subtle phenomenon, as it does not always concern basic everyday needs but also basic margins and resources, which have become rare as a result of increasing industrialization and environmental destruction. Resources like nature, space, clear air, silence, and access to clean water can become merchandise, and the access to them can become a distinction marker in consumer society. Amartya Sen (1933–), who received the Nobel Prize in Economics in 1998 and initiated the introduction of the Human Development Index, pointed to this phenomenon particularly in developing countries. For him, economy is not primarily about the division of goods, but, about the extension of human capabilities. Not only is income vital for life but also freedom and the lack of oppression.

There is an underconsumption of the rich as differentiating marker, yet an overconsumption of the lower social classes is known, in the sense of an unrestrained consumption, as manifestation of a dependency on consumer goods. In this context is psychological impoverishment, because self-image depends on the possession of unnecessary goods. For the modern economy, the relation between production and consumption is less important than the control of demand by market exploration and the steering of needs through advertising. Hereby no longer is the consumer vital to production, but the producer is the one who controls the consumers' behaviors, social decisions, and needs.

In contrast to Amartya Sen, Jean Baudrillard assumes that a democratic claim for an equality of individual chances gets increasingly reduced to an equality originating from the objects that often stand for social success. The idea that growth would automatically mean common prosperity is often supported, even in times of crisis. At the same time, a contrary thesis has to be considered: growth produces and reproduces social inequality. There are no societies of common abundance or common deficiency alone, but a structural affluence and a structural deficiency always exist simultaneously.

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See Also: Developing Countries; Overconsumption; Sustainable Development; Sustainable Waste Management; Waste as Food.

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United Kingdom

The histories of consumption and waste management in modern Britain are inseparable. Personal consumption has always generated some measure of household waste, and particularly in urban societies, its unregulated presence became an ever-increasing problem over time. As towns grew larger and more densely populated in the 19th century, even the relatively poor populations of British cities generated problematic quantities of waste, whose presence was increasingly seen as threatening public health. Systematic efforts to manage the problem began in earnest in 1868 with the passage of the Public Health Act, which set in motion a nationwide movement to improve sanitation and reduce illness. The legislation empowered local government authorities to provide the infrastructures needed to collect and dispose of house wastes and to recover the costs through local taxation. There

was no attempt to regulate the generation of refuse per se, but the legislation did recognize that there was a fundamental duality in the nature of waste: although it was an undesirable nuisance, it also potentially had value. Ownership of collected refuse was thus vested in the authorities who were given the right to sell it, or process it for sale, using the income to offset service costs. Municipalities were quick to employ their discretionary powers. By the end of the century, most cities had in place comprehensive measures for dealing with urban trash. Many of them established organizational structures and procedures to sort and reclaim materials for sale, and by the start of World War I in 1914, the largest cities, such as London, Birmingham, and Glasgow, had large and often sophisticated operations for processing the growing amounts of by-products of consumption.

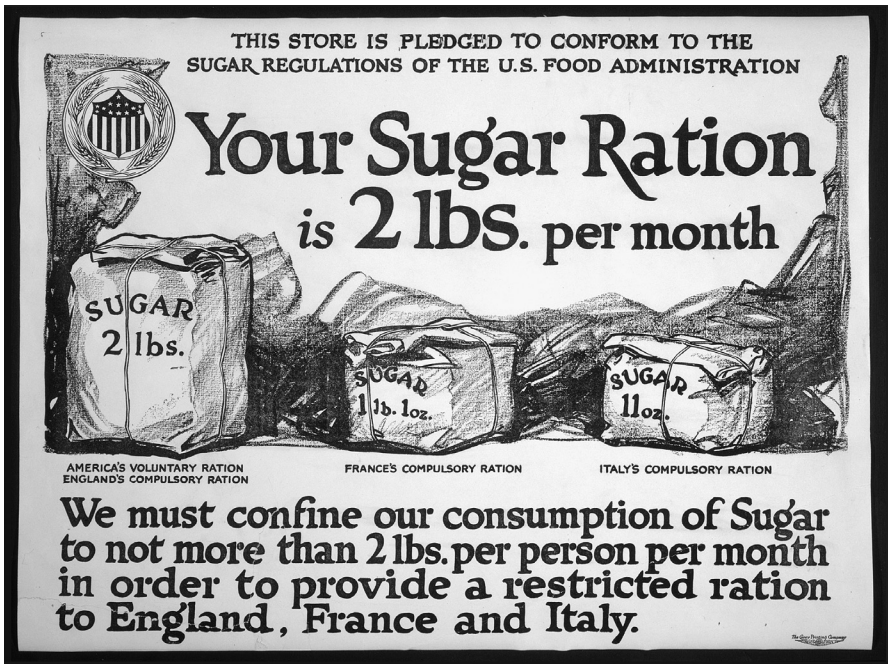
Public Cleansing

It would be misleading to paint too glowing a picture of early-20th-century waste management, or "public cleansing," as it was then known. Judged by later standards, it was still a relatively crude and unregulated process. Even so, it was generally an organized activity that focused exclusively on dealing with whatever refuse was generated. Both local politicians and the emerging professional class of practitioners who managed the services saw their task as carrying out this work using or developing the most efficient methods possible for managing a steadily growing quantity of urban rubbish. That growth was fueled by an expanding population, where poverty was diminishing and consumption was starting to increase. Even though that increased consumption was initially largely confined to the basics of life, it generated extra household refuse, which had both financial and physical impacts on cities. Birmingham, Britain's second-largest city in 1900 with a population of 650,000, saw its household waste output rise by over 11 percent between 1900 and 1915, from 202,658 tons to 225,647 tons, and costs rose even more, with increases amounting to almost 44 percent over the same period. Recycling, or salvage, was important for reducing outlays on the service and in Birmingham's case, saved almost 10 percent annually. Waste was an ever-increasing problem, the successful management of which was judged not just by levels of efficiency in its collection and disposal but also by the extent to which the service conformed to budgets that were often based more on political considerations than on what practitioners considered necessary.

Once waste was collected, it had to be disposed of. Some authorities processed or incinerated their collected refuse; others simply dumped it onto open land in the expectation, or hope, that it would eventually degrade and disappear. Concerns about the environmental impact of such deposits surfaced in earnest during the 1920s. A report commissioned in 1928 by the Ministry of Health highlighted the ecological problems of air and water pollution resulting from the uncontrolled dumping of domestic refuse, and their potential adverse affects on the population. This was a landmark of sorts in that it marked the first time that local authorities were provided with recommended practices in waste disposal. The report also represented the first instance of formal interest by the British state in waste management.

During the 1930s, efforts were made by the ministry to assess how efficiently all local authorities in England and Wales ran their waste management operations, based on the cost per ton of refuse handled. However, because providing information was voluntary and because many councils estimated (rather than measured) how much waste they dealt with, the resulting picture was neither truly comprehensive nor dependably accurate. Nevertheless, it is clear from individual city records that refuse services before the start of World War II in 1939 were broadly satisfactory by contemporary standards. The leftovers of consumption were taken up at a rate matching their production; household rubbish was generally removed weekly and usually disposed of by a combination of incineration and sanitary landfill (controlled tipping). That involved depositing waste in layers sandwiched between deposits of earth in order to speed decomposition and minimize nuisance from offensive odors and the breeding of insects.

Efficiency in collecting waste from homes was still the main goal for waste practitioners, whose political masters were well aware that emptying the bins was seen by the public as one of the most important services that cities provided. Disposal



During World War I and World War II, consumption of all sorts in the United Kingdom was drastically reduced by rationing and shortages. A sugar ration notice from 1917 (left) restricts sugar purchases to 2 lbs. per person in England. British schoolgirls (right) enjoy a morsel of cheese in 1941, which was rationed beginning in May of that year. A typical ration for one adult per week was 2 oz. Rationing and recycling reduced waste correspondingly, but a labor shortage meant that managing existing waste became more challenging.

was seen as the lesser problem, because tipping land was still generally easy to find and, despite emerging environmental concerns, what would eventually become known as landfilling was seen as an essentially benign practice.

The relatively modest growth in personal consumption and the associated rise in waste creation during the 1930s had been managed easily. The period of World War II, from 1939 to 1945, saw consumption of all sorts drastically reduced by rationing and shortages, which reduced waste correspondingly. On the other hand, labor shortages meant that managing waste became increasingly difficult. The level of service provision declined generally and collection arrears measured in weeks became commonplace, but there was no breakdown in waste management and managers were subsequently able to stress that the public's health had not been compromised by a lowering of standards during the war. Despite this acknowledgment and its implications for the concept of waste management, practitioners continued to see the public health role as a key function in the immediate postwar years. They still saw the generation of rubbish as inevitable, its presence a hazard, and their primary function to deal with it promptly and effectively for the welfare of the population. Whatever its core identity, waste management's importance in the hierarchy of local government was emphasized by its cost. Public cleansing budgets were usually among the largest departmental expenditure in cities.

In Glasgow, for example, one of Britain's largest cities, spending on refuse services was only exceeded by education and police departments throughout much of the 1950s. Public health had been the original rationale for organizing municipal refuse services and its endorsement helped waste management to secure substantial spending allocations. However, signs of a significant change in the understanding of its role came in the early 1950s, when responsibility for its oversight passed from the Ministry of Health to the newly created Ministry of Housing and Local Government. The building of new homes was prioritized and government thinking now linked refuse services more closely with housing than with health.

On the basis of wartime experience, the contents of dustbins were now considered relatively benign, if sometimes malodorous, and their danger to health far less pronounced than it had been when house waste had even included human excrement. This change in conceptualization was accepted by the practitioners who, from the late 1950s, were starting to meet new problems resulting from growing prosperity and the emergence of a consumer society that not only generated greater quantities of waste but also waste that changed dramatically in both composition and volume.

Growth Trends

Personal prosperity became more commonplace in the second half of the century, as the British per capita gross domestic product and disposable incomes grew steadily during and after the 1950s. Disposable incomes increased particularly markedly, by 46 percent in the 1960s and by a further 30 percent in the 1970s, marking a measure of affluence among a public that now had the means to consume, and spend they did. New consumers purchased a wide range of goods that increasingly incorporated synthetic materials in their packaging or construction. Plastics began to replace glass containers and paper-based wrappings in the 1960s and 1970s, so that density rather than weight became increasingly important in deciding how to handle house wastes.

This new emphasis on volume was accentuated by a growing shift away from solid fuel open fires for domestic heating toward the use of gas, electricity, and oil. That trend, itself partly the result of low alternative energy costs and partly an expression of increasing consumer choice, had been encouraged by legislation that combined both public and environmental health issues. The Clean Air Act of 1956 was intended to improve air quality by banning the burning of coal in urban areas and was phased in after 1956, acting as a catalyst to encourage consumers to change the way they heated their homes. This may have helped solve the problem of air impurity but it also created new problems for urban waste managers. Whereas the majority of combustible house rubbish had been burned on open fires (even in summer months), this was impossible with the new heating systems. Instead, everything went into dustbins, and dense fire residues were steadily replaced by a far greater volume of assorted material, some of which was incompatible with established methods of waste disposal.

1960s and Early 1970s

In the 1960s and early 1970s, most British cities either incinerated their refuse before burying it or put it straight into so-called sanitary landfills where it was expected to decompose harmlessly. Greater volumes of biodegradable waste were not an immediately critical problem, but they filled tipping sites at an increasing rate and had unwelcome implications for long-term disposal planning. Finding suitable sites close to cities had been a growing problem since the 1950s, and the only viable alternative was incineration, which faced new problems. Incinerators had been designed to work with material that, once ignited, sustained combustion readily. But as combustible residues continued to decline as a proportion of the waste stream, the majority of waste that was going into furnaces increasingly needed to be primed with additional fuel. The growing presence of plastics made matters worse. Furnaces lost efficiency from the tendency of synthetic plastic materials to melt and clog fire grates, which inhibited combustion.

Furthermore, chimney emissions from burning plastics were obnoxious and, in some cases, a danger to health. Landfill did not solve the problem, but created additional ones. Buried plastics, for instance, were not biodegradable and tended to destabilize landfill layers, compromising the eventual use of tipping sites for other purposes. This undermined one of the long-standing cornerstones of the philosophy of tipping as a means of recovering otherwise unusable land.

Despite the growing difficulties associated with the disposal of domestic refuse, attention remained firmly focused in the 1970s on managing whatever the output was, rather than attempting to reduce it. Nevertheless, the 1974 Control of Pollution Act was significant because it was the first major waste-related legislation since 1868. It also indicated formally an increasingly clear recognition that waste was being created at an accelerating rate by an increasingly affluent society and that its disposal was likely to have an incrementally adverse impact

on the environment. For the first time, all waste facilities and landfill sites had to be licensed by the state and a requirement for country-wide waste disposal plans by local authorities was introduced. This, tied in with a major reorganization of local government, meant to improve refuse management by establishing separate bodies to handle disposal regionally. And, tacitly acknowledging the growing complexity of the residues of personal consumption, cities now had to provide sites for the public to deposit problematic wastes such as automobile batteries and lubricating oils.

The 1970s marked the start of an era of change in waste management conceptualization, even if the emphases in practice continued to focus heavily on traditional aspects of the public cleansing service into the 1990s. The state began to take a more active role in its efforts to achieve greater efficiency, splitting the collection and disposal operations in 1974 and creating regional rather than local arrangements for disposal. Waste generation continued to increase and the difficulties in disposing of it continued.

A second important change in governmental conceptualization of waste was evident in the Environmental Protection Act of 1990, which for the first time required all local authorities to consider recycling in formulating their now-compulsory waste strategies. Despite a conviction among practitioners that waste was an inevitable problem and that goals of moving toward a "zero waste society" were unrealistic and even counterproductive; pressures based on notions of general environmental welfare rather than public health defined more narrowly gathered momentum. The introduction of a progressively increasing landfill tax in 1996 provided a strong and continuing incentive to minimize the amount of refuse buried. These pressures have provided still greater encouragement for minimizing landfill, but despite continued governmental affirmations of faith in the concept of waste minimization, the management of the disposal of domestic trash still takes priority over controlling its creation in the first place.

Solving the Problem

Coping with the products of consumption was formally recognized as a necessity in the 19th century when concerns with public health were gathering momentum. Over a century and a half later, the concept of promoting personal health specifically through managing trash has been largely replaced by one of preserving the health of the general environment through a combination of preventative and palliative measures to handle consumerism's castoffs, with the aim not only of maintaining the public's health and well-being but also the sustainability of the planet.

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See Also: Consumerism; Household Consumption Patterns; Incinerator Waste; Landfills, Modern; Pollution, Land; Public Health; Recycling; Waste Disposal Authority; Waste Reclamation Service.

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United States

The United States is one of the wealthiest and most consumptive nations on Earth, testament to its status as a world economic leader since the Industrial Revolution. In 2010, the International Monetary Fund (IMF) calculated that the United States had a gross domestic product (GDP) of over $14 trillion, second

in the world only to the European Union, if the entire union is considered as a whole with $16 trillion. With a heritage valuing seemingly limitless abundance of natural resources, the American people transformed forests, floodplains, and meadows into farms, factories, and cities. Initially forming states from former English colonies on the Atlantic seaboard at the end of the 18th century, national development spread rapidly westward across the continent in the 19th century, ultimately comprising 50 states spanning 3.79 million square miles. These include 48 contiguous states spanning the Atlantic coast to the Pacific Coast, as well as two noncontiguous states (Alaska and Hawaii) and territories in the Caribbean Sea and throughout the Pacific Ocean.

The land is both vast and productive. Today, most people in the United States enjoy relatively affordable foods (produced from abundant domestic agribusiness). Energy consumption includes widespread access to electricity and heat from fossil fuels, as well as from the largest number of nuclear power plants in the world. Privately owned oil-consuming automobiles comprise the dominant form of transportation. Low tipping fees allow Americans to dispose of wastes primarily in sanitary landfills at little economic (if not ecological) cost.

The consequences of industrial development aroused scattered local movements in the early 20th century and the expansion of the postwar consumer society inspired a broader national environmental movement in the 1960s. Although subsequent legal and cultural developments (including the advent of Earth Day in 1970) have sought to curb the worst environmental abuses, the more than 300 million people living in the United States today continue to be among the world leaders in per capita emissions of carbon dioxide released into the atmosphere and municipal solid waste deposited in landfills.

Brief History

The United States was born on the eastern seaboard, where the white settlers-turned-citizens harbored mixed emotions of dread and delight. When the nation was new, too much wilderness was problematic—a material obstacle and physical threat to be subdued and reconstructed with the pride of a frontiersman. Of course, there were currents of American romantic imagination with an enthusiasm for the primitive, solitary, mysterious, and picturesque. The historian Francis Parkman, having made his arduous journey by horseback across the Oregon Trail in the summer of 1846, gave the primitive landscape the sort of romantic interpretation in history that writers like Washington Irving and James Fenimore Cooper had given it in fiction, and that Thomas Cole and his Hudson River school had given it in art. Even as the new nation's landscape was changing, Cole still found it so exhilarating in 1836 that he called on his countrymen to remember "we are still in Eden."

But American romanticism never seriously challenged American pioneer pride. Probably no one amid this vast landscape, with the exception of the American Indian, was free from construing the wild forest and hostile environment as much to godliness as it was to a barrier to westward expansion, material progress, and prosperity. As it happened, physical barriers of the American Acadia were progressively annihilated, as an enormous western landscape was purchased and seized: first, in 1803, when the Jefferson administration (under pressure from yeoman farmers seeking profitable opportunities) purchased from France 828,000 square miles of Louisiana territory; and, later in the 1840s, when the Polk administration, in a spirit of Manifest Destiny, marched westward in order to seize Texas and what are presently New Mexico, Utah, Nevada, Arizona, California, and part of Colorado. With western expansion came forceful and often violent expulsion of large native populations of Indians. By 1869, the U.S. landscape was undergoing prodigious socioecological transformation through capital investments in physical and social infrastructures—networks of communication and transportation like canals, steamboats, railroads, telegraphy—that required reproduction of a particular sort of material and social relations that could sustain them. A quickened pace of production, exchange, and consumption was, historian John Kasson writes, enough to nudge Ralph Waldo Emerson in circa 1850 to note that, "as distance is annihilated by locomotive and steamboat," the nation's trajectory might be hell-bent: "Everything is sacrificed for speed . . . They would sail in a steamer built of Lucifer matches if it would go faster."

By 1900, Scottish immigrant and steel magnate Andrew Carnegie boasted "The old nations of the earth creep at snail's pace; the Republic thunders

past with the rush of the express." Kasson provides a glimpse of U.S. material growth:

> Rapid implementation of new machines, interchangeable parts, and standardized processes allowed older industries to expand radically . . . From the fourth-ranked position among manufacturing nations of the world after 1860, the United States pulled into the lead. By 1894 the value of its manufactured products nearly equaled that of Great Britain, France, Germany combined.

But if too much wilderness bedeviled the new nation, too much development of the sort sketched by Kasson sparked serious concern, so much so that no previous generation had been more bedeviled by problems—and no earlier problem, except for the malady of slavery, had seemed more vexatious. In the roughly 50 or so years after 1870, the general mood of optimism yielded to more sober doubts. Marking these years was a transfer of the center of economic and political gravity from country to city. Indicative of transformation was that many of the repugnant connotations of the hostile American forest were transferred to the urban environment, as implicated in muckraking exposes like Lincoln Steffens's *The Shame of the Cities* and Upton Sinclair's *The Jungle*. Demographic countermovements also marked these years; too much urbanization, not too little, prompted some of the more privileged citizenry to radiate from city to suburbia. Suburban expansion and sprawl were fostered not only by the railroad and telegraph but also by the electric streetcar (1880s), elevated trains (1890) and subways—all of which presaged the 20th century's automobile and housing booms and sprawling interstate highway. In the waning decades of the 19th century, a novel geography emerged through which capitalist relations reproduced themselves paradoxically in an urban–rural interplay, and, as William Cronon put it:

> . . . the same market that brought the city and country ever closer together . . . also concealed the very linkages it was creating and . . . produced a landscape of obscure connections. The more concentrated the city's markets became, and the more extensive its hinterland, the easier it was to forget the ultimate origins of the things it bought and sold. The ecological place of production grew ever more remote from the economic point of production, making it harder and harder to keep track of the true costs and consequences.

The fruits of this production were distributed across the continent. By the turn of the 20th century, economist Thorstein Veblen identified a culture of conspicuous consumption as the emerging middle class had access to a wide variety of staples and luxury goods. Residents of cities such as New York and Chicago could shop in gigantic department stores selling all manner of clothes and household durables. While increasingly, most Americans lived in metropolitan areas (the census of population would first characterize the United States as majority urban in 1920 and the major change of the following century was to increase suburban development around central cities), Americans in all regions could rely upon the U.S. Postal Service and network of railroads to shop from mail-order catalogs. Chicago's Montgomery Ward and Sears, Roebuck and Company facilitated the mass distribution of farm equipment, furniture, toys, household appliances, and all manner of goods in the late 19th century with their catalog services (the Sears catalog contained over 500 pages of densely worded entries for goods by 1900). At the same time, Philip Armour's refrigerated rail car allowed giant meatpacking operations to convert thousands of head of cattle, hogs, and chickens into meat that could be distributed to customers hundreds or even thousands of miles away. The consumers of these goods may not have had any idea where they were made, who made them, or what the true costs to labor and nature were, but the world of goods was made ever more affordable and accessible

Consequences

What, then, of the consequences? By the 1890s, sufficient physical and intellectual change had occurred in American life. Just as the years from 1870 to World War I engendered rippling currents of disenchantment, so the fast-shifting material circumstances after the 1920s produced all but catastrophic convulsion. Without question, the United States hummed like a beehive with industry. In spite of

great depressions and crises reverberating throughout the world economy and manifesting themselves in the United States as fierce labor strife from 1877 through the 1890s, no more-powerful achievement fired the imagination during the first decades of the 20th century, writes Daniel Yergin, than the United States' ability to surmount a global coal crisis in order to harness oil and natural gas that could more powerfully generate electricity that sparked scientific innovation, technological progress, and the sort of advancement in mass production and consumption that engendered a dazzling facade of material abundance. With financial fortune and world hegemony shifting from Britain to the United States during the early decades of the 20th century, no surge of material expansion had been more stupendous in the history of the world economy, Giovanni Arrighi contends, than the one that was coming to fruition by 1945 within the crucible of horrific global war and U.S. labor power and capital.

Consumption and Destruction

As one may readily surmise, the unprecedented surge of material expansion and productive consumption can also be considered an expression of creative destruction. Creative destruction may be the 20th and 21st centuries' overriding paradox. It is a product of the processes of capitalist development through which our ecosystem and geographical landscapes have been created and profoundly altered in order to surmount crises that obstruct capital flows and offer fresh opportunities for a perpetuation of capital circulation and accumulation. The paradox of creative destruction is simultaneously a paradox of progress and chaos; after all, the ecosystem, in which we are embedded, has undergone so much metabolic rift from the effects of colossal surges of productive consumption and waste that the essential harmony in the finely spun web of biotic life on the planet has been compromised and undermined to a point where human sustainability may be precarious.

If the worldwide depression of the 1930s slowed American industry and consumption, the retooling of the economy for military production during World War II primed a colossal surge of productive consumption and accompanying waste after 1945. Government demand for airplanes, automobiles, and weaponry continued as the nation entered a cold war with the Soviet Union. As part of that ideological battle, American companies exported mass-produced goods abroad. A key symbolic battle between the superpowers occurred in 1959's "kitchen debate" between Vice President Richard Nixon and Soviet Premier Nikita Khrushchev, as Nixon used a model test kitchen to boast of all the labor saving and recreational devices available from American manufacturers.

These devices and sundry other goods were widely available in the new suburban developments ringing American cities during the postwar era. A construction boom encouraged by federal mortgage insurance and the federal highway system that emerged in the 1950s transformed meadows and woods across the nation into residential subdivisions. The residents of these suburbs had access to ever more sophisticated forms of consumption due to improved corporate strategies in retailing, credit, packaging, advertising, retraining workers, gathering and circulating information and feedback. Planned obsolescence of consumer products became evident in a greater emphasis on style in mass production, not only of clothing, but also durable goods such as automobiles. As one U.S. marketing consultant expressed quite frankly in the 1950s: "Our enormously productive economy . . . demands we make consumption our way of life [and] convert the buying and use of goods into rituals . . . We need things consumed, burned up, worn-out, replaced, and discarded at an ever increasing rate.

As the 20th century matured, waste grew thick. As a matter of fact, what had been perhaps merely a nuisance before the 1920s became so monumental an environmental blight by mid-century that no one who is ecologically and historically sensitive can overlook it. The statistical trend in waste, which mirrors an accelerated world economy, is notable. Martin Melosi shows in *Sanitary City* that, by 1910, major U.S. cities had produced twice as much mixed rubbish per capita as major English and German cites. Melosi declares that U.S. per capita production of solid waste per day in 1920, in 1970, and in 1980 was approximately 2.75 pounds, five pounds, and eight pounds, respectively; that its production 1920–70 grew by 45 percent; and that it increased during the 1970s by approximately 35

percent. During the 1980s, avers William Kovacs, the United States generated four times more municipal waste than the next-biggest waste generator, Japan. By the 1990s, states Peter Menell, the larger U.S. cities generated significantly more solid waste than citizens of 20 other industrialized nations. That the trend in U.S. population increase alone precipitated growing waste is questionable, given that the *New York Times* says that, between 1950 and 1970, the population increased 30 percent, but waste grew 60 percent, and the U.S. Bureau of the Census (together with Franklin Associates) shows that, during 1970–86, population increased 18 percent while solid waste disposal grew 25 percent. Between 1998 and 2001, states David Pellow,

> The volume of municipal solid waste grew by 6.6 million tons, or 20 percent, to a total of 409 million tons per year . . . meantime, the United States has only 5 percent of the world's population but generates 19 percent of its wastes.

Harmful Waste

Where Heather Rogers states that the primary discards during the days from Daniel Boone to Henry David Thoreau to William F. Morse were fairly benign and largely recyclable (mostly organic food scraps, manure, and human waste), others tell us that by the end of World War II, the restructuring of production technology brought varying forms of harmful waste. Barry Commoner declares there arose a displacement of natural products (wood, soap, cotton, wool, wood, paper, and leather) with synthetic petrochemical products (detergents, synthetic fibers, and plastics) whose fast growth was perpetuated by heavy-duty U.S. government subsidy. Samuel Epstein and others affirm that definitions of hazardous waste are slippery. But Commoner helps guide our grasp of it: writing in 1975 and echoing Rachel Carson's *Silent Spring*, Commoner bewailed that

> . . . for the first time in . . . four billion years . . . living things are burdened with a host of alien man-made substances that are harmful to them. . . . Since 1950 [h]undreds of toxic chemicals, many of them carcinogenic, have persisted in the water, supplies, air and food.

Epstein and others declare that the United States produced one billion pounds of hazardous waste by 1950, and the fast rate of lethal waste production increased each year through 1980 by approximately 10 percent. Steven Ferrey affirms that, throughout the 1980s, the U.S. Office of Technology Assessment placed hazardous waste production at approximately 260 million tons per year, and Kovacs states that in the same decade, the United States produced 95 percent of the world's hazardous and special wastes. What is more, U.S. waste now includes more than paper production, which helps prompt deforestation, and more than plastic production, which is not biodegradable; our waste also includes e-waste, which is a product of the fastest penetration and obsolescence rate of any communication medium in history and a witch's brew of toxins like lead, beryllium, mercury, cadmium, polyvinyl chloride plastics (PVCs), hexavalent chromium, and brominated flame retardants.

How to dispose of this waste was (and is) largely a matter left to individual municipalities. As cities grew, they experimented with dumping wastes in nearby bodies of water, reclaiming valuable scrap materials from them, and incinerating them either to produce energy or simply dissolve wastes into the air. The method most commonly used, however, was placing waste in specialized areas on land. Initially, these were open dumps, which aroused criticism due to odors and worries about vermin and disease. The city of Fresno, California, opened the first modern sanitary landfill in 1937, establishing a path to disposal most American communities adopted in the 1940s and continue to this day. At the beginning of the 21st century, more than 70 percent of all American municipal solid waste generated goes to more than 2,000 sanitary landfills across the nation. Although interest in reducing the burdens of land disposal (among them worries about finite space in the northeast and landfill siting patterns that draw charges of racial discrimination throughout the nation) led to the development of thousands of local recycling centers and curbside collection programs between 1970 and the end of the 20th century, landfills remain the most common destinations for household wastes in the United States.

Reaping wealth from waste production before the great wars was nothing new, but the commodification

of waste gained fresh territory after the 1950s. Over the two or so decades from 1970 to 1990, for example, when landfill real estate brimmed with noxious junk and available spaces prompted conflicts among state authorities and entrepreneurial opportunists, when social and racial tension bristled because of leachate, odors, contamination, and aesthetics, when the state officials could find no adequate resolutions except to close an overwhelming number of landfills in operation, a conspicuous "garbage crisis" reared its smelly head. The dynamic of this particular crisis not only compelled a desperate intrastate waste trade, pitting states against one another; it also permitted a pathetic international waste trade, smacking of forms of systemic predatory violence called environmental racism and environmental imperialism.

Military Issues

It can be justly stated that a most devastating metabolic rift has been perpetuated in the 20th century by the U.S. military, which "in its incessant pursuit of prowess and preparedness," as Michael Renner puts it, "has poisoned the land and the people it is supposed to protect." Notwithstanding military secrecy on a promise of national security, we can reasonably conclude that military despoliation of the domestic landscape, not to mention the global landscape, derives from its standard daily practices since World War II. Considering the cold war decades, Seth Shulman declares: "billions of gallons of toxic wastes—a virtual ocean—have been dumped by the U.S. military directly into the ground at thousands of sites across the country."

No more-lethal and insidious waste has ever been produced than the stunning amounts of nuclear debris coming from the United States' heroic construction of nuclear arsenals since the 1940s—from uranium mining and milling to warhead manufacture to testing and deployment to waste disposal.

World capitalism did not invent 20th-century war any more than it invented writing or science and technology. But the United States, which has accounted for the preponderance of global military activity, plunged itself in the last century into a great global war (not to mention subsequent smaller conflicts) cohering around interimperial rivalries. The United States has accumulated massive powers to transform with apocalyptic intensity the historical geography of the globe. With this in mind, one should not overlook that historian Richard Rhodes, who, having dismissed individual scientists and their problem, solving endeavors as culprits of metabolic rift, declares astutely that the atomic bomb was produced and sustained by "profit and steady work . . . and inspired by a goal of acquiring the final word on the accumulation of power." Nor should one ignore a major thinker like Hanna Arendt, who wrote that "only the unlimited accumulation of power could bring about the unlimited accumulation of capital."

While the United States is armed with potent technologies, its ambitions appear to be on the rise as well. For perspective, it is significant to recognize that, as a number of writers have stressed, U.S. streambeds, soils, and underground aquifers near and far from nuclear production facilities are already thoroughly contaminated with chemical and radioactive wastes and will certainly remain dangerous for hundreds of thousands of years.

Ecological Devastation

Pessimism and fatalism are tempting, because a broad consensus has emerged concerning the social and political implications of the metabolic rift propelled by the United States' productive consumption and its accompanying waste. The broad consensus exerts some influence, to be sure. The 1996 declaration signed by the Union of Concerned Scientists offers one instance:

> Human beings and the natural world are on a collision course and their activities inflict harsh and often irreversible damage on the environment. . . . If not checked, many of our current practices put at risk the future . . . and may so alter the living world that it will be unable to sustain life . . . that we know.

The basic rebuttal is that rhetoric of technocratic alarmism and apocalyptic imagination is not tempting but rather troublesome, for it is theoretically suspect and politically dangerous. It presumes that technocrats and other experts can know with certitude the point of collision between human and natural worlds, a presumption that ignores that humans exist not as entities in compartments distinct from biotic life but rather as creatures embedded in a

sophisticated evolving fabric of biotic life; and that human actors have engaged often unwittingly in a systemic transformation of their metabolic relation with the biotic world, an engagement executed with unpredictable consequences. Amid unpredictability and uncertainty and guided by socially and historically constructed evidence, moreover, the clarion calls of apocalypse can too easily foster further authoritarian impulses, not to mention something like a reconfiguration of the ethos of Noah's Ark with the planetary gardeners weeding forms of life incompatible with their taste.

As one reconsiders the sort of alarmist rhetoric, one should not shrug aside Peter Stearns's statement, which suggests pretty accurately the magnitude of our consumption and waste predicament: "By 2000 the United States with less than 5 percent of the world's population was consuming over 30 percent of the energy resources and creating the pollution to match." Stearns's statement affords the badly needed invitation to ponder the consequences of our history of productive consumption and waste.

Conclusion

Publisher Henry Luce dubbed the 20th century "The American Century" in 1941. This name identifies the period when world historians place the peak of the United States' dominance in geopolitics, trade, and industrial production. American reliance on the nation's abundant natural resources fueled its expansion. At the beginning of the 21st century, questions exist about whether the United States can maintain the position and practices it enjoyed in the last century. After the fall of the Soviet Union, the United States stood alone as the world's last remaining superpower, but the resources of the military were tested in prolonged military campaigns in Iraq and Afghanistan. Worries about the United States' relative trade position with Japan emerged in the 1980s and while the stagnation of the Japanese economy since 1990 eventually muted those concerns, fears about staying competitive with the rapidly industrializing economy of China emerged. Worries have grown about both the growing national debt and the debt carried by individual Americans (in part, sociologist Juliet Schor argues, due to psychological pressures to overconsume in order to maintain social status). Federal policies with roots in the 1930s encouraged widespread lending by banks to prospective homeowners, thus allowing millions to buy into the American dream of homeownership through loans they could pay back in 20 to 30 years. Extensive deregulation of banks in the 1990s and 2000s encouraged widespread speculation in the banking industry, the results of which sparked a housing foreclosure crisis beginning in 2007 and a wave of bank failures in 2008 that have continuing global repercussions. Americans' continued reliance on fossil fuels spur concerns both in that these finite resources leave households and industry vulnerable to rising prices and that their use produces emissions linked to global climate change and local environmental degradation.

Which is not to say that Americans are oblivious to the consequences of their consumption. Ecological concerns within the United States have inspired a variety of environmental organizations over the years, ranging from the Sierra Club (founded to protect wilderness in 1892) to 350.org (founded to reduce emissions of carbon dioxide in 2007). President Theodore Roosevelt signed laws protecting wilderness and the American food supply at the start of the 20th century, and widespread concern about the effects of consumption on the air, water, and land led elected officials of both parties to pass important environmental protection laws in the 1960s and 1970s. Interest in environmental protection has been largely muted at the federal level since 1980; the United States' significant national environmental laws regarding waste and pollution were enacted before the conservative Sagebrush Rebellion, marked by Ronald Reagan's presidency, ended bipartisan interest in environmental protection. The United States did not sign onto the 1997 Kyoto Protocol to reduce greenhouse gases, nor has the federal government adopted even symbolic efforts to combat climate change. Systemic attempts at discrediting scientific conclusions about environmental health emerged, further thwarting federal regulation of industry. Aging, inefficient methods of energy production, transportation, and product design lack regulatory spurs to innovate and reduce inefficiencies that harm both the environment and the economy.

Some of these developments are new, but much involves the paths developed in the United States throughout its history. That the foregoing pages

offer a linear, pessimistic perspective is an unsustainable charge. U.S. history reveals that Americans have reproduced their socioecological lives and geographical landscape through processes of capitalist circulation, productive consumption, exchange, and accumulation. While this system achieves growth through varying forms of creative destruction, its developmental trajectory is not predetermined because it derives from ongoing speculation and fresh investment. And so, even though the existing path poses troublesome questions for the future, environmentally and socially sensitive options still exist.

The slogan *think globally, act locally* (popularized as the American environmental movement grew in the 1970s) resonates. Most of the significant policy attempts at reducing wastes and carbon emissions in the United States since 1981 have come at the state and local levels, such as California's low emission vehicle (LEV) program to reduce automotive emissions and several municipalities' zero waste programs. Entries on the 50 individual states and various cities of the United States provide more examples. Whether these decentralized efforts will produce significant changes in American patterns of consumption and waste is an open question, as is whether the United States will continue to enjoy its relative wealth and power in the 21st century.

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See Also: Consumption Patterns; Earth Day; Economics of Consumption, U.S.; History of Consumption and Waste, World, 1900s; Overconsumption; Power Plants; Sociology of Waste; Toxic Wastes.

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Uranium

Uranium is an exceptionally dense, metallic chemical element. With the exception that uranium compounds have for centuries assisted in tinting glass and coloring pottery, their present use is almost solely as a source of fuel for nuclear fission. Uranium's value thus lies in its ability to generate energy and atomic warfare. Because of the disposal of toxic and radioactive materials and because of the generation of by-product matter that has the potential for the building of nuclear arms, the wastes that uranium processing and consumption produce are among the most dangerous in human history.

Mining and Milling Waste

Waste from the uranium industry occurs at all stages of the nuclear fuel cycle. From mining alone, there are four main types: waste rock from the actual mining; tailings from the ore processing (commonly called "milling"); wastewater; and industrial waste, such as the radioactively contaminated scrap produced when a uranium mill is closed down. Uranium ore occurs naturally as mineralization in sandstones and quartz pebble conglomerate rocks, as well as (to a lesser extent) in other types of mineral vein deposits. Mining takes place in 18 countries. It is most prominent in Australia, Brazil, Canada, Kazakhstan, Malawi, Namibia, Niger, Russia, South Africa, and the United States. The ore's uranium content, which

Low-level waste from nuclear power plants is problematic because of the toxicity of uranium and its compounds, rather than radioactivity. The sludge contains heavy metals and contaminants such as arsenic and chemical reagents used during milling.

is sourced mainly from open-pit or underground mines, is often 0.1–0.2 percent. Hence, to obtain a sufficient grade of ore, large amounts of it have to be mined. Initially, up until the 1960s, uranium mining predominantly occurred in open-pit mines from ore deposits located near the surface. For the following 20 years, underground mines were viable. After the world market decrease of uranium prices from the 1980s onward, however, most became inefficient.

Uranium ore goes through several processes of conversion and enrichment to concentrate the radioactivity by 2–3 percent and thus become nuclear reactor–grade fuel or by 80 percent to become potent enough for use in atomic weapons. A series of crushing mills grind the crude uranium ore to the consistency of fine sand, to which chemical solvents are added for dissolving out the uranium. A mixture of uranium oxides, with a chemical formula equivalent to U308, emerges from the process. This mixture, known as "yellowcake," makes up the raw material for all the subsequent processes that eventually lead to a chain reaction in a reactor core. Yellowcake contains 85 percent uranium by weight, but besides this, there remains a hundred-fold quantity of residual sand, called "tailings," which also contain the radium that had accompanied the uranium. Per ton of ore, over 3,700 liters of liquid waste are also produced. This sludge is both chemically toxic and mildly radioactive.

Mill tailings, normally dumped as sludge in special piles or ponds, are generated in nearly the same quantities as those of the ore milled. At a grade of 0.1 percent uranium, 99.9 percent of the material mined is left over. Apart from the portion of the uranium removed, the sludge contains all the constituents of the ore. As long-lived decay products such as thorium-230 and radium-226 are not removed, the sludge contains 85 percent of the initial radioactivity of the ore. Due to technical limitations, all of the uranium present in the ore cannot be extracted. The sludge, therefore, also contains 5–10 percent of the uranium initially present in the ore.

Much of the low-level waste comes from uranium conversion and fabrication works. It is mostly problematic because of the chemical toxicity of the uranium and its compounds, rather than radioactivity. The sludge contains heavy metals as well as other contaminants, such as arsenic and chemical reagents used during the milling process. Radionuclides contained in uranium tailings emit 20–100 times as much gamma radiation as natural background levels on deposit surfaces. Nevertheless, these radiation levels decrease rapidly with distance from the sludge piles.

Because of the radioactive decay of uranium, the untreated ore also contains its decay "daughters." These include the inert gas radon-222, which continues to be formed by radioactive decay in the discarded tailings. And because the tailings are finely divided, radon is readily released to the atmosphere. This is a major health hazard in uranium mining communities, as it is in parts of the southwest United States where huge mounds of tailings have been created. Radon is also present in the atmosphere of underground mines and gets inhaled by miners, along with dust particles to which its own short-lived and highly active daughters adhere. Consequently, uranium miners have suffered unusually high proportions of lung cancer diagnoses.

Tailings deposits are subject to many kinds of erosion. Hazardous substances from the tailings can be released downstream via earthquake, landslide, or flood events. They can also migrate to local groundwater or be dispersed downwind by prevailing winds as radon gas dust. Because of the long half-lives of the radioactive constituents involved, safety of the deposit has to be guaranteed for very long periods

of time. Throughout the world, an estimated 70 percent of uranium deposits are located on the lands of indigenous people. This causes enormously complex problems regarding land rights and the dispossession of traditional cultures.

High-Level Waste

The most dangerous waste is the high-level radioactive material produced from the core of nuclear reactors or atomic weapons. Such waste includes uranium, plutonium, and other radioactive elements made during fission. Most of the isotopes in high-level waste emit large amounts of radiation and have lengthy half-lives, requiring centuries before they settle to safe radioactive levels. In some cases, this exceeds 100,000 years. On average, a large nuclear reactor produces 25–30 tons of used fuel per year. It has been argued that this form of energy production is inherently wasteful. The concept of entropy, one of the main principles of the second law of thermodynamics, has been employed to demonstrate that using nuclear power to produce high-grade energy for a national grid that then goes into such everyday uses as domestic heating is like "cutting butter with a chainsaw."

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See Also: Atomic Energy Commission; Coal Ash; Fusion; High-Level Waste Disposal; Mining Law; Nuclear Reactors; Radioactive Waste Disposal; Radioactive Waste Generation; Toxic Wastes.

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Utah

Utah is ranked 34th-highest for resident population in the United States and 49th for per capita personal income. The consumption of finished products and services in Utah follows typical 21st-century traits, with minor variations based on the natural and social environments, as well as cultural traditions. Utah has developed as a multicultural state, bringing together Native Americans, descendants of the pioneers who founded the state, and different waves of immigrants who have arrived mainly from Europe, Latin America, and Africa. There are more than 790,000 households in Utah with an average household size of 3.7 people. Median family income in Utah is $65,000.

Most consumption categories, defined by purpose, belong to products that meet primary needs—although because of individual tastes, interests, and usage, some categories reflect overconsumption. A qualitative and quantitative approach helps to describe basic characteristics of leading contemporary Utah consumption patterns.

Housing, Transportation, and Social Services

Advanced networks of mortgage and rental services characterize the Utah housing market. Not-for-profit and government social services in Utah do not allow development of a pattern of homeless people on the streets. Among the leading companies that build affordable houses in Utah is Ivory Homes. The median price of homes in Utah is about $156,000.

Because of the absence of effective public transportation in the state, private transportation is the primary mode of travel in Utah. Many families have more than one vehicle. Larry Miller and Ken Garff are leading companies that sell American, Japanese, and European vehicles.

The UTE public transportation in the Greater Salt Lake City area includes TRAX and city buses. One-way tickets, daily passes, and monthly passes are available. Many social segments, like the students of the University of Utah, use the free transportation offered by the state.

Energy and Water

Coal, natural gas, and oil reserves are substantial fossil energy resources located in the eastern part of Utah. Utah produces more electricity than it consumes: 45.4 billion kWh versus 27.8 billion kWh, respectively. Main energy sources are coal (42 percent) and petroleum (34.5 percent), followed by natural gas (21.8 percent), and renewables (1.7 percent).

Because of Utah's low population density, its energy consumption is not high; it ranks 48th for energy expenditures per capita. Energy end use by sector is as follows: residential (20.1 percent), commercial (18.6 percent), industrial (28.1 percent), and for transportation (33.3 percent).

The leading sectors of energy usage are the Utah Transit Authority and the state's industrial sectors. Major international gas companies have numerous stations in Utah (such as the Chevron Corporation). Sinclair Oil Corporation is a Utah-based company with wide distribution in much of the United States. The population of Utah also uses the gasoline services of Maverik and 7-Eleven. Utah has considerable renewable energy potential in the areas of geothermal, wind, and solar power. The state is also rich in water resources: surface water, such as lakes, reservoirs, and rivers; and ground water, such as wells and springs. Utah's surface-water quality is one of the highest ranked in the United States. Utah is also among the top 10 states for public water supply. Most of the freshwater is used for irrigation (81.1 percent), followed by public supply (13.4 percent). Freshwater consumption by other categories varies: from 0.3 percent (domestic) to 2.4 percent (aquaculture).

Food, Beverages, and Alcohol

Walmart, Costco, Sam's Club, Smith, Fresh Market, and Harmon's are among the main suppliers of food and beverages for individual consumers in Utah. A network of small, independently owned markets from the private sector is not very well developed in the state. Small, independent ethnic stores sell Mexican, Russian, German, Greek, and Asian foods. Organic vegetables, bread and pancake mixes, maize, and sugar from sugar beets are local Utah food products that are distributed throughout the nation. Tourists prefer Utah-heritage producers of honey and honey products. Cherry and Jell-O are the official state fruit and snack. Utah is the second-largest tart cherry producing state in the United States and it has the highest per capita consumption of Jello in the world.

Utah provides a robust system of food stamp distribution for low-income families and individuals. Special programs assist in getting milk products to children and helping kindergartens' kitchens.

Alcohol consumption in Utah is not high. According to statistics, the percentage of car accidents with fatalities because of drunk driving is the lowest in the United States (19 percent in 2007).

Other Consumption Categories

There are three main types of suppliers of clothes, footwear, and cosmetics in Utah: big box stores like Walmart, Target, Ross, and Macy's; stores based on donations like Deseret Industries; and small business stores, both distributors and online. Many shopping centers in the Greater Salt Lake area follow a similar layout with the main focus being on a big box store, such as Walmart, surrounded by smaller retailers of varying products and services.

RC Willey, Walmart, Rite Aid, Walgreens, and Home Depot are the leading providers of furniture and household equipment and maintenance.

Books and office and school supplies is a category covered by Barnes & Noble, Deseret Books, Office Depot, Staples, and other big and small companies. In the early 21st century, the role of the Internet gradually increases in selling books. In Utah, Best Buy is one of the most popular stores for electronics and electronic media, including video games and movies, while Rite Aid, Walgreens, and Walmart have departments dedicated to over-the-counter and prescription medicines.

In social institutions and services, educational institutions and hospitals are the leading providers. In a population of 2.8 million, more than 560,000 are students in Utah's public education system. Foremost in the healthcare sector are Intermountain Medical Center, registered as a not-for-profit organization, and University of Utah Healthcare.

Consumption and Health

Goods and services consumption concerns all aspects of human life: physical, mental, social, and moral. Utah has an advanced system of preventive

health. Many family therapists assist individuals and couple with addictions, such as alcohol, gambling, and pornography. Not-for-profit organizations help victims of domestic abuse and the victims of over-the-counter and prescription drug abuse. Financial problems are some of the main factors cited in the abuse of prescription drugs and overdoses in Utah. About one in four Utah children are overweight, with nearly 10 percent of all Utah children classified as obese. Of the 24 percent of Utah adults who are obese, nearly 64 percent were Class I Obese, 23 percent were Class II Obese, and nearly 13 percent were Class III Obese.

Waste Collection, Disposal, and Recycling

Several landfills exist in Utah. Trans-Jordan Landfill accepts residential and some types of commercial waste. The disposal sites are divided into municipal solid waste disposal, green waste disposal, compost and woodchip material, and electronic waste (e-waste). Six of the Utah landfills accommodate asbestos: ECDC Environmental LC, Energy Solutions LLC, North Utah County Transfer Station, Salt Lake Valley Landfill, Waste Control Management, and Clean Harbors Grassy Mountain LLC. WM of Utah—Mountain View Landfill offers a safe, confidential, and cost-effective medical waste disposal system. It provides individuals, companies, and institutions a means of disposing of used hypodermic needles, lancets, test strips, and other medical waste. Wasatch Integrated Waste Management District has two facilities in Layton, Utah: a landfill and an energy recovery facility.

The green waste recycling facility at the landfill has compost and wood chip products available. The household hazardous waste facility accepts household quantities of e-waste, paint, varnish, pesticides, lawn-care products, aerosols, paint thinner, antifreeze, motor oil, diesel, gasoline, cleaning items, automotive products, and rechargeable and lead-acid batteries. The recycling drop-off center accepts mixed paper, newspaper, some plastics, aluminum, steel food cans, cardboard, and some glass.

The Summit County Landfill is located in Coalville, Utah. It accepts only household waste and household hazardous waste (HHW). Examples of HHW include HHW paints, solvents, paint thinners, strippers, and stains; mercury-containing items, such as switches, thermostats, smoke detectors, and thermometers; automotive products; fertilizers, pesticides, and herbicides; rechargeable batteries, fluorescent lights, and neon tubes; pool/spa chemicals; film-developing chemicals and acids; and insect repellents.

During the 2007 hazardous waste reporting cycle, 90 Utah facilities reported generating 82,829 tons of hazardous waste, excluding hazardous wastewater, which was managed by the generator on-site. These waters were either returned to the system, discharged to a private or publicly owned water treatment facility, or returned to a groundwater aquifer following treatment. Among the largest Utah hazardous waste generators are Deseret Chemical Depot (33,293 tons), Nucor Steel (17,284 tons), and Clean Harbors (Aragonite Incinerator Facilitys, 14,113 tons).

There are two Utah-specific hazardous waste sites: F999 (residues from demilitarization, treatment, and testing of nerve, military, and chemical agents), and P999 (nerve, military, and chemical agents).

EnergySolutions is an international company headquartered in Salt Lake City. It is a worldwide leader in the safe recycling, processing, and disposal of nuclear material.

A survey in Utah shows that more than 80 percent of Utah residents recycle. There are specialized electronic recycling companies in Utah like GRX (Guaranteed Recycling Experts), Executive Recycling, and SFI Computers, Inc. The landfills also accept recycling products.

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See Also: Food Consumption; Household Hazardous Waste; Landfills, Modern; Recycling; Shopping.

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Ventilation and Air-Conditioning

Ventilation and air-conditioning are the technologies that permit regulation of indoor or automotive environmental comfort. Design of ventilation and air-conditioning systems is a major subdiscipline of mechanical engineering. The popularity of certain regions has grown exponentially since the advent of ventilation and air-conditioning systems, which use the principles of fluid mechanics, heat transfer, and thermodynamics to regulate temperature and humidity. Environmental concerns have changed recent thinking about ventilation and air-conditioning systems, resulting in modifications in the technologies favored to cool and regulate air temperature so that they are more energy efficient and sustainable.

Ventilation

Ventilation has existed since ancient times, as this process is necessary to diminish odors and lessen airborne pollutants such as smoke, dust, and volatile organic compounds, including isoprenes and terpenes. Excavations have shown, for example, that Roman ventilation systems often were placed against the wall or built into walls, providing insulation, bringing heat, and removing stale air from rooms. Ventilation includes both the exchange of interior air with that from outdoors and the circulation of air within a building. Ventilation can be either natural or mechanical in nature and is used by architects and builders to assure that users of buildings are comfortable and that the building is secure and habitable.

Natural ventilation refers to ventilating a building with outside air but without the use of fans or other mechanical systems. This can be achieved through a variety of means, some simple and others more sophisticated. Opening windows, for example, can be used to bring air into an enclosed room, while trickle vents may be chosen when the spaces to be ventilated are small and the design of the structure permits. More complex natural ventilation systems, such as the stack effect, permit warm air in the building to rise naturally to upper openings and be drawn to the outside while cooler outside air is drawn into the building naturally through vents or other openings in lower areas. Natural ventilation has the advantage of using no or very little energy and requiring very little maintenance. The comfort of occupants, however, may be compromised by natural ventilation. Warm or humid weather may make maintaining thermal comfort through natural

ventilation alone impossible, thus requiring the use of conventional air-conditioning systems. The effects of natural ventilation are sometimes duplicated through air-side economizers, which use control systems, dampers, ducts, and mechanical fans to draw in and distribute cool outdoor air as necessary.

Mechanical ventilation, sometimes referred to as forced ventilation, is that which uses an air handler to control indoor air quality. The dilution or replacement of indoor air with outside air can frequently control many common problems such as contaminants, excess humidity, and odors. In humid climates, a great deal of energy must be used to remove excess moisture from ventilated air. Certain areas within homes, such as kitchens and bathrooms, often have their own mechanical exhaust systems to control both odors and humidity. Such systems are most efficient when the flow rate and noise levels are considered. Flow rate is determined through a proper balance of fan speed and exhaust vent size, which is established by the size of the room the mechanical ventilation system serves. Where ducts for the fans travel through spaces that are not climate controlled, such as attics, it is necessary that the ducts be insulated so as to prevent condensation from occurring on the ducting. Ceiling or table fans may also be used within a room to circulate air.

Air-Conditioning

Air-conditioning systems (which became popular in residential and commercial buildings after World War II, and which historian Mark H. Rose credits for making possible the population boom in the Sun Belt region of the United States in the late 20th century) remove heat from air within a dwelling or other building. Typical air-conditioning systems provide cooling, humidity control, and ventilation for a room or an entire structure. Air-conditioning removes heat from air by a variety of processes, including convection, radiation, and heat pump systems that collectively are known as the refrigeration cycle. The conduction mediums used for this process, such as air, chemicals, ice, and water, are collectively referred to as refrigerants. Different climates have different types of air-conditioning systems that are most effective. Seasonal and geographical considerations are often the determining factors regarding which air-conditioning system is most effective in a given building.

Cooling and humidity control are provided through two separate processes. Cooling takes place through a refrigeration cycle that utilizes four essential elements to create the desired effect. The system refrigerant, in a gaseous state, is pumped to a high pressure and temperature. It then enters a condenser (also known as a heat exchanger) where it loses energy, through the process condensing into liquid form. An evaporator returns the refrigerant indoors, using a metering device to permit the liquid to flow at the proper rate at low pressure. As the liquid refrigerator evaporates, it absorbs heat from the indoor air, returns to the compressor, and repeats the cycle. This process absorbs heat from indoors and transfers it outdoors, allowing the building that is air-conditioned to cool. Modern buildings used for residences, office or retail spaces, or public services typically contain central air-conditioning systems. Central air-conditioning systems use a combined condenser/evaporator unit installed outside and are popular for use with most small buildings for efficiency and economy. The duct system used for a central air-conditioning setup must be maintained annually to prevent pathogenic bacteria, which can cause severe repercussions in humans. Air conditioning provides dehumidification as the evaporator operates at a temperature below dew point, causing moisture in the air to condense on its coil tubes, from where it is extracted. All air-conditioning systems, including window units, use air filters that help remove dust from the air.

Environmental Concerns

Ventilation systems, especially those that utilize air-conditioning, have permitted areas of the globe that were very uncomfortable during summer months to provide working conditions that greatly increase productivity. Air-conditioned facilities are often necessary for certain equipment to function, especially that in the manufacturing, kitchen, and computer sectors. Air-conditioning was first introduced successfully by Willis Haviland Carrier in 1902 and was initially popular in business and commercial settings. Air-conditioning became popular in residential settings after 1950, permitting areas of the American southwest to grow dramatically. Air-conditioners installed in automobiles became common at about the same time.

Although air-conditioning provides many benefits, many experts are concerned about the energy such systems consume and the environmental damage caused by their manufacture and use. Ozone-damaging hydrochlorofluorocarbons have been phased out.

Although air-conditioning and ventilation systems provide many benefits, during the 1970s, many people began to be concerned about the energy such systems consume and the environmental damage that some chemicals used during the manufacturing process and regular operation can cause. For that reason, over the past 30 years, manufacturers have increased efforts to raise the energy efficiency of ventilation and air-conditioning systems.

The refrigerants commonly used in air-conditioners have also been changed as a result of environmental concerns. R-22, a hydrochlorofluorocarbon manufactured by E. I. du Pont de Nemours and Company and its licensees, was once the most popular refrigerant used in air-conditioners. After concerns regarding the damage R-22 caused the Earth's ozone layer, however, its manufacture was phased out, with the refrigerant last used in the United States in 2010. Energy-saving air-conditioning and ventilation systems are increasingly popular, with such devices using well-designed blades to move air, which can reduce energy expenditures by 33 percent compared to conventional blades stamped from sheet metal. As concerns over the economic and environmental impact of ventilation and air-conditioning increase, further investigations into sustainable systems will likely continue.

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See Also: Air Filters; Automobiles; Carbon Dioxide; Clean Air Act; Environmental Protection Agency (EPA); Home Appliances; Toxic Substances Control Act.

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Vermont

Vermont is a U.S. state in the New England region of the northeast. One of the smallest states and the second-least populated state, it has the smallest capital city in Montpelier and the smallest largest city of any state in Burlington. It is the only New England state with no Atlantic coastline. Lake Champion makes up half of the western border, and the state shares an international border with the Canadian province of Quebec to the north. The Native American Abenaki and Iroquois tribes were the state's original inhabitants. Most of the territory that became Vermont was claimed by France but ended up in British possession after the French lost the French and Indian War in 1763. Although it has one of the lowest unemployment rates in the United States, economists describe the state's economy as stagnant. The 2005 U.S. Bureau of Economic Analysis

report put Vermont's gross state product at $23 billion—the 50th of 50 states.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Vermont had an estimated 644,226 tons of municipal solid waste (MSW) generation, the lowest tonnage in a survey of the 50 states and the capital district. Based on the 2006 population of 620,778, an estimated 1.04 tons of MSW were generated per person per year (ranking joint 40th). Vermont landfilled 366,987 tons (ranking last) in the state's four landfills. It was ranked 31st out of 44 respondent states for number of landfills and had no plans to increase its landfill volume. The state exported 87,940 tons of MSW, and the import tonnage was not reported.

Vermont has no waste-to-energy (WTE) facilities, but 47,286 tons of MSW (26th out of 32 respondents) were sent to out-of-state WTE plants. It recycled 229,953 tons of MSW, placing Vermont 39th in the ranking of recycled MSW tonnage. Landfill tipping fees across Vermont were an average $96 per ton, the most expensive in the United States. Whole tires, used oil and oil-based paint, lead-acid and ni-cad batteries, mercury-added products, and white goods were reported as being banned from Vermont landfills. Vermont was also among the first states to have a statewide ban on backyard burning.

Bottle Bill

In 1953, Vermont became the first state to pass a bill banning disposable bottles (known as a "bottle bill," or "container deposit law"), requiring a minimum refundable deposit to encourage recycling. The bill banned only the sale of beer in nonrefillable bottles. However, the bill expired after four years due to a political group made of an alliance of breweries, soft drink makers, and the glass and metal industry. The businesses with the most direct involvement in the beverage-container industry created the nonprofit group Keep America Beautiful, which promoted antilitter ads and public service announcements that were credited with diverting scrutiny away from the container manufacturers. In 1971, the Oregon Bottle Bill became the first U.S. container deposit legislation to be passed.

Elizabeth Mine Superfund Site

The Elizabeth Mine, Orange County, is a 1,400-acre abandoned rural copper mine and associated ore-processing site that was worked from 1809 to 1957. The site was part of a Copper Belt around 20 miles long in Orange County. After its abandonment, many underground workings were flooded with groundwater and acid mine drainage (AMD) flowed downslope. The mine tailings piled on the site are high in metals and sulfides. Water penetrating and flowing over the piles produces sulfuric acid and dissolves and mobilizes the metals. The mine drainage flowed into two small watersheds, Copperas Brook and an unnamed stream connected to Lord Brook, from where it polluted the west branch of the Ompompanoosuc River. Samples of mine tailings, surface water, sediment, fish tissue, groundwater, and drinking water all showed metal levels exceeding background levels. Runoff from the tailings piles and heap leach piles accounted for over 80 percent of the aluminium, cadmium, cobalt, copper, and zinc loads. Around one ton of iron per week is discharged into Copperas Brook.

Subsequently, the site became part of a massive Environmental Protection Agency (EPA) Superfund cleanup. The cleanup involved extensive archaeological work to avoid damage to the mining facilities, which include the only intact cluster of historic hard-rock metal-mining buildings in the region and other features of national importance, during the remediation work. This involved intensive archaeological excavations of the mid-19th-century copper factories, which were a unique resource, but contaminated with lead. The lead concentrations here reached 680,000 milligrams per kilogram, levels unsafe for human–soil contact. The domestic and processing buildings also have the potential to reveal much about the lifeways of miners in the 19th and early 20th centuries. Mining landscapes such as that associated with the Elizabeth Mine are also now rare in New England. The extant World War II flotation mill is a rare survivor in the eastern United States, and deposits of waste material are valued as major landscape features connected to the history of metallurgical technology. Copper production at the mine was at its height from 1942 to 1958, during World War II and the Korean War, and the flotation mill and its discharge are the remnants of this last period

of the mine's operation. One tailings pile had been at risk of slope failure prior to remediation work; if this catastrophic failure had occurred, it would have damaged property downstream and could have contaminated 20 miles of stream and river.

The site has been awarded $9 million from federal cleanup funds since 2003, and the EPA has worked to prevent acid mine drainage by stopping runoff from making contact with the three piles of tailings. In the process, a tailings dam was found to be unstable and a soil buttress was used to stabilize the dam and prevent more pollution downstream. The cleanup process was controversial, as some wanted the site's historic significance preserved, while others wanted to completely return the site to nature. There was also serious concern about the amount of trucking that the cleanup program would involve.

The Elizabeth Mine was the scene of several breakthroughs in U.S. copper metallurgy, including the first successful attempts at mine-side smelting, large-scale sulfide ore smelting, hot blast and anthracite smelting, and the use of chromite refractories. As such, the site is eligible for inclusion in the National Register of Historic Places.

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See Also: Beverages; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA/Superfund); Copper; Mineral Waste; Mining Law.

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Virginia

In 1787, Thomas Jefferson extolled the rural vitality and beauty of the Commonwealth of Virginia. The man who would become the third president of the United States described Virginia as cleaner and more dynamic than the sickly, poverty-ridden cities of Europe. In the small villages of Virginia, cultivating the land produced people of "substantial and genuine virtue." The ideal was work as a yeoman farmer, transforming nature into bounty.

At the beginning of the 21st century, Virginia is a far cry from the agrarian ideal Jefferson described. Although farms still exist, the population has grown due to almost one million jobs in the defense industry and U.S. military. Dairy farms in northern Virginia have given way to suburban subdivisions housing employees of both the Dulles Technology Corridor's software and computer chip industries and the federal government.

Waste and Recycling Statistics

With an estimated population of 7,882,590, the Commonwealth of Virginia disposed of 19,559,757.69 tons of municipal solid waste (MSW) in 2009. However, Virginians were responsible for only 64 percent of the waste handled in their state. Maryland, New York, and the District of Columbia account for 30 percent of MSW going into landfills in the commonwealth. Virginia stands ahead of the U.S. average in capturing the value of MSW by recycling 38.5 percent of it and sending another 7 percent to waste-to-energy (WTE) plants to be burned to produce electricity. In the case of northern Virginia, Fairfax, Arlington, and Alexandria counties were running out of space for waste disposal so they chose to open WTE facilities, rather than export their trash. This has reduced landfill needs by 75 percent and increased post-collection recycling while producing enough energy to provide electricity for 100,000 homes. Impressive as these numbers are in relation to the national average of 24 percent recycling and 69 percent heading to landfills, Virginians produce well over the national average of refuse at 1.6 tons per capita.

As might be expected, recycling rates are highest in the more densely populated areas of northern Virginia (where density levels reach 800 inhabitants per square mile, four times the state average); Richmond and Fredericksburg reached recycling rates of over 40 percent in 2009.

One notable exception is the Hampton Roads/Tidewater Area (Norfolk, Williamsburg, Jamestown, and Virginia Beach), which has shown a

steep decline in recycling in the first decade of the 21st century. Most of the urban centers have single-stream recycling collection, resulting in a 57 percent increase in commingled capture rates. Virginia mandates a 25-percent primary materials recycled rate for all density areas of 100 people per square mile and a 15-percent rate for localities more sparsely populated.

MSW collection and disposal are handled on a county-by-county basis. Virginia has 200 waste facilities, including the Pentagon, Norfolk Navy Yard, and the Central Intelligence Agency (CIA). These disposal facilities send three-fourths of the managed MSW to landfills, with the remainder incinerated, recycled, or composted. Recycling and composting may be managed by a private company or a public service authority using one of the more than 324 recycling and nine composting facilities in Virginia. The Commonwealth of Virginia Department of Environmental Quality collects data for MSW and recycling on an annual cycle in two separate reports.

At current levels and with households generating 2.7 times more waste than commercial and industrial sectors, Virginia is spending $6.20 per person for waste reduction efforts and its landfills are expected to be full by 2032. Private sector initiatives, mainly by major retail chains, offer the traditional paper, plastic, plastic bags, and aluminum recycling, as well as collecting batteries, compact flourescent lightbulbs, small electronics, printer cartridges, and compact discs. From 2007 to 2009, electronics recycling increased by 37 percent, but single-stream paper and metal capture still account for 57 percent of total recycling in Virginia. New programs for capturing expired medications and other hazardous waste were implemented in 2010.

On the southern coast, in the Hampton Roads area where recycling rates have fallen, stands a unique monument to waste disposal. Virginia Beach constructed a vertical landfill by compacting and sealing an 800-foot-long and 60-foot-high mound of trash to create the 165-acre Mount Trashmore Park in the center of town. After its completion, Virginia Beach began shipping its solid waste to a nearby WTE facility in Portsmouth and to a landfill in Suffolk instead of establishing another landfill in the city.

Moving inland and up the Chesapeake Bay Peninsula, the Virginia Peninsulas Public Service Authority (VPPSA), one of Virginia's regional governmental agencies for managing MSW established as a political subdivision of the state, provides an extensive array of services, including curbside recycling, composting at its own facility, household chemical collection, computer and electronic recycling, special hazards waste, and 21 drop-off centers for communities.

Federal Buildings

Northern Virginia's proximity to the U.S. capital and the limited space available in the District of Columbia means that many federal buildings are located within the commonwealth's borders. Because the nature of their waste production—potential sensitive information—a portion of their MSW must be handled by waste managers with security clearance, and nonsecure MSW must be processed by U.S. General Services Administration (USGSA) guidelines. Any sensitive documents are shredded into a powder that is then incinerated. In conjunction with the Environmental Protection Agency (EPA), the USGSA established environmentally preferred purchasing guidelines for all federal agencies. Virginia dictates energy efficiency in purchasing in Executive Order 48, published in 2008, without providing much guidance on recycled content or biodegradability except for paper products. It seeks to achieve Leadership in Energy and Environmental Design (LEED) certification for new and remodeled buildings, which requires a plan and place for collecting and processing recyclables.

Conclusion

The Commonwealth of Virginia has taken significant steps for the efficient, safe, and profitable management of MSW while exceeding the mid-Atlantic regional recycling average. By decentralizing the process, it has afforded localities greater leeway in designing programs appropriate for the constituencies, but this has left it vulnerable to gaps in coverage and range of services. With the impending space crisis over usable landfills, Virginians will have to decide whether to put their energies into drastically reducing their MSW or

into building more WTE facilities to power them through the 21st century.

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See Also: Definition of Waste; District of Columbia; History of Consumption and Waste, U.S., Colonial Period; Incinerators; Recycling.

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Waring, George

Col. George Edwin Waring Jr.'s career as a sanitation engineer bridged the primitive waste collection and disposal practices of the 19th century and the sophisticated, technologically intensive methods of the 20th century. He is perhaps the most recognizable face of municipal sanitation in the late 19th century.

Waring, from Poundridge, New York, was a successful scientific agriculturalist, managing farms for Horace Greeley and Frederick Law Olmsted. Olmsted subsequently hired him to work as a drainage engineer in the construction of Central Park, after which Waring worked on a variety of drainage and sewerage projects nationwide until the outbreak of the U.S. Civil War. He joined the Union Army as a major; commissioned a colonel in 1862, he left the military in 1865 to build drainage and sewerage systems along the East Coast, including in Ogdenburg and Saratoga Springs, New York, and Lenox, Massachusetts. During the 1870s, this work brought him some recognition as a municipal engineer.

Memphis System

Waring came to prominence due to a crisis in Memphis, Tennessee. That city had been devastated by yellow fever epidemics in the 1870s. In 1878, more than one-sixth of the city's population died of the disease. In 1879, civic leaders repealed the city's charter and established a commission to govern the city and rebuild its sanitary systems from scratch. Local and state officials invited the National Board of Health to investigate and make recommendations; Waring was one of the investigators. He proposed that Memphis build—with public funds—a unique sewer system to discharge household sewage on a regular basis but not to handle stormwater. Stormwater, under his system, would be handled by surface streets. Despite some opposition from local property owners and some engineers, Waring's plan gained sufficient support from the state legislature that Memphis had completed the new sewer by the end of 1881.

One of the appeals of Waring's sewer was cost. He estimated that the Memphis system cost about one-tenth of what an ordinary stormwater system would cost the city. Waring's focus on eliminating the source of diseases at a low cost led other municipalities to adopt his system in the 1880s and 1890s. In 1881 and 1883, Waring patented aspects of his Memphis system, formed a company (the Drainage Construction Company), and marketed it to cities throughout the United States. Not only did attention

to the Memphis system produce sewer contracts for Waring, but it also led to his 1895 appointment as street cleaning commissioner of New York City.

Work in New York City

New York City's reputation for graft and corruption under the Tammany Hall political machine led reform mayor William L. Strong to appoint Theodore Roosevelt as police commissioner and Waring as street cleaning commissioner. Armed with a mandate to eliminate political cronies from sanitation jobs, Waring sought to instill an efficient military structure based upon the principles of sanitation as he understood them. Under Waring, New York City adopted the best sanitation methods attempted piecemeal throughout the country. Waring directed households to use a "primary separation" system in which garbage, rubbish, and ashes were kept in separate receptacles awaiting collection. The Street Cleaning Department could then easily use different methods of disposal for the separate waste materials.

Waring used a variety of waste disposal methods. He continued the use of ocean dumping; he also commissioned new types of dumping scows to empty wastes farther from shore and supposedly reduce the chances of their washing up on beaches—partially successful, at best.

More successful were his attempts to reclaim value from waste. He installed a reduction plant on Barren Island to extract ammonia, glue, grease, and dry residum for fertilizer from garbage, all of which were sold to offset the department's costs. He began an extensive land reclamation program on Rikers Island using waste as fill. These efforts fit Progressive attempts to reduce filth and maximize efficiency.

Under Waring, New York City built the first municipal rubbish-sorting plant in the United States, where salvageable materials were picked out of the discarded rubbish (almost exclusively by recent immigrants from Italy) and then resold. Profits offset the city's collection costs. Waring also initiated the White Wings program to combat the horse manure and litter filling the city's streets. Uniformed street sweepers, working under the close watch of supervisors, descended upon the streets with military precision. Dressed entirely in white, these workers drew positive attention to the city's efforts, and citizens and newspapers remarked upon the new standards of cleanliness in New York streets.

Waring mobilized the citizenry to elevate sanitary practices through efforts such as the creation of the Juvenile Street Cleaning League, which enlisted hundreds of youth to teach the community (including their parents) about ways to keep the city clean. This public education campaign attempted to instill civic responsibility for the streets, reducing clutter and the threat of disease.

Yellow fever both launched and ended Waring's career. During an 1898 investigation of a Cuban yellow fever epidemic, he contracted the disease and died on October 29. Waring's tenure as street cleaning commissioner lasted only three years but was enormously influential. In his speeches, articles, and examples, Waring popularized New York's system, leading many other cities to adopt similar measures. Modern sanitation reforms focused more on technological solutions and less on citizen participation, missing a crucial element in Waring's program. The most successful recycling programs of the late 20th century recalled Waring's appeals to citizen engagement a century earlier.

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See Also: Economics of Waste Collection and Disposal, U.S.; History of Consumption and Waste, U.S., 1850–1900; New York; New York City; Residential Urban Refuse; Sewage; Street Scavenging and Trash Picking.

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Washington

The state of Washington is in the Pacific northwest region of the United States on the Canadian border, south of British Columbia. Nearly 60 percent of Washingtonians live in the Seattle metropolitan area, a hub of transport, business, and industry with an arts community of international reputation, sited along the Puget Sound, a body of water and general region of the Salish Sea. The state comprises deep temperate rain forest in the west: mountain ranges in the central, northeast, and far southeastern parts; and semideserts used for intensive agriculture in the east. Fifty miles south of Seattle is Mt. Rainier; its proximity to the metropolitan area makes it the most dangerous volcano in the continental United States. The only state named after a president, Washington State or the state of Washington is commonly referred to as such to distinguish it from the nation's capital, Washington, D.C. Washington is a leading agricultural state and is home to significant businesses such as Boeing, Nordstrom, Costco, Microsoft, Nintendo, Amazon.com, Expedia, Inc., Starbucks, and wood products industries.

Statistics and Rankings

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Washington had an estimated 8,313,340 tons of municipal solid waste (MSW) generation, placing it 17th in a survey of the 50 states and the capital district. Based on the 2006 population of 6,374,910, an estimated 1.3 tons of MSW were generated per person per year (ranking 21st). Washington landfilled 5,262,632 tons (ranking 20th) in its 16 landfills, and it was ranked 26th out of 44 respondent states for number of landfills. The state exported 1,361,802 tons of MSW and imported 167,819 tons. Washington has three waste-to-energy (WTE) facilities, which processed 325,398 tons of MSW (16th out of 32 respondents). It recycled 2,725,310 tons of MSW, placing Washington 15th in the ranking of recycled MSW tonnage. Landfill tipping fees across Washington were an average $45.30 per ton, where the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively.

Disposal Sites

Garbage is often dumped in low-lying places or places that are out of sight; throwing trash into waterways meets both of these criteria. Washington is unusual in that a number of underwater trash dumps have been recognized and investigated. The underwater deposition has exciting implications in that it preserves materials, such as wood and basketwork, which would not ordinarily survive in a dry land trash deposit. Prehistoric examples include the 3,000-year-old Hoko River wet site in Clallam County, the 2,000-year-old Biderbost site in Snohomish County, and the 1,000-year-old Munks Creek in Skagit County. Hoko River is a fishing camp that was used by Native Americans of the Makah people for hundreds of years; the Biderbost site is a fish weir; and Muck Creek is a riverbank site.

Underwater historic dumped trash deposits are plentiful and usually considered to be part of the land sites they are associated with (although this is also often the case with prehistoric sites). These deposits include bottle dumps, can dumps, construction and demolition dumps, and household refuse. Artifacts ranging from the 1840s to World War II have been recovered from underwater trash deposits near the Fort Vancouver dock on the Columbia River.

Hanford Site

Located in Benton County, the Hanford site was a nuclear production complex established in 1943 as part of the Manhattan Project. B Reactor, the first large-scale plutonium production in the world, was built at Hanford and provided the plutonium for the first nuclear weapon and the atom bomb used on Nagasaki, Japan. The site was expanded during the cold war and decommissioned at its conclusion. Early safety and disposal practices were substandard, creating significant radioactive pollution and leaving 204,000 cubic meters of high-level radioactive waste at the site. This constitutes two-thirds of all U.S. high-level radioactive waste by volume. Hanford is the most contaminated nuclear site in the United States and is the subject of the nation's largest environmental cleanup. Archaeologists have also excavated the dumps used by the tens of thousands of workers from the Hanford site in World

The Hanford site in Benton County, which was a nuclear production complex established in 1943 as part of the Manhattan Project, is the most contaminated nuclear site in the United States as well as the nation's largest cleanup project.

War II in an attempt to find out more about the lives of the people who moved to the barren desert of eastern Washington to work on a secret project.

The plutonium-239 for the first-ever nuclear weapon test, Trinity, was made at Hanford. The clumsiness of the contractors employed to run the site led to much hazardous chemical and radioactive waste being dumped indiscriminately in rubbish pits over the 40 years of operational use. During cleanup work in 2004, a discarded safe was found in a rubbish pit; it held a glassware jug containing 400 milliliters of plutonium. Lab testing at Pacific Northwest National Laboratory led by Jon Schwantes, who is credited with coining the term *nuclear archaeology,* indicated that this batch of plutonium was the first ever processed at Hanford and the first time plutonium had been made on a usable scale. In 1942, Glen Seaborg's group at the University of California in Berkeley had produced a microgram sample of plutonium-239.

Using the known rate of plutonium's radioactive decay, the scientists dated the sample by comparing the ratio of plutonium to uranium, as plutonium naturally decays into uranium. This process is not dissimilar to archaeological radiocarbon dating. The results indicated that the sample dated to 1946, give or take a 4.5-year margin of error. At this point of World War II, there were only 11 reactors in the United States, four of which were reprocessing fuel into plutonium. Three of these reactors were at the Hanford site, the fourth was in Oak Ridge, Tennessee. Comparison of minor plutonium isotopes in the sample matched it to the signature isotopes from the X-10 reactor at Oak Ridge. As the Hanford reprocessing site was the first of its kind and was completed before the Hanford reactors, its inaugural running was done using fuel from Oak Ridge. By the time of the second run, the Hanford reactors were producing fuel, so the sample from the safe is the first sample of weapons-grade plutonium-239 ever used. Historical research showed that a safe was sealed in 1945 because of radioactive contamination and was disposed of in 1951; it is presumed that this is the same safe. It is unclear why this material was not used in any atomic weapon.

Another issue that came out of Hanford in the 1980s was the problem of using semiotics to mark the danger of dumped nuclear waste to people who might dig it up in the far future. How could the hazard of radiation be conveyed millennia into the future when languages might be completely different? One solution suggested by the engineers of Westinghouse Hanford was the use of a ceramic disk, as ceramics are one of the most stable and enduring materials in the archaeological record. Some suggested that the sign used on the disk should be a digging figure with the international ban symbol imposed over it. However, some thought that this would only encourage future people to dig—such being human nature—as the tombs of the pharaohs were also marked with warnings not to dig into them. Other approaches included forming an "atomic priesthood" society to watch over nuclear waste sites through the generations; developing monumental structures that communicated the idea of "stay away"; and using existing symbols such as the skull and crossbones, or Edvard Munch's *Scream* figure.

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See Also: Archaeology of Garbage; Hanford Nuclear Reservation; High-Level Waste Disposal; Nuclear Reactors; Radioactive Waste Disposal.

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Waste as Food

Every society classifies some things as edible and others as inedible, though often in different ways. What one group considers waste, another may see as food. Under special circumstances, a subgroup may come to see what is normally considered waste as food; for instance, because of a particular ideology, economic hardship, or the gesture's symbolism. More rarely, a disorder called "pica" drives individuals to impulsively ingest items that their own cultures and even they would consider inedible.

The dividing line between the edible and the inedible is frequently a matter of differing cultural interpretation. More obscure examples, such as entomophagia (insect eating) or geophagia (dirt eating) aside, many are familiar with culinary relativism. For instance, snails, frogs, raw hamburger meat, and horse can all be found on menus in the country most renowned for its cuisine. Also, the intestines, ears, and hooves of pigs might be considered waste in some contexts—not least by Muslims and Jews—but they are mainstays in Lyon, France's *capitale gastronomique*.

Social Concepts of Food

Humans choose their food mainly for reasons other than nutrition. For example, people may choose food because of taste, availability (cost as well as climatic and geographic factors), religious restrictions, or because it conveys a sense of identity or a certain status. One of Mary Douglas's key points in her 1966 work *Purity and Danger* is that food avoidances have important social functions in creating and policing group boundaries between castes, classes, or religious communities. In other words, distinguishing food from waste—as well as categorizing others' food as waste with respect to one's own group, or vice versa—is central to the way human beings connect themselves to some people and separate themselves from others.

Freegans

An example of a subgroup in contemporary Western society that consumes waste is freegans. Freeganism is a series of strategies based on limiting one's participation in the monetary economy and reducing one's consumption of resources. It often includes urban foraging or dumpster diving for food. Although eating others' garbage saves money, this is more of a counterhegemonic form of activism that rejects disposing of perfectly edible food (e.g., because it has reached a pre-ordained "sell by" date without actually spoiling) rather than a survival strategy. Freegans would not consider the discarded things they eat to be waste; rather, they disagree with their classification as such by others.

Hardship

Unlike freegans, the homeless, elderly living on insufficient pensions, or whole populations during times of hardship may have no choice but to eat things normally considered waste. Some examples include consuming taboo animals, stretching edible ingredients with nonfood items (as when sawdust was mixed with flour in Athens during World War II, or spoiled milk mixed with sugar became a dessert in the United States during the Great Depression), or scavenging the leftovers and scraps of the privileged few who have access to food. Shifting the boundary between waste and food when facing starvation or extreme poverty is an adaptive strategy, not an ideology.

Symbolic Eating

Waste is also consumed, at times, for symbolic reasons. When Catherine of Sienna reproached herself for feeling revulsion at the wounds of the sick and poor whom she was tending, to prove her commitment to charity, she deliberately drank a bowl of

pus. Muslim followers of north African saints at times consume the saints' vomit or dirty bathwater as a way of acquiring their blessings. In India, a holy woman may be honored by her hosts' act of washing her feet and then drinking the dirty water. Paradoxically, a consumed substance signifies internalization, incorporation, and acceptance for precisely the same reasons that make it polluting—the way it penetrates the body and is absorbed into it. Those who consume such wastes not only take into themselves an emanation of that person's body—an intimate act—but also signify acceptance of the other by conveying that they experience no distaste at what would normally be disgusting or repulsive about them.

Pica

Not all instances of consuming the inedible involve differing individual or group interpretations of the waste–food boundary. People who suffer from pica crave, and may even feel addicted to, eating nonfood items such as ash, clay, charcoal, coffee grounds, egg- or seashells, baby powder, chalk, paraffin, starch, or soap. The term *pica* comes from the scientific name of the magpie, a bird often seen with an odd assortment of objects in its beak (though for nest building, not eating). It is not so much that people with pica come to regard these items as food, but rather that they crave them despite acknowledging that they are not food.

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See Also: Culture, Values, and Garbage; Dumpster Diving; Food Waste Behavior; Freeganism; Zero Waste.

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Waste Disposal Authority

Any human society produces waste—residues or items, materials and substances having lost all use and exchange value. What is considered to be waste varies widely from one society to another depending on its cultural, sociological, religious codes, history, and economic system. However, a trend seems constant: waste disturbs—it creates disorder and danger for the community. In her well-known 1967 work *Purity and Danger*, the British anthropologist Mary Douglas chose this very criterion to define the notions of "uncleanness," "dirt," and "waste." Waste, for her, is what is out of place, messy, and perceived as a disruptive agent by an individual or group: "As we know it, dirt is essentially disorder . . . Dirt offends against order. Eliminating it is not a negative movement, but a positive effort to organize the environment."

The ordered arrangement of a human community rests upon the authority that governs it, whether it be collegial or held by a single individual. It is the very function of those empowered in this way to organize society in its environment, to ensure its smooth running by imposing rules and by its distribution into groups assigned to distinct spaces. One might be tempted to think that waste—as the agent of confusion and disorder—lies beyond such power, as the opposite of the order established by authorities. It is nevertheless because of the danger and the disorder that waste represents that the governing powers must take on its management, by allaying this threat for the community, especially by neutralizing it and defining the places where it must be deposited.

Rural Communities

Archaeologists and anthropologists have noticed that in small rural communities, human, organic, or manufactured waste is managed mostly individually by each domestic group, accumulated in or near the house, or scattered as fertilizer on fields or out in the open country away from living spaces. This generally does not represent a threat for the community as a whole, as waste is produced in small quantities, is often reused, and because there is enough space for it to be evacuated. Those in power do not intervene in a collective waste man-

agement, specifically in the demarcation of a space where waste should be deposited.

Urban Communities

On the other hand, in urban agglomerations, the concentration of population and of buildings led to an accumulation of waste that proved difficult to curb at the individual level, causing a number of disturbances in the urban space. Urban authorities were led to take on the task of waste management by defining collective modes of management and particular spaces of disposal. The invention of these technical systems of collection and treatment also entailed a distinction of waste according to its nature: as solids, such as leftovers, household materials, and objects deriving from businesses and industries; and as liquids, such as wastewater resulting from domestic washing, as discharges from industrial and craft activities, and as human and animal excretions. As the possible source of multiple disorders, whose nature varies from society to society (sanitary, ecological, social, and symbolic), waste disposal has thus become one of the major concerns of urban authorities held to be responsible for the neutralization of the inherent dangers of garbage.

Political leaders—almost always at the municipal level—often harnessed this prerogative of waste management in order to justify their dominant position, reward allies, eliminate potential rivals, discriminate between certain communities, or coercively impose their will on the collective as a whole. In such cases, waste disposal ceases to be a simple service to become a tool or weapon in the hands of the political elite. In some contexts, control over wastes has negative effects on both the polis and the waste policy. Despite spending millions of taxpayer dollars each year on the program in an effort to make Chicago the most environmentally friendly city in the United States, the city failed to develop universal (or even majority) recycling collection by the end of Richard M. Daley's mayoral administration in 2011. This was in part due to aldermen controlling pickup of recycling and garbage in the city's 50 wards.

While the solutions adopted for the issues of waste disposal may thus differ according to the nature of the waste in question—according to the cultures, regions, and historical periods concerned—they can be grouped into three major, complementary tendencies: evacuation and concealment, accumulation and ostentation, and recovery and processing.

Western Waste Disposal: Evacuation and Concealment

From antiquity onward, with the birth of cities, those in power have had no choice but to lay down the ground rules for individual and collective practices of waste management in order to guarantee the cleanliness of living spaces. The mobilization of doctors and authorities was motivated at first by the need to contain epidemics, which seemed to spread more quickly in towns with dense housing and the accumulation in private and public spaces of human, animal, and domestic waste. Whereas the Greek physician Hippocrates laid the grounds for the set of medical practices that were later designated "hygiene," Roman authorities created in their capital, Rome, the first sewerage system, the Cloaca Maxima, to evacuate wastewater and city-dwellers' excreta outside the city.

However, after the fall of the Roman Empire and until the end of the medieval period, European city leaders made no concerted, collective effort to manage their citizens' waste or to define specific spaces or devices of waste disposal. Cities such as Paris, London, or Rome were veritable cesspits in which urban dwellers, storekeepers, and craftspeople used to dump their liquid and solid waste from doors and windows straight into the rivers or onto the pavement and the beaten earth where, if they were not salvaged as manure for fields or as food for cattle, they accumulated in a sludge that spattered passersby.

During this time, the intervention of authorities remained limited to largely ineffective, repressive police measures, such as ordering the evacuation of waste and street cleaning under the threat of fines. It was not until the 16th century—with the ravages caused by great plagues in Italian and French cities—that governments began to intervene in collective waste disposal, setting up the first municipal services of collection. And it was only in the 18th century that—following the impetus of the medical elite, whose scientific advances suggested the role played in public health by the decontamination and cleanup of private and collective spaces, notably in

reducing the proliferation of insect vectors of diseases like malaria, dysentery, typhus, or typhoid—the first systematic waste disposal policies were actually put into place.

A real turning point took place between 1820 and 1840, with the birth in France of the hygienist movement following Louis Pasteur's discoveries of the role of microbes and garbage in the spreading of harmful germs. Hygienist theorists advocated the evacuation of junk to the outskirts of living spaces, in dumping grounds and wastewater sewage works. This distancing of trash went together with its concealment from city dwellers; solid waste was collected by specialized municipal officers in special containers and brought to municipal dumping sites remote from city centers. Later, a complex system of invisible, underground pipes connected people's homes to sewage works or to wastewater treatment plants on the cities' outskirts, providing the basis for mains sewage. Finally, hygienist thinkers posited a close association between waste, dirt, and working classes, all of whom were considered dangerous to a social order led by the bourgeoisie. The conception of waste control as control over not only a sanitary threat but also a social, even a moral, disorder became the norm for Western urban political elites. The sanitary order thus became strictly synonymous with the moral order, to be maintained by public authorities by means of specialized waste disposal infrastructures, equipment, and sites, and by educating the populations—particularly, those most deprived—in basic hygiene principles.

At the beginning of the 21st century, the great Western nations provide the model of hygiene and public health. This model will prove influential in determining waste management policies in many foreign countries across the Atlantic and in southern countries, which are undergoing urbanization. Colonization is involved in the export of European public health and hygienic policies. After the fall of the colonial empires, it will be the turn of networks of global communications and of international cooperation to spread patterns of waste management modeled on the Western hygienist system, particularly within the framework of development aid. Public policies and Western waste management infrastructures, of which sewer and landfill remain emblematic, have become an ideal of development and modernity in emerging countries, despite a frequent mismatch with local geographical, economic, and political contexts. The same holds true for people's representations and practices pertaining to the conceptualization and treatment of what is considered waste.

Waste as a Resource for Power: Accumulation and Ostentation

This Western waste management pattern, based on the principles of distancing and concealment, is widely globalized and is applied with varying degrees of success in all major cities of the planet. However, during various periods and in a number of societies, political waste management has also been founded on a very different, even opposite, logic.

In many Sahelian African societies, for example, large trash piles are erected chiefly next to residences. Waste is patiently accumulated over several decades to symbolize a chiefdom's territorial precedence and to materially demonstrate its wealth in goods and people. Members of these chiefdoms also consider that garbage accumulated over a long time exudes a powerful and harmful energy, attracting potentially dangerous supernatural entities. Local authorities are then in charge of controlling this occult threat, not by disposing of waste as far as possible from living areas as in Western cities, but by drawing it close to those in power and placing it under their supervision. In some cases, African chiefs also had the prerogative of using the dangerous force contained in their trash piles to serve the community—in the course of fertility rituals, for example, or during trials by ordeal of the most serious crimes, like witchcraft.

In many societies, public authorities also use waste management as a tool of domination and coercion, for instance, by favoring its accumulation, rather than its evacuation, in districts sheltering populations stigmatized for their religion, ethnic origin, or socioprofessional status. In India, for example, the caste system—a hierarchical organization of individuals depending on their degree of "purity"—allowed leaders (elites belonging to high castes) to assign lower-caste people to unhealthy living areas, allotting them activities, such as waste collection, deemed most polluting.

Conversely, in some urban environments, city dwellers do not hesitate to use garbage as a tool for aggression and domination, for instance, in quarrels between neighbors where waste may be knowingly thrown on the doorsteps of others. People can also use wild garbage deposits or the deliberate throwing of refuse beside (rather than in) collection devices to provoke or to call into question lax municipal authorities. As of 2010, the vast majority of urban populations around the world have integrated the views on salubrity diffused by Western hygienist physicians, as well as the idea of a bioresponsibility of those in power to whom it falls to ensure the cleanliness of the community's living areas. To each his share in the contract, the plaintiffs seem to argue: physicians bring their knowledge, populations demonstrate their willingness to behave properly, and both expect policy makers to take responsibility for decisions that are theirs to take.

The 21st-Century Paradox of Political Waste Management: Recovery and Processing

The globalization of Western conceptions of cleanliness and of urban order has imposed in everyone's mind the necessity to literally remove waste from living spaces. In addition, the awareness of the damaging environmental effects of waste disposal—in the open countryside, deposited on dumping grounds, buried in landfills, or thrown to the sea—requires authorities to find technical solutions to get rid of waste without polluting. At the same time, in the West, as in a growing number of emerging countries, industrial and household waste production continues to increase, while discharged objects, materials, and substances are becoming more and more polluting and complex to degrade—often being of too-poor quality to be recovered and reused. Consider, for example, the proliferation of plastic bags in the landscapes of many developing countries.

Henceforth, those in power can no longer assume their "bioresponsibility" by simply concealing, removing, or destroying waste. With the emergence of the "sustainable development" concept in the 1990s, authorities are prone to speak of waste "recovery," thereby neutralizing the sanitary and environmental dangers it represents, all the while exploiting its potential for salvage, recycling, or energy production. A shift in the conception of waste management has occurred: authorities must no longer make waste disappear but must exploit it as one resource among others, through costly and complex technical devices such as incinerators, recycling, or methanation plants. This change of perspective also requires teaching people new waste treatment practices: not merely to evacuate waste by means of collection devices provided for this purpose by authorities but also to sort between various types of waste and even to reuse waste material (e.g., composting). Having integrated concealment and distancing, Western populations are now required to relearn how to handle waste.

The fact is that this is a challenge for Western governments, which still favor a hygienist and economic logic (incineration and landfilling) at the expense of a sustainable, ecological logic (recycling, reuse, or even a reduction of waste production). This is also a challenge for emerging countries, whose authorities are struggling to set up waste collection and treatment infrastructures in accordance with Western hygienist and ecological criteria. Matters are often complicated by fears of the concerned populations and their reluctance to live next to waste storage or reprocessing facilities, a phenomenon called Not in My Backyard (NIMBY).

In this way, Western governments rediscover that waste is not only a sanitary, environmental, or even social threat but may also constitute a wealth. And yet, all communities, at one time or another in their history, practiced waste recovery. Until the 1960s in the West, every household reused as best it could the slightest leftover, thereby producing very little "waste" in the etymological sense of the word. Some populations in the West, as in the cities of emerging countries, also developed a complete informal economy organized around the collection and recovery of objects, substances, and materials dumped on the streets or in landfill sites (for example, 19th-century Parisian *biffins*, or Cairo ragmen garbage collectors). In some cities, masses of detritus have long been recovered to fill land and to level ground, allowing the building on swampy areas or the shoring up of rivers banks, such as in Mopti, Mali.

However, these informal activities of waste recovery—and the enrichment that can result from them—remain, for the most part, badly perceived

by authorities and the majority of the population. Nowhere have waste collectors been well considered; rather, they are viewed as shady, even deviant individuals. It is as if, when the recovery of waste spins out of the control of those in power, it is perceived as illegitimate, even dangerous, for the collective good. This is a proof that waste management remains an irreducible prerogative of those in power, who are expected to assume their "bioresponsibility" to manage the various disorders that it causes, exploit its multiple potentialities, and define those areas where it is or is not entitled to be.

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See Also: Cloaca Maxima; Culture, Values and Garbage; History of Consumption and Waste, Ancient World; History of Consumption and Waste, World, 1700s; History of Consumption and Waste, World, 1800s; Landfills, Modern; Politics of Waste; Recycling; Sewers.

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Waste Management, Inc.

Waste Management, Inc. (WM), incorporated in 1987 as USA Waste Services, leads its industry as the largest waste company in North America, with almost 50,000 employees and revenues of over $11 billion in 2009. It provides comprehensive garbage and environmental services to over 20 million municipal customers in the United States, Canada, and Puerto Rico, and it operates over 250 landfills and 345 transfer stations, which enable the efficient and economic consolidation, compacting, and transportation of waste. The company engages in an array of programs to benefit the environment, including energy generation through the recovery of natural gas produced by landfills. WM is also the largest recycler in North America, collecting material such as paper, cardboard, glass, plastic, metal, and electronics.

Early History

The success of WM—indeed, even the very existence of it and companies like it—has resulted from changes in the manufacturing landscape and consumption patterns beginning in the 1800s and continuing into the 21st century. The Industrial Revolution ushered in an age of factories, mass production, and urban living. The invention of the steam engine, the proliferation of railroads, and the development of the automobile contributed to the rapid economic growth of cities and a rising middle class. Both World War I and World War II initiated scientific advances in the service of the military that were then applied to consumer products for the growing middle class. The increased mechanization and mass production of consumer convenience items, accelerated by developments in chemistry, created industrial and municipal waste at an alarming and unmanageable rate. However, the still-young country had not developed a system for collecting its massive quantities of garbage. Many households fed their trash to the family pig or used a home incinerator; others dumped it in the streets or in nearby rivers or streams. Factories and municipalities, with no federal regulation, were free to dispose of waste by incinerating it, releasing toxic chemicals, or dumping it into bodies of water or unsanitary landfills, creating pollution. Even

though scientists linked disease with the prevalence of garbage in the 1850s, the disposal of waste was largely unregulated and unchecked unless local or state governments intervened to regulate garbage and protect human health.

WM's history dates back to the 1890s, when Dutch immigrant Harm Huizenga began carting ashes and waste in Chicago. His Ace Scavenger Service was one of hundreds of small, private waste-hauling businesses working in U.S. cities at the time, and the business was successful enough for the family to continue operations after Harm's death in 1936. To address the insidious problem of waste, New York City was the first urban center to enact a public health code and create a municipal solid waste and recycling program. Appointed as the city's sanitation director in 1897, Colonel George Waring, Jr., utilizing his experience as a Civil War officer, waged war on garbage both through collection and public relations efforts. Within five years, 79 percent of cities in the United States followed suit and offered solid waste collection. Between that time and the close of World War II, a collect-and-dump paradigm remained dominant. With municipalities managing local garbage collection, they focused their attention on creating efficient, cost-effective strategies for removing vast quantities of waste.

Regulation and Growth

Except for a 1934 U.S. Supreme Court decision banning waste disposal in the ocean, it was only in 1965 that the federal government weighed in on the management of garbage. That year, Congress passed the Solid Waste Disposal Act (SWDA), the first national legislation dealing with the issue of solid waste. While the SWDA did not outline regulations for solid waste management, it did offer financial incentives to states that developed planning, training, or research demonstration projects. In 1976, the Resource Conservation and Recovery Act (RCRA) amended the SWDA, delineating four goals for the management of municipal and industrial waste and giving the Environmental Protection Agency (EPA) the authority to develop and enforce regulations to meet them. These goals include protecting human health and the environment from the potential hazards of waste disposal, conserving energy and natural resources, reducing the amount of waste generated, and ensuring that waste is managed in an environmentally sound manner. Since the passage of the act, two goals have been added: preventing future problems caused by irresponsible waste management and cleaning up hazardous waste spills.

Waste Management, Inc., developed, prospered, and even faltered in this quickly shifting regulatory and economic environment. At the time, postwar consumerism was increasing, and, consequently, demand for garbage collection rose. With intensified demand, private companies were entering the garbage collection business and doing it more cost effectively than cities. Ace Scavenger, one of these small, private hauling companies, operated in the Chicago area and had just 12 trucks when it was taken over in 1956 by Dean L. Buntrock, the son-in-law of Harm Huizenga's son Pete.

With demand for garbage collection outpacing supply, Buntrock purchased competitors and developed new ventures to expand the company. Realizing the SWDA was a harbinger of a new era in the industry, Buntrock and H. Wayne Huizenga,

As the largest waste and recycling company in North America, Waste Management had almost 50,000 employees and revenues of over $11 billion in 2009. Its goals include increasing recycling and energy from waste and creating wildlife habitats.

who owned hauling services in Florida, merged their operations in 1968 under the Waste Management, Inc., name, and the company became publicly traded beginning in 1971.

WM continued to grow exponentially through an ongoing series of acquisitions. Meanwhile, the company leadership implemented a cutting-edge management information system that allowed unprecedented information flow into the Oak Brook, Illinois, headquarters. It expanded its operations to include the collection and management of hazardous waste—an area highly regulated by the RCRA and, therefore, an area with few competitors—and started to collect recyclable material. With the 1984 acquisition of SCA Services, WM became the largest waste disposal company in the United States.

Controversy, Reorganization, and Acquisition

Although the phenomenal growth of the company should have been cause for celebration, the reputation of the firm was compromised in the 1980s. A front-page article in the *New York Times* revealed several citations WM received for violating federal and state regulations at toxic-waste sites. In addition, former employees claimed that the company had illegally disposed of toxic waste and had tampered with evidence related to the illegal activities. On top of environmental transgressions, WM was accused of unfair business practices and ultimately paid over $3 million in fines for illegal collusion and price-fixing.

Despite the damage WM's reputation suffered, the company's large infrastructure, its expanding landfills, and its foray into recycling allowed it to survive relatively unscathed. In 15 years, the company had gone from $750 million to over $4.5 billion in revenue. Well positioned for the future, WM reorganized in 1993 as a publicly traded holding company under the name WMX Technologies. It had a controlling interest in Chemical Waste Management, Waste Management International, Wheelaborator Technologies, and Rust International, and full ownership of Waste Management of North America. Unfortunately, the new company was never able to create synergy among its divisions. Its revenue and profits declined, and assets were divested. Although Buntrock, CEO of WMX, was replaced and ultimately forced off the board, WMX was unable to recover and by the mid-1990s, the company's future was in serious doubt.

Meanwhile, a competitor, USA Waste Services, Inc. (founded by Donald F. Moorehead, Jr., first incorporated in Oklahoma in 1987, and reincorporated in Delaware in 1995), was enjoying the success WM had experienced during its golden years. Operating out of Dallas, Texas, USA Waste Services utilized an acquisition strategy to become the third-largest waste management company in the United States by 1998. By the time WMX was in crisis, USA Waste Services was in a position to acquire the nation's largest waste management company. The sale concluded in 1998, and the new company was renamed Waste Management, Inc., and the headquarters was relocated to Houston, Texas.

New Initiatives

The acquisition of Waste Management, Inc., by USA Waste Services has largely been successful. In 2004, David P. Steiner became CEO of the firm. Under his tenure, the new Waste Management, Inc., has experienced strong revenue and income and fantastic growth. Even in the difficult 21st-century economy, it has thus far been able to maintain its financial strength, develop customer-driven solutions, continually improve the safety of its operations, pursue sustainability initiatives, and take advantage of opportunities for growth. However, growth in the waste management industry can no longer come through acquisitions or building new landfills. WM is meeting the challenge of adapting to a changing environment through a number of new strategic initiatives. Its Healthcare Solutions offers disposal and recycling programs to healthcare facilities; it it will likely use the expertise developed through this business to create other industry-specific initiatives in the future. WM's LampTracker is the largest bulb recycler in North America. Bagster, WM's Dumpster in a Bag program, allows customers to collect up to 300 pounds of debris or waste, which is then removed by WM collection vehicles. The Green Squad program works with commercial customers to help them identify cost savings through waste reduction and energy efficiency.

WM's sustainability goals, announced in 2007, include generating more energy from waste, increasing recycling, investing in green technology,

and creating wildlife habitats. These goals reveal the interesting challenge the waste management industry faces. While private garbage-hauling companies originally had only to collect and dispose of the trash consumers were willing to pay to get rid of; over the coming decades, the waste management industry will be challenged to leverage waste to create value from trash and, ultimately, to reduce the amount of waste.

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See Also: Landfills, Modern; Packaging and Product Containers; Recyclable Products; Recycling; Resource Conservation and Recovery Act; Solid Waste Disposal Act; Zero Waste.

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Waste Reclamation Service

The Waste Reclamation Service was an agency operating under the auspices of the U.S. Department of Commerce during World War I to address shortages of war materials the nation was facing. Organized when the U.S. government was facing crucial shortages of war materials, the Waste Reclamation Service sought to increase public awareness related to the consequences of disposing of goods and materials that otherwise could be salvaged to assist in the war effort. The Waste Reclamation Service also facilitated local councils that would plan ways to coordinate collecting, sorting, cleaning, and reusing items gathered. While of limited duration because of the United States' late entry into World War I, the Waste Reclamation Service's approach proved highly influential to later efforts to deal with problems focusing on consumption and waste.

Background

World War I, also known as the Great War, was a major conflict centered in Europe that began in the summer of 1914 following the assassination of Austria-Hungary's Archduke Franz-Ferdinand, heir to that nation's throne, by a Serbian anarchist. A complex series of treaties and alliances caused hostilities to quickly escalate after Austria-Hungary invaded Serbia; with Germany quickly invading Belgium, France, and Luxembourg; and Russia attacking Germany. Lead players in the war consisted of the United Kingdom and its dominions and crown colonies, France, Russia (until 1917), Italy (after 1915), the United States (after 1917), and others, who collectively comprised the Allies; versus Germany, Austria-Hungary, the Ottoman Empire, and Bulgaria (after 1915), who were collectively referred to as the Central Powers.

Although the Germans had early success and moved quickly into France in 1914, their advance soon settled into a battle of attrition focused upon trench warfare on the western front. The collapse of Russia's government, and the Russian Revolution of 1917, led to that nation's withdrawal from the war and permitted the Central Powers to focus their energies on the western front. World War I caused extremely high levels of casualties, claiming nearly 10 million lives, over 20 million injuries, and left nearly eight million missing. The war was also extremely costly in terms of materials, with shortages developing that were caused in part by difficulties transporting raw materials from overseas and also due to the sheer demand caused by the sustained conflict.

The United States was a relatively late entrant into the conflict, having pursued a policy of nonintervention from the war's beginning until April 1917, when Congress formally declared war on

Germany and Austria-Hungary. Although he had managed to keep the United States out of the war after the German U-boat sinking of the British liner RMS *Lusitania*, which caused 128 American deaths, President Woodrow Wilson was under increasing pressure from a variety of sources to enter the conflict on the side of the Allies. Wilson was also interested in gaining a seat at the negotiations that would end the war so that he could advance support for the League of Nations, of which he was an ardent supporter.

After the Germans resumed unrestricted submarine warfare in January 1917, the United States' entry into the war was probably inevitable, but an incident known as the Zimmerman Telegram assured that the United States would oppose Germany and its allies. The Zimmerman Telegram was a communication from the German foreign minister, Arthur Zimmerman, which asked German agents to suggest to the Mexican government that should Mexico declare war on the United States, Germany would return a portion of the American Southwest to Mexico at the war's conclusion. After the telegram was intercepted by the British, decoded, and made public, the response was intense. Congress followed Wilson's call for a declaration of war, voting to enter the conflict on April 6, 1917.

Waste Reclamation

The United States' earlier policy of nonintervention left it ill prepared to enter World War I. As the United States had historically not had a large standing peacetime army, troop levels were low. This resulted in the passage of the Selective Service Act, which implemented a draft that ultimately activated over 2.8 million enlisted men. While the draft proved remarkably effective at getting American troops to Europe, there was a huge need to equip and clothe them. Basic materials such as cotton, linen, paper, iron, steel, copper, brass, tin, and rubber were all in short supply and desperately needed for the war effort. The War Industries Board (WIB) was established in July 1917 to assist with and coordinate the purchase of war supplies. The WIB encouraged suppliers to use mass-production techniques and product standardization to increase efficiency and reduce waste. After several leadership changes, Bernard M. Baruch, a Wall Street financier and adviser to Wilson, took control of the WIB and ultimately increased U.S. industrial production by over 20 percent. Dealing with labor-management disputes and price negotiations, the WIB regulated tensions to prevent a shortage of supplies and materials reaching troops at the front lines. The WIB established a Waste Reclamation Section, which evolved into the Waste Reclamation Service after Wilson used an executive order to decommission the WIB on January 1, 1919, after the war had ended.

The Waste Reclamation Service, under the auspices of the U.S. Department of Commerce, was seen as a valuable vehicle to allow the continued salvaging of waste that could then be used for military or peacetime purposes. During the war, the Waste Reclamation Section had reclaimed waste material worth an estimated $1.5 billion, worth at least 10 times that amount in 2010 dollars. In particular, the Waste Reclamation Service had salvaged materials worth the following values in little more than a year's formal operation: (1) scrap iron: $600 million; (2) rubber: $300 million; (3) scrap metal: $300 million; (4) waste paper: $200 million; (5) cotton and wool: $100 million; (6) woolen rags: $75 million; (7) cotton linters: $50 million; and (8) second-hand bags: $25 million.

Continuing with this, the Waste Reclamation Service set an early goal of reusing $300 million per year of waste that would otherwise be discarded. The Waste Reclamation Service continued the over 85 local reclamation councils that had been established across the nation, which facilitated and ran the reclamation of waste in their localities.

Dependent upon the cooperation of national and local groups, the Waste Reclamation Service gained the assistance of a variety of government agencies and national organizations. Government agencies that were part of the initiative included the Federal Board for Vocational Education, U.S. Army, U.S. Department of Agriculture, U.S. Department of Labor, U.S. Navy, U.S. Post Office, and U.S. Railroad Administration.

Realizing that widespread support for the Waste Reclamation Service required support from diverse national organizations, the following groups agreed to cooperate: (1) American Federation of

Labor, (2) American Red Cross, (3) Boy Scouts of America, (4) Girl Scouts, (5) International Association of Rotary Clubs, (6) Jewish Welfare Board, (7) National Catholic War Council, (8) National Council of Women, (9) National Young Men's Christian Association, (10) Salvation Army, and (11) U.S. Chamber of Commerce.

Together, these groups worked to organize individuals, businesses, waste dealers, and others to reduce waste and reclaim as much as possible. The most important materials to reclaim included paper, metals, rubber, leather, and cloth, which were to be collected on a weekly basis from homes and businesses. Although the Waste Reclamation Service started out with a great deal of enthusiasm, the economic prosperity of the 1920s soon made many question the need for such a program, and it was allowed to quietly fade away. Certain national policy advisers, such as Baruch, bemoaned the lack of war preparedness such a program addressed and lobbied Congress and the president for its reinstatement, to no avail.

The Waste Reclamation Service and its predecessor provided several valuable services to the United States. First, it greatly assisted the war effort insofar as it provided a steady and reliable supply of materials needed to assure victory during World War I. Second, it greatly raised awareness regarding the amount of waste that occurred in the prewar era, suggesting to many that cost efficiencies were possible, including examining the energy costs that disposal entailed. Third, the Waste Reclamation Service provided an organizational format that permitted a cohesive approach to collecting, sorting, cleaning, and reusing waste. Finally, it greatly encouraged thinking about waste in a manner that permitted conceptualizing means of reusing, rather than disposing of it. Together, these contributions have in many ways influenced current views regarding waste and consumption.

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See Also: Definition of Waste; History of Consumption and Waste, U.S., 1900–1950; Household Consumption Patterns; Human Waste; Industrial Waste; Organic Waste; Recycling in History; Rubber.

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Waste Treatment Plants

Humans require access to an adequate supply of potable water for sustenance and recreation. Although tremendous amounts of water exist on Earth, much of this is not fit for human consumption. Much of the Earth's water has been contaminated by effluent (runoff) or domestic waste. In order to remedy this, waste treatment plants pursue the process of water purification that permits water to be safe for human use. The water purification process removes undesired chemicals, organic and inorganic materials, and biological contaminants from raw water, making it fit for human consumption and other purposes.

The purification of raw water can take place in a variety of settings. These settings include large-scale municipal water purification plants, portable and emergency water-purification systems, industrial water purification, and small-scale distillation of water. Each of these methods focuses on the central goal of removing undesired chemicals and contaminants from water. Depending upon the purpose intended for the water processed, different treatment methods are favored. Providing clean drinking water for humans is, of course, one of the major purposes of water purification. Many other uses exist for water purification, however. These include meeting the needs of medical, pharmacological, chemical, and industrial applications for clean

and potable water. Waste treatment plants reduce the concentration of foreign substances in water, including suspended particles, parasites, bacteria, algae, viruses, and fungi, as well as other dissolved and particulate material that water may have come in contact with as a result of the water cycle.

Determining Water Quality

Government agencies determine and set standards regarding the quality to which water must be purified before it can be consumed by humans. Local, national, and international water standards typically outline a set of minimum and maximum concentrations of harmful contaminants allowed within the water for it to still be considered safe. Since it is nearly impossible to determine water quality simply by its appearance, multiple processes have been developed to test water contamination levels.

Household methods such as boiling water, or utilizing activated carbon filters, such as the popular Brita water filters, have been developed to remove water contaminants, but although these methods are inexpensive and can be widely used, they are insufficient in many cases. Some of these methods are actually misleading to consumers, as they do not address the possibility of more dangerous contaminants. New standards of purification have also caused a reassessment of many traditional sources of water, such as natural spring water. Natural spring water had historically been considered clean for all practical purposes. Natural spring water has come under increased scrutiny recently, however, and is now subject to treatment and batteries of tests much like water from other sources. Chemical analysis that determines the content of water as well as the concentration of contaminants contained therein is the only reliable means of determining which methods of purification are necessary.

The purification of water has taken on new importance according to a 2007 report by the World Health Organization (WHO). According to the WHO report, 1.1 billion people around the globe lack access to a safe and reliable drinking-water supply. "Safe and reliable water," the standard that is sought, has been defined as water of a quality that can be consumed without immediate or long-term harm from consumption. Safe and reliable water is necessary for human consumption or food preparation. Approximately 88 percent of the four billion annual cases of diarrheal disease reported worldwide have been attributed to a lack of sanitary drinking water. Unsafe water, coupled with inadequate sanitation and hygiene, leads to approximately 1.8 million deaths due to diarrheal diseases each year. These diseases have spurred a growing consensus to provide potable water to as much of the Earth's population as possible.

Sources of Water

Humans use water supplies that come from a variety of sources, such as groundwater, lakes and reservoirs, rivers and canals, and desalinated water. Groundwater refers to water that arises naturally from beneath the ground and water that has occurred during rainfall—this is commonly known as spring water or well water. Lakes and reservoirs are water stored above ground that stands naturally at the head of rivers. Rivers and canals account for waters that travel from one location to another and often contain bacteria and algae. Desalinated water is that which comes from the ocean and is treated so that salts and other minerals are removed, making it fit for human consumption. After a water supply is secured, this source must be tested to determine if the water is safe for human consumption. When necessary, water purification is provided to ensure its safety

Water Purification

Waste treatment plants allow for the purification for source water so that humans may use it. Most water used in the Western world is treated at waste treatment plants. These plants utilize different methods and protocols in the pretreatment process to ensure purification. While plants use somewhat different methods to treat waste, depending on the plant's size and the severity of the contamination, certain practices have been standardized to guarantee general compliance with national and international standards. Most waste treatment takes place after water is pumped from its natural source or directed via pipelines into holding tanks. This process is important, as the pipes and pumps may cause contamination if not constructed according to certain protocols. After the water has been

moved to a central location, the process of purification may begin.

Pretreatment

The cleanliness of water is assured through a variety of steps during waste treatment, a process that includes removing biological contaminants, chemicals, and other materials. The first step in the waste treatment process, known as pretreatment, is screening. Waste treatment plants use screening to remove large debris such as sticks and trash from water that is being treated, especially when purifying surface water. Surface water is more likely to have been polluted with contaminants that stem from daily human interaction. The second step in purification occurs through storage. Storage requires water to be held in reservoirs for long periods of time so that natural purification occurs. Storage uses slow sand filters to purify water, and water thus stored can be used to alleviate short periods of drought in emergency situations.

Preconditioning is the third step in the purification process. Preconditioning is often used to treat water with high mineral content, which is also known as "hard water." Hard water is not harmful if consumed. However, waste treatment plants often use sodium carbonate to force calcium carbonate out of hard water. Preconditioning ensures that hard water achieves the same consistency as soft water. Prechlorination represents the fifth and final step of the pretreatment process. When waste treatment plants engage in prechlorination, they chlorinate incoming water to minimize the growth of organisms in pipes and tanks. Although prechlorination remains a standard part of the waste treatment process in many areas, many plants have begun to discontinue this process because of adverse affects on the quality of water treated and concerns regarding chlorine's environmental ramifications.

Increasing awareness of the risks associated with traditional waste treatment plants, such as chlorine leaks and corrosion from chloramines, have led to investigations into safer methods of waste treatment such as activated-carbon filtering and distillation.

Other Purification Steps

Waste treatment plants use chemical treatment and refinement processes once the various pretreatment processes have removed visible contaminants in water. The refinement process usually begins with flocculation, a step that clarifies water. Flocculation removes the cloudiness or haziness caused by the growth of phytoplankton in water or the disturbance of land by human interactions with water. Turbidity (i.e., cloudiness) is common in water coming from locations near municipalities because human interaction is more common near urban areas. Flocculation forms solids, also known as precipitates, which are then removed through physical methods. Precipitates (a solid that forms from a solution) arise from the coagulation of small particles present in raw water. After they form, precipitates are passed through sand filters or a mixture of sand and anthracite. Once water exits the flocculation basin, sedimentation occurs. For this process to take place, water enters a sedimentation basin. Sedimentation basins are sometimes referred to as decant ponds and are used to control wastewater. Sedimentation basins are useful for moving water through the purification process while also permitting particles remaining in

the water to settle to the bottom of the tank through gravity. Sludge that results from this process forms on the floor of the tank and is removed and treated. From sedimentation basins, water moves to the next step, filtration. Filtration removes the remaining suspended particles and unsettled floc by moving water through a rapid sand filter. The rapid sand filter removes organic compounds that affect taste and odor. Some rapid sand filters use rapid gravity to achieve this process, while others utilize pressure filters to achieve the same result. If sufficient space exists, slow sand filters or lava filters may also be used for filtration.

Disinfectation is the final step waste treatment plants use to purify water. During this stage, disinfectant chemicals are added to the water to filter out harmful microbes. Disinfectants kill pathogens such as bacteria, viruses, and protozoa, all of which are potentially injurious to humans. The disinfectation stage often involves a form of chlorine, especially chloramines or chlorine dioxide. Since chlorine is a toxic gas, its use may result in potentially dangerous releases. To circumvent these risks, some waste treatment plants now use ozone, ultraviolet, or hydrogen peroxide disinfection instead of chlorine.

Alternative Methods of Purification

Certain areas do not have access to waste treatment plants and must use alternative methods of purification. Methods used to assure that water is potable in such settings include boiling, granular activated-carbon filtering, distillation, reverse osmosis, and direct-contact membrane distillation. These processes are often more expensive than traditional water treatment methods, although they present fewer environmental risks than large-scale waste treatment plants. Risks from mistake and human error have caused many municipalities to cease using chlorine and chloramines as agents of purification. The risks associated with traditional waste treatment plants include chlorine leaks and ramifications from the highly corrosive nature of chloramines, which can dissolve the film within water pipelines, releasing lead, a known neurotoxin, into the water supply. As awareness of the risks associated with conventional waste treatment plants grows, governmental bodies, administrators, and activists continue to investigate safer methods of waste treatment.

Water Safety

Drinking water must meet standards placed according to country and any site-specific needs. In the United States, the Environmental Protection Agency (EPA) issues regulations that set standards for public water systems. Other sources of drinking water, such as bottled water, are in turn regulated by the Food and Drug Administration (FDA). To assure consumer safety, water is tested for pH, nitrogen, iron, and bacteria levels. Not all countries have waste treatment systems. As a result, millions of deaths are caused by waterborne illnesses due to contamination in developing countries, deaths that could be prevented by waste treatment plants.

The Millennium Development Goals, the result of an international collaborative effort that took place under the auspices of the United Nations, set eight objectives for ending global poverty at a high-level plenary meeting of the UN General Assembly in 2010. At that time, the Millennium Development Goals set, as one of its objectives, reducing by half the number of people without access to sanitary drinking water by 2015. Increased developmental monies will allow increased investment in waste treatment plants in an effort to achieve this goal.

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See Also: Beverages; Clean Water Act; Fish; Household Consumption Patterns; Human Waste; Industrial Waste; Organic Waste; Pollution, Water; Safe Drinking Water Act; Sewage Treatment.

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Water Consumption

Consumption of water is essential for the sustainability of human life. It is used in numerous renewable and nonrenewable ways and is commoditized via transformation into a multitude of items. Humans both consume water and make sense of such use in a variety of ways. Water is used cross-culturally, including household consumption, industrial and agricultural use, and the appropriation of water for ritual and ceremonial purposes.

Water Facts and Origins

A ubiquitous resource, water is an indispensable element of any ecosystem. The human body is composed of approximately two-thirds water, and 70.9 percent of the Earth's surface is covered by water. The total area of distribution is approximately 317 million square miles, and the total volume of Earth's water is roughly 1.140 billion cubic miles. Close to 97 percent of the Earth's water is contained in oceans. The remaining 3 percent of the world's water is fresh: 2.4 percent is frozen in the polar ice caps, roughly 0.6 percent is contained in groundwater aquifers, and only 0.007 percent of the world's water is surface water stored in rivers, streams, lakes, and ponds accessible for human consumption.

In chemical terms, a water molecule is comprised of two hydrogen atoms bound to an oxygen atom. Such simplicity is exemplified by the fact that these elements are the two most common ones in the known universe. Water may be found in either of three states: as a liquid, it falls as rain, is collected via catchments, and flows as streams and rivers to form the world's oceans; as a solid, it covers the polar ice caps and many alpine areas; as a gas, water vapor or steam is used for cooking, generating electricity, and was a popular power source for transport until electricity and petroleum products came to dominate.

Questions surrounding the origins of water on Earth are the subject of lively academic debates. Various schools of thought have emerged on the subject, with theories positing that large bodies of water may have been present on the Earth's surface about 4.45 billion years ago. The presence of a substantial percentage of the Earth's water may have had its origins in the planet's own formation. As the Earth cooled, the temperature became favorable for the trapping of gases within the atmosphere. Such gases were released from various materials that were cooling on the surface. On the other hand, perhaps ice-encrusted comets and meteors contributed to a later buildup of the Earth's water stores over time, in either large-scale deposits or via smaller deliveries over time.

Water Cycle

Surface water on Earth constantly moves through a cyclic modulation known as the "water cycle." Powered by solar energy and gravity, this represents a continuous circulation of water between the surface of the Earth and the atmosphere. Solar energy vaporizes water, causing it to rise into the atmosphere from vegetation, soils, and the oceans. Water vapor then condenses into clouds. Due to gravitational forces and weather conditions, the condensed water vapor falls to the Earth in liquid form as rain or as a solid via snow. Snow remains frozen on land for a long time until it melts, changing into liquid form, and flows into the oceans via streams and rivers. Most rain falls over the oceans, but some falls over land and infiltrates to groundwater, forming aquifers that store water, which is then available for harvesting in various ways.

Water Harvesting and Usage

Water harvesting occurs in many contexts and is enacted in multiple ways. Following a sustained and severe drought in Australia, which began around 2003, various government bodies imposed severe water restrictions and implemented measures for small-scale harvesting of freshwater from suburban properties for nonpotable use. An example is the continued encouragement to install and use rainwater tanks, which collect rainwater runoff from the roofs of houses or buildings. Water harvested in this manner is suitable for various uses, including laundry, watering gardens, and household cleaning. Water that is harvested from rooftops or the

gutters of buildings in many parts of the world often requires treatment for water borne diseases, and significant efforts are required to keep freshwater stored in tanks free from animal contamination. On a much larger scale, water harvesting for agricultural purposes involves the securing of freshwater for humans, livestock, and the irrigation of crops. Water for agricultural use has not traditionally been harvested from ground aquifers or surface sources. Instead, it has been popular to secure freshwater through harvesting rainfall. Throughout preindustrial civilizations, rainwater harvesting provided a solid and steady foundation of water for agricultural uses and enabled larger civilizations to flourish in areas that were relatively dry or experienced variable rainfall. The harvesting of rainfall is being rejuvenated for agricultural purposes in developing countries because it is a viable and renewable option to secure water in resource-scarce areas.

Water usage by humans can be consumptive or nonconsumptive. When one considers the volume of water on the Earth is nearly 1 billion cubic miles, it is difficult to imagine water being exhausted by human consumption. The world is not literally running out of water; however, early evaluations of human consumption of water indicate that humans appropriate over 50 percent of accessible freshwater stocks, such as rainfall and groundwater. Within such use, it is important to highlight the distinction between consumptive (nonrenewable) and nonconsumptive (renewable) use. Nonconsumptive freshwater resources are only limited by their flow rate, or how much humans take relative to the overall flow of the resource. Consumptive use of nonrenewable water resources is limited by stocks. The latter are largely represented by groundwater sources that take a very long time to replenish, while the former refers to the harvesting of rainwater and in situ uses of rivers. The use of river water for industry may also be consumptive and thus limited by acceptable pollution levels.

Water for human consumption that is harvested either from groundwater aquifers, surface sources, or rainwater may be subsequently abstracted. Water "abstractions" are freshwater that has been taken from aquifers or surface stores and transported to alternates place of use, over relatively short or long distances. Where abstracted water is returned to a surface water store, such as a river, further abstractions may be available downstream. Although water is a uniquely renewable resource and abstractions are in some cases seemingly only limited by the availability of transport and associated costs, some stores replenish slower than others. Limits on recharge rates are imposed by flow in the cases of rivers, streams, and lakes, and slow-restoring stocks in groundwater aquifers below the water table. This dual characteristic of water has implications for how humans consume it. Overall, freshwater is a renewable resource, as it may change from one form to another rather quickly. However, there exist fixed supplies and isolated reservoirs that do not recharge at rates comparable to those of consumption. Freshwater abstractions place significant pressure on water supplies, particularly where they are harvested from slow-recharge-rate "fossil" aquifers.

The ubiquity of water use by humans and its multiple methods consumption vary widely. Statistical and social trends in consumption, use, and waste of water are difficult to trace. Although freshwater is of major environmental and economic importance, the distribution of freshwater resources varies significantly among and within countries. Available freshwater resources in arid regions are limited, and demands often outweigh supplies, leading to unsustainable use patterns. Some countries in the Middle East have a significant freshwater shortfall. Saudi Arabia, Yemen, the United Arab Emirates, and Libya all have a shortfall over 1.25 cubic miles per year. Within regions that receive monsoonal rains, estimates of surplus are rather difficult to determine, as tropical diseases and water contamination may decrease readily available freshwater. In some countries, the supply of freshwater is dependent upon social status and wealth as opposed to egalitarian needs.

Household Use

The amount of water consumed by humans for household use varies widely, as do general consumption rates around the globe. The definition of safe and potable water for household consumption also varies across and within regions, often markedly over time. Data reviewed from the 1980s and 1990s suggest rapid changes to levels of safe access to potable water over time. Individual countries often

use varying definitions of concepts such as "rural" and "urban," making estimates difficult. Nevertheless, approximately 8 percent of freshwater is consumed for household use globally. Such uses include drinking, bathing, sanitation and sewage, gardening, and, in some cases, cooling. The distribution of water for household consumption is uneven. High-income countries appropriate approximately 11 percent for household use, while in low-income countries this figure falls to just under 8 percent. Moreover, within affluent Western countries, water consumption rates are higher in urban areas enjoying higher incomes, suggesting a strong association of water use with material wealth.

Industry (Including Energy Production and Consumer Products)

It is estimated that approximately 22 percent of global human water use is for industrial purposes. In high-income countries, this figure jumps to 59 percent, and in low-income countries it falls to 10 percent. Major industrial usage includes ore and oil refineries (where water is used in chemical processes to refine raw materials to produce petroleum products and metals) and manufacturing, where water is often used as a solvent or is turned into a consumer product. The major single industrial use of water is as a cooling agent in electricity production, whether it is coal, oil, gas, or nuclear. Water is only directly involved in the production of electricity where power is generated through harnessing the energy produced by water pressure driving a turbine connected to a generator. This commonly occurs in dams. Hydroelectricity is relatively cheap and is a renewable energy source. However, hydroelectricity does impact the environment insofar as dams submerge large areas of upstream land. The alteration of the immediate environment through flooding by dams also may endanger fish and other species. Land is also lost that may have been rich in resources and favorable for lowland farming activities.

In other areas of industry, water is used as a tool. Through high-pressure water jets, industrial-scale cutting of hard materials becomes cost effective and renewable. Water is also appropriated in industry for cleaning by using high-pressure water guns, as well as for cooling machinery. The portion of consumptive industrial water usage varies widely, but it is generally lower than the amount of freshwater appropriated for agricultural use.

Agriculture

Agriculture represents the most extensive consumption of water by humans. Globally, 70 percent of freshwater appropriated for human use is within agriculture. There is, of course, disparity, as within high-income countries the amount of water used in agricultural purposes falls to 30 percent, while in low-income countries, it rises to 82 percent. Rising populations and increased food production have placed further demand on the world's water resources as agricultural usage increases. The world's population is growing by roughly 80 million people per year, which places an increased demand on freshwater stocks. Irrigation of crops is essential for adequate food production. In many areas, it is necessary for any crops to grow at all. Where irrigation is not necessary for basic growth, excessive irrigation may be employed to produce crops of superior quality or to grow an excess for export. Such uses of abstracted water are unsustainable. Most irrigation in modern agriculture draws from groundwater aquifers, and many have become overdrawn. An example is China's uneven distribution of water and the excessive overuse that occurs in arid areas. As the country has boomed in terms of population and the economy, it has engaged in excessive agricultural production. One area, the North China Plain, is responsible for around half of the country's wheat production. It is a region with a limited supply of freshwater relative to increasing demand.

Spiritual or Religious Uses

Together with the land and sky, water has been offered a prominent place within religious mythology and ceremonial use. Great rivers such as the Mekong, Nile, and Ganges are considered the abodes of gods, as divine substance, and as purifying agents. As a feminine deity, the Ganges in India mercifully agreed to flow upon Earth and water the whole world with the waters of life. Beginning on Mt. Meru, the cosmic mountain at the center of the Hindu cosmos, the Ganges River is considered a liquid form of the divine goddess Sakti, who is the consort of Shiva and is depicted as an auspicious

mother. Other rivers in India and across areas of Asia influenced by Sanskrit culture are also called "mother." Lakes such as Titicaca and Texcoco are inextricably involved in cosmogenic myths. In many cultures, the life-giving properties associated with water have been projected into the almost universal perception of water as that which precedes solid form—the animating and subtle substance that supports all earthly creation.

As a result, creation myths often present water as metaphor for a procreative, pure, or potential state. Considered a source of creative energy and forms, the Japanese creation myth of Izanami and Izanagi features creative deities stirring a primeval ocean with a divine spear in their creative act; the Thai new year festival of Songkraan surrounds the jovial throwing of water and bathing statues of the Buddha; and the Judeo-Christian creation story involves the spirit of the creator moving upon the waters, out of which land emerges.

Future

Due to the undeniable fact that life cannot be sustained without water and that it cannot be synthesized nor replaced, understanding water consumption and better addressing its conservation are becoming increasingly pertinent topics within the discourses of academia and global politics. While water consumption within identifiable renewable limits may continue indefinitely, in many regions, the human consumption of water far exceeds natural renewal rates. Notions such as *peak water*—a term that suggests, like oil, human appropriation and consumption of the finite supply of freshwater may pass a point of highest yield—have been implemented to reorganize thought about water consumption and reconceptualize water management. Although humans may not completely consume freshwater in ways comparable to consumption trends associated with other resources, the correlation between access to safe water and wealth in the contemporary world drives the need for varied and innovative solutions to global freshwater supplies—particularly, those that integrate the social, cultural, chemical, and economic aspects of water usage and conservation.

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See Also: Ocean Disposal; Pollution, Water; Sewage Treatment; Water Treatment.

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Water Treatment

Water treatment is the process of altering water to meet specific health or supply goals. Defined broadly, water treatment involves improving supply or sewage water quality for domestic consumption, industrial and commercial use, or the protection of the environment. In both engineering terms and common use, water treatment tends to be associated with providing a safe water supply, especially controlling pathogens and other contaminants in drinking water.

Clean water may be an essential component of everyday life, but the challenges associated with its provision vary greatly worldwide. In the most developed countries, efforts to meet consumption increases are straining water sources and treatment systems, prompting much discussion over sustainability and an impending water crisis. In developing countries, ensuring widespread access to treated water remains a major concern.

Approaches

These issues are controversial and highly politicized: water treatment is not simply a problem for engineers. Some approaches to water treatment do focus on chemical and biological concerns—on treatment as purification. Policy work, however, generally frames water treatment problems as matters of governance, rather than of scarcity. These discussions are influenced by social science research

advocating integrated or holistic approaches where water treatment does not stand in isolation from clean water supplies, water management, or diverse social and cultural practices.

Purification-focused approaches situate water treatment within larger public water systems. Water from ground or surface sources is modified to create "safe" or "useful" water that is then piped to homes and businesses. Water treatment processes mainly entail filtration and decontamination but can also encompass biological treatment or desalination.

Public water treatment processes commonly begin with chemical coagulation and sedimentation—the forming of solids that settle on the bottom of tanks. Sand or gravel filtration then removes suspended solids that may interfere with disinfection. Chlorine or, increasingly, UV light or ozone is employed to neutralize bacteria and viruses. The water is then tested according to standards, such as those provided by the Safe Drinking Water Act, which regulates all public systems in the United States. Organized around measures of quality based on particulate counts of problematic substances, this approach tends to frame water treatment as a technical problem of whether plant design, operation, and performance meet standards and demand while also managing costs.

There have been significant shifts toward more holistic approaches to water treatment in policy and environmental studies. Water quality is seen today more as an environmental problem than just a chemical or biological one. Integrated water resource management, for example, involves considering multiple uses and environmental protection along with the supply and purification process. Tying safe water to clean sources, integrated models mark shifts from treatment for use to reducing source water pollution and from plant management to broader water governance issues. If there is increasing agreement in defining water treatment problems more inclusively, the challenges of addressing them are fraught with disagreement. Solutions, especially those involving the redistribution of responsibility to nongovernmental actors, are at the center of intense debate over the compatibility of market forms with environmental goals and improved access. The control of water treatment systems is at stake in many struggles over whether water is a public or tradable good, a right or resource.

As policy makers struggle to organize and manage better water treatment systems, sociologists and anthropologists have challenged the very idea of water as a uniform natural resource and purification as simply a technological process that underpins these debates. Water is made and made different by policy, treatment, and everyday practices. Multiple conceptions of "purity" are connected to purpose as standards define categories of use (such as drinking, recreation, or reuse); taste is tied to familiarity, not just safety in technical terms; water-as-commodity stands in opposition to water-as-right.

Cultural meanings, practices, and values are part of complex relationships with water that are difficult to alter and at times in conflict with policy. In the 1950s and 1960s, for example, many believed that fluoridation of drinking water was a communist plot, rather than an attempt to improve public health. Where some technical and policy approaches might see the social and cultural as obstacles, recent interdisciplinary work argues that water, purification technologies, resource management, and cultural practices must all be considered together. These authors argue that purification cannot be adequately understood in isolation from how people think about and use water, or without closer consideration of the technological infrastructures that configure both collective practices and water. Part of "sociotechnical" systems, water treatment processes shape the possibilities for sustainability and change. The politics of water supplies cannot be reduced to economic or management problems, or resolved simply with more efficient technologies or better funding.

Politics

The politics of water treatment are particularly evident with development and the stark divisions between who gets treated water and who does not. Water consumption increased twice as fast as population over the 20th century, but there are enormous disparities in access to treated water and the amount that different populations consume. Over 99 percent of people in developed regions have access to improved water and sanitation facilities, but only

52 percent of people have access in developing regions. With over 1.1 billion people lacking access to improved drinking water sources, waterborne illness remains a leading cause of death. These problems are further complicated by local and global politics and by rural/urban differences. Water systems control people and contribute to inequality as distant and politically weak populations are least served. Water and water treatment continue to be the focus of many important development efforts. The World Health Organization established guidelines for water development in 1984 as recommendations with the hope of improving health and developing local standards. Here, water treatment challenges center around whether the water coming out of a tap or pump is contaminated, and the focus is once again on technical problems and technical solutions of purification. A lack of skilled operators, funding, or infrastructure is remedied with efficient, affordable hand pumps or home water treatment systems. Although there is increasing evidence of participatory development models and promises to consider the social and environmental aspects of sustainability, and access has improved markedly over the past few decades, more work is needed on translating these strategies into practice.

Public Health

Water treatment technology and quality concerns are closely tied to public health, both historically and today. There are ancient instructions for boiling and filtration, but modern water treatment developed in response to contaminated urban wells in the 19th century that were connected to disease. While piping water from distant sources, boiling, and treating water with sand and charcoal filters are long-standing practices, the continuous filtering and chlorination of municipal supplies to combat cholera and typhoid began in the early 20th century. The practice was adopted in most American cities by the 1920s. But with the focus on treating water for use, waste treatment lagged far behind water supply in the United States. The discharge of raw sewage directly into waterways remained the norm until federal funding was provided in the 1960s and environmental legislation, including the Clean Water Act, was passed in the 1970s. More recent concerns have centered on plant operator certification in light of fatal failures and the control of surface and groundwater contamination from agriculture and industry.

Sustainability

While water treatment implies purification technology, it does not stand in isolation from the many conceptions of sustainability that cut across the social sciences. Engineers grapple with aging infrastructure, new kinds of water pollution, and an increasing volume of water to be treated. The chemicals used in water treatment and the residual waste the process creates are also a growing concern as sludge from sedimentation, brine from desalination, and even concentrated chemicals in home carbon filters threaten the environment. As intense debates over public/private control persist, solutions remain elusive. Empirical research suggests that government regulation, standards, and public pressure are crucial components to water conservation, since source sustainability is not a market goal. Still, sustainability—in all its forms—requires a flexible or fluid, rather than goal-oriented approach, capable of dealing with the possibility of climate change, water stress, and the relationships between people, water, regions, and larger networks.

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See Also: Beverages; Clean Water Act; Fish; Household Consumption Patterns; Human Waste; Industrial Waste; Organic Waste; Pollution, Water; Public Water Systems; Safe Drinking Water Act; Sewage Treatment; Waste Treatment Plants; Water Consumption.

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Weather and Waste

Humans are having an impact on the Earth. Waste, especially in the form of pollution, has affected the weather by contributing to climate change, acid rain, smog, and damage to the ozone layer in the atmosphere. On the other hand, weather also has an impact on waste generated by people. The climate of a region and the weather affect the decomposition of waste, from backyard compost heaps to municipal landfills. The increasing intensity of storms often attributed to global warming also creates vast amounts of debris by destroying property, clogging waterways, and overtaxing sewer systems. Cleanup from these events is a great expense.

Over the last two and a half million years, Earth has cycled between great ice ages and warmer interglacial periods. Geologically speaking, these changes are incredibly rapid because of the sensitivity of the climate system. The study of past climatic conditions found buried in ancient arctic ice can be extrapolated to give clues about the future. Ice cores and deep sea sediments have shown that dramatic changes to the climate can—and have—occurred on a human time scale, and that human activities since the 18th century are contributing to the rapidly increasing speed of change.

Impact of Pollutants on Weather

Levels of carbon dioxide in the atmosphere have been steadily increasing since the beginning of the Industrial Revolution in the 18th century. Actual measurements of carbon dioxide concentrations in the atmosphere started in 1958, and the amount of gas found has increased every year since. Using these measurements and ice-core data, it has been determined that the concentration of carbon dioxide in the atmosphere was 316 parts per million by volume (ppmv) in 1958. That number rose to 369 ppmv in 1998 and is over 370 ppmv in 2010. Pre-industrial concentrations, in contrast, were approximately 278 ppmv, and ice age levels were about 200 ppmv. Average global temperatures have risen about 9 degrees Fahrenheit since the last ice age. While there are a variety of factors that impacted the end of the ice age and the warming of the atmosphere, carbon dioxide levels played an important part. The data also illustrate that the level of pollution humans created in 200 years is about equal to the natural cycles that occurred over thousands of years.

The large amounts of carbon dioxide released into the atmosphere are generated by a number of human activities. A primary source is the burning of fossil fuels, coal, oil, and natural gas in homes, factories, vehicles, ships, and aircraft. Deforestation is also a contributor, because it removes the vegetation that would convert the carbon dioxide into oxygen. Carbon dioxide absorbs heat radiating from the surface of the Earth, acting like a blanket. The increased air temperature holds more water vapor, creating more blanketing cloud cover, increasing the temperature even more. Gases that have this warming effect when released into the atmosphere are called "greenhouse gases."

Carbon dioxide is not the only gas contributing to global warming. While it is the greatest contributor, there are a number of greenhouse gases that have similar effects. Another is the colorless, odorless, combustible gas methane. Methane is released from a variety of natural and anthropogenic sources. Natural methane emissions are largely the result of the decomposition of organic materials in oxygen-free environments. As global warming thaws permafrost, increasing amounts of methane will be released. Wetlands, swamps, and peat bogs also provide methane-releasing conditions. Human-made sources include mining operations, emissions from the energy sector, rice production, livestock digestion processes, and municipal solid waste landfills.

Other gases released into the atmosphere impact air quality. Sulfur dioxide is released both artificially through the burning of fossil fuels and naturally through volcanic eruptions. Electric power plants fueled by coal or oil are responsible for 70 percent of sulfur dioxide emissions and 30 percent of nitrogen oxides in the United States annually. Inhaling these compounds causes respiratory distress in humans. Nitrogen dioxide forms when the nitrogen oxide oxidizes in the atmosphere. When sulfur dioxide and nitrogen dioxide gases mix, they form sulfuric acid and nitric acid, both of which are harmful to the environment. When they combine with hydrocarbons and ozone in the atmosphere, the sun causes a photochemical conversion, which results in acid rain. Acid rain can fall in the form of rain, snow, fog, or smog, turning air pollution into

water pollution. When acid rain falls to the ground, lakes and streams become acidic. This leads to the degradation of forests and fish stocks downwind of the industrialized areas generating the pollution.

Extreme weather events are climatic episodes that demonstrate significant variation from the average weather for a region. These incidents are considered to be a natural component of climate, but many scientists believe that the frequency and severity of these events will increase because of global warming. There are three categories of events: destructive storms, floods and droughts, and extreme temperatures. The impact of these phenomena on people is often in the spotlight, but plant and animal species are equally affected. As the global population continues to grow and infrastructure is built, the increasing severity of extreme weather credited to global warming will have a growing influence on the global economy.

Impacts of Climate Change

Climate change will vary from location to location around the world. It is unlikely that many of the coming changes will be beneficial. The ability to adapt to a new climate will depend on the resources available to the population. Those living in developing countries will have fewer options available.

How much will sea level rise? There have been large changes in sea level over the course of Earth's history. During the warm period before the last ice age, the average global temperature was a bit warmer than in the 21st century and the sea level was 5 or 6 meters higher. At the peak of the ice age, about 18,000 years ago, sea level was over 100 meters lower than it is in the 21st century. Changes over shorter periods of time are generally caused by other factors. One contribution is from the thermal expansion of ocean water. As global warming causes an increase in average air temperature, surface water will warm and expand, causing average sea levels to rise. Another contributor is melting glaciers. Melting from ice caps like Greenland and Antarctica has a smaller, but still measurable, impact. Another relatively minor contribution to sea level change comes from humans storing water that would have entered the sea by diverting the flow for irrigation or storage in reservoirs. Coastal areas, river deltas, and low-lying islands were already feeling the impact of a modest rise in sea level by 2010.

The availability of freshwater will also be affected by global warming. Precipitation cannot be predicted reliably, but areas can be identified that will likely have a substantial increase or decrease in rainfall. The amount of precipitation is expected to increase in high latitudes and parts of the tropics and decrease in many mid-latitude and subtropical regions. In addition, increasing temperatures mean a higher percentage of precipitation will evaporate, making less water available at the surface. There are a number of actions that can be taken to improve water efficiency. Most irrigation is via open ditches, which is wasteful. More than half of the water is lost through evaporation and seepage. Micro-irrigation techniques, recycling water, avoiding deforestation, and sustainable use (such as rainwater storage) are viable strategies to conserve freshwater.

The ability to grow crops and raise livestock suited to the local climate will also change in a world influenced by global warming. With the detailed knowledge that exists about the conditions needed to grow specific crops and the expertise in breeding techniques available, it should not be difficult to match most crops to new climatic conditions around the world. There are four factors that will have the greatest impact on agriculture and food production. Most important is the availability of water. Areas that already have arid and semiarid conditions will be vulnerable to additional change. As temperature rises, some crops will experience a reduction in yield. Increasing instances of severe weather conditions and climate extremes, heat waves, floods, or drought will interfere with food production. The final factor may actually lead to an increase in production. Some crops receive a boost in production by an increase in carbon dioxide in the atmosphere. Higher carbon dioxide concentrations stimulate photosynthesis. Humans are flexible, so it is possible that food production will not be impacted greatly by climate change, but it is impossible to factor in the likely occurrence of climate extremes and severe weather events and their duration.

Future: Global Collaboration

The first attempt to discuss worldwide environmental issues was in 1972 when the United Nations met

for two weeks in Stockholm, Sweden. The Stockholm Conference provided the opportunity for delegates from 113 countries to report on the status of their national environments. Industrialized countries were primarily concerned with controlling pollution and overpopulation as well as conserving natural resources. The major issues in developing nations were hunger, disease, poverty, and the initial effects of growing industrialization. Consensus was reached on a number of issues, and the United Nations Environment Programme (UNEP) was established to monitor changes in the physical and biological resources of Earth.

Representatives from many countries met again in 1982 in Montego Bay, Jamaica, to establish a comprehensive law regulating the pollution of the marine (ocean and sea) environment. The intent of this law was to reduce and control pollution in international waters.

The Montreal Protocol of 1987 was the result of a series of meetings that began in Vienna, Austria, in 1985 concerning the depletion of the ozone layer. Negotiators from 20 nations finalized an agreement to reduce chlorofluorocarbon (CFC) production by 50 percent by 2000. This landmark piece of environmental diplomacy was the most ambitious attempt to date at fighting environmental degradation on a global scale. More information about the ozone hole over Antarctica and the thinning ozone layer over North America was shared after this agreement. In 1989, a follow-up meeting was held in Helsinki, Finland. The Helsinki Declaration called for the total phasing out of CFC production and reduction of other ozone-depleting substances by 2000. The London Amendment of 1992 added even more CFCs to the list, and the Montreal Amendment of 1997 added a new licensing system for officials to monitor worldwide trade to prevent CFCs from being marketed illegally.

In 1992, the United Nations Conference on Environment and Development was held in Rio de Janeiro, Brazil. Called the Earth Summit, this was the largest number of world leaders ever assembled to discuss the prevention of an ecocatastrophe caused by uncontrolled development. Pollution, population growth, depletion of resources, destruction of land, loss of biodiversity, and climate change were some of the problems openly addressed. Nations adopted Agenda 21, a comprehensive plan to achieve sustainable development worldwide. While there were some problems with this plan, it resulted in the formation of thousands of agencies and ecological groups around the world to address the issues of pollution at local and regional levels.

A global commitment to environmental issues continued in Kyoto, Japan, in 1997. The United Nations Framework Convention on Climate Change (UNFCCC) specifically addressed the causes of climate change. This meeting resulted in the Kyoto Protocol, a 170-nation effort to combat global warming. Another meeting of world leaders convened in 2002 at the World Summit on Sustainable Development on Johannesburg, South Africa. An effort was made to develop cooperative strategies to control the release of pollutants and reduce other hazardous practices. The concept of sustainability integrates development and economic growth with respect for the environment.

There is a great deal of uncertainty in the science of predicting climate change. Under most scenarios demonstrating the increase of carbon dioxide emissions, the rate at which climate change is happening is greater than Earth has seen in thousands of years. The most apparent changes will be to sea level, availability of freshwater, and the distribution and methods of food production. The need for international cooperation in addressing pollutants and their impact on our climate has been recognized. Agreements to reduce or eliminate concentrations of greenhouse gases in the atmosphere with the intent of stabilizing climate worldwide have been reached. The challenge for the future is to create a healthy, sustainable world.

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See Also: Acid Rain; Clean Air Act; Clean Water Act; Sustainable Development.

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West Virginia

Historically, West Virginia has been a resource-rich state, which has helped fuel consumption within both the immediate region and the United States since the 1800s. Several predominant factors have contributed to this trend, most notably the physical, economic, and political landscape of West Virginia.

Physical

West Virginia is slightly smaller in size than Ireland, at 24,077.73 square miles. It is 4,800 feet above sea level at its highest and 240 feet below sea level at its lowest, hence, its nickname, the Mountain State. It has a population density of approximately 75 people per square mile. Its total population (1,852,994 in 2010) is similar to the city of Houston, however, spread across an area 40 times the size. It is one of few wholly rural states and the only state located wholly in Appalachia, bordered by Kentucky, Maryland, Ohio, Pennsylvania, and Virginia.

Economic

Because of its geographic isolation, sparse population, and reliance on extraction-based economies, West Virginia has long been considered one of the weakest economies in the United States, with one of the lowest per capita incomes and limited major interstate transportation routes. However, this figure belies West Virginia's strong culture of self-reliance, stewardship, and innovation.

West Virginia has been always been an innovator in rural consumption, becoming the first state to offer free rural mail delivery in Charles Town (1896) and the first to enact a state sales tax (1921). Both concepts were later adopted by other states.

West Virginia has always existed as an extraction-based economy. In the 1700s, it was a major salt manufacturer. West Virginia still has large reserves that are used in chemical production. Other natural resources include glass, timber, steel, and, most notably, coal. Since the 1800s, West Virginia's glass companies were world famous, producing glassware from new and recycled glass. Few existed by 2010, but one of the nation's remaining marble companies is in West Virginia.

The state is 79 percent forested and the third most forested state in the United States, most of it reforested. By the 1920s, West Virginia was deforested to provide timber for the U.S. steel industry centered in nearby Pittsburgh, Pennsylvania. Due to the introduction of sound practices, the timber industry and West Virginia environment were able to rebound. Similarly deforested countries send scientists to West Virginia to study reforestation practices.

West Virginia agriculture is over 90 percent single owner. Major commodities include poultry/eggs, livestock, dairy, and apples. Wild ginseng is a distinctive crop. By necessity, many agriculture industries practice commodity reuse and conservation, such as recycling hay-bale wrap.

The state is one of the nation's leading energy producers; West Virginia ranks second in the nation in interstate sales of electricity. Coal mined in West Virginia accounts for 15 percent of U.S. coal consumption. Although increased regulation has been implemented, ecological concerns are a challenge. Carbon sequestration projects aim to store carbon dioxide underground. Coal mining has had noticeable effects on the people and environment of West Virginia since the 18th century, and the advent of mountaintop removal mining in the 1960s brought new concerns over the consequences of coal extraction to the land, water, and people of West Virginia.

West Virginia's underground natural gas storage facilities in depleted oil and gas fields are 6 percent of the United States' total and are major suppliers to the northeast. One-half of West Virginia households use natural gas. Additionally, West Virginia landfills are beginning to implement landfill-gas capture programs.

Hydroelectric power comes from rivers and man-made lakes. West Virginia is home to the largest wind farm in the eastern United States. The West Virginia industrial sector is the leading U.S. consumer of energy, but, is also one of its largest energy infrastructures due to its coal and natural gas reserves, hydroelectric and wind power, and forest resources.

The chemical industry in West Virginia began during World War I when German chemicals could no longer be imported, expanded to create munitions during World War II, and many of the state's first Environmental Protection Agency (EPA) superfund sites were former munitions sites. Despite the associated environmental challenges, West Virginia's chemical industry has the highest community acceptance levels in the United States.

Like many rural communities, "use it up or use it out, burn it, or throw it over the hill," were acceptable forms of waste disposal. Illegal dumping was the only disposal available in many remote areas until the late 1980s. However, this has been steadily changing. Innovation is driving West Virginia's green businesses. In Marshall County, the CertainTeed Gypsum plant recycles synthetic gypsum for use in high-quality wallboard; total recycled content is 99 percent. Similar industries have taken hold as waste exchanges increase.

Over the past 15 years, a $1-billion ecotourism industry has become one of the major sources of economic development in the state. Tourism activities include skiing, whitewater rafting, rock climbing, fishing, hiking, hunting, and caving. West Virginia University football games are the biggest single-day events in the state and "Mountaineers Recycle" volunteers provide tailgate recycling. Venues for music, cultural, and motorcycle festivals are becoming increasingly prevalent.

New legislation limited state economic development funding to counties with active recycling, litter control, illegal dump cleanup, and solid waste management programs. The goal of tying economic development funding to environmental programs is to clean up West Virginia, making it attractive to new businesses, industries, and residents.

Political

Even before it became a state by presidential proclamation in 1861, West Virginia was addressing solid waste disposal. In 1834, Charleston, West Virginia, enacted a law protecting vultures from hunters because they helped eat the city's garbage.

Different aspects of the total management of solid waste are divided among several state agencies: the Department of Environmental Protection, the Public Service Commission, and the Solid Waste Management Board, before trickling down to county solid waste authorities. The Department of Environmental Protection (WVDEP) monitors industry/communal impacts, including monitoring mine water runoff, cleaning up illegal dumps, the governor's Rehabilitation Environmental Action Plan (REAP) program, and the state Recycling Coordinator's office. Other than regulated solid waste hauling, there are no state laws mandating recycling, with the exception of the West Virginia Recycling Act, which establishes a state goal of 50-percent waste stream reduction.

The governor's REAP program was started in the 1970s to rid the state of junked cars and appliances with the slogan "We Must Purge These Proud Peaks of Their Jumbled Jungles of Junkery." Governor Joe Manchin desired to clean the state up, making it more attractive to outside industries and empowering residents with a sense of pride.

Solid waste hauling in West Virginia is not based on a free market system. West Virginia regulates solid waste as a utility through the state Public Service Commission (PSC), with established hauling territories assigned to PSC-certified haulers. The purpose of the regulated hauling is to ensure that all residents have access to trash disposal. Although some major solid-waste-hauling companies conduct business in West Virginia, it is primarily served by many small, independent waste haulers who often inherit their business. Court cases concerning out-of-state haulers wishing to do business in West Virginia have had little effect on existing, regulated hauling.

The West Virginia Solid Waste Management Board works directly with county/regional solid waste authorities, providing planning, and offering solid waste grants. It can issue solid waste disposal revenue bonds and is statutorily responsible for the state's Solid Waste Management Plan.

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See Also: Farms; Industrial Revolution; Mineral Waste.

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Wisconsin

Wisconsin is a midwestern state, ranking near the middle of American states in population with 5,686,986 in the 2010 census (20th in current rankings) and in area with 65,498 square miles (23rd among the 50 states). The state capital is Madison; the largest city and metropolitan area is Milwaukee. Wisconsin has two lake borders, on Lake Michigan to the east and Lake Superior to the north. The word Wisconsin originates from a French corruption of the name given to the Wisconsin River by an Algonquian-speaking Native American group at the time of European contact. (The original word and its meaning are now unknown.) The state built a reputation as "America's Dairyland" and was the center of American dairy production until California surpassed it at the end of the 20th century. Wisconsin still ranks second in total dairy production and fans of the state's professional football team affectionately call themselves "cheeseheads." Boasting plenty of green space, the Wisconsin Dells and Door County have developed as popular tourist destinations for midwesterners. Pride in its natural amenities is a reason why the state has had a long tradition of environmental preservation and activism.

The Wisconsin economy is built on manufacturing, agriculture, and healthcare, but the state is often perceived as a farming state, despite the fact that manufacturing makes up a much greater part of its income. Agriculturally, Wisconsin is one the nation's leading producers of several crops and ranked second for overall milk and butter production. Food processing is a large component of Wisconsin manufacturing, including several well-known brands such as Oscar Mayer and Tombstone frozen pizza. Kraft Foods has over 5,000 employees in Wisconsin. Transportation and capital equipment are the mainstays of manufacturing in the state, but Wisconsin is also a major production center for paper, packaging, and consumer goods.

The 16th Nationwide Survey of MSW Management in the United States found the following: in 2006 Wisconsin had an estimated 5,881,023 tons of MSW generation, placing it 25th in a survey of the 50 states and the capital district. Based on the 2006 population of 5,617,744, an estimated 1.09 tons of MSW were generated per Wisconsinite per year (ranking 39th); 3,540,157 tons were landfilled (ranking 23rd) in the state's 35 landfills; it was ranked joint 36th out of 44 respondent states for number of landfills and was continuing to increase its capacity. Wisconsin exported 315,000 tons of MSW and the import tonnage was 1,518,598. Wisconsin has two waste-to-energy (WTE) facilities that processed 454,321 tons of MSW (15th out of 32 respondents); 1,886,545 tons of MSW were recycled, placing Wisconsin 19th in the ranking of recycled MSW tonnage. Landfill tipping fees across Wisconsin were an average $37 per ton, while the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively. As of 2009, the following materials were banned from Wisconsin landfills: yard waste under six inches, white goods, lead acid batteries, and tires. Materials set to be banned in the future include used oil filters, televisions—both cathode ray tube and non-cathode ray tube—computers, and other electronic equipment.

Wisconsin is known as a leading state in progressive waste management and recycling, having passed Act 335, known as the Recycling Law, in

1989. This legislation required communities to establish effective recycling programs and banned certain waste items from landfills. As a result of this initiative, it is estimated that 35–40 percent of Wisconsin's MSW is recycled or composted.

Waste Characterization Studies

The Wisconsin Department of Natural Resources (DNR) carried out statewide waste characterization studies in 2002 and 2009. These studies were exceptionally detailed, examining the individual streams: residential, industrial/commercial/institutional (ICI), and construction and demolition (C&D). The 2009 study report was released in 2010. An overview of the state's waste stream composition showed the following estimated percentages: 996,383 tons of organics (23.3 percent); 914,777 tons of construction and demolition (21.3 percent); 840,052 tons of paper (19.6 percent); 605,346 tons of plastics (14.1 percent); 211,980 tons of metals (4.9 percent); 110,261 tons of problem waste (2.6 percent); 71,991 tons of glass (1.7 percent); 10,210 tons of household hazardous waste (0.2 percent); and 530,503 tons of other waste (12.4 percent). The 2009 study showed that the waste stream had changed since 2002, with the amount of C&D, paper, and metals declining and organics and plastics increasing.

The 10 most prevalent categories in 2002 were (1) untreated wood, 607,650 tons (12.8 percent); (2) food, 486,619 tons (10.2 percent); (3) roofing shingles, 284,752 tons (6 percent); (4) compostable paper, 228,310 tons (4.8 percent); (5) mixed recyclable paper, 201,715 tons (4.2 percent); (6) plastic film, 188,990 tons (4 percent); (7) recyclable cardboard, 188,176 tons (4 percent); (8) composite/other plastic, 174,597 tons (3.7 percent); (9) ferrous metals, 171,086 tons (3.6 percent); and (10) rock, concrete, and brick, 165,727 tons (3.5 percent).

The 10 most prevalent categories in 2009 were (1) food, 455,259 tons (10.6 percent); (2) untreated wood, 383,638 tons (8.9 percent); (3) roofing shingles, 247,349 tons (5.8 percent); (4) composite/other plastic, 242,094 tons (5.7 percent); (5) plastic film, 238,126 tons (5.6 percent); (6) compostable paper, 213,694 tons (five percent); (7) bulky items, 172,554 tons (four percent); (8) recyclable cardboard, 167,216 tons (3.9 percent); (9) yard waste under 6 inches, 161,256 tons (3.8 percent); and (10) bottom fines/dirt, 155,853 tons (3.6 percent). The biggest changes noted between 2002 and 2009 were a 104,694-ton increase in yard waste under six inches and decreases of 119,738 tons in mixed recyclable paper and of 224,012 tons in untreated wood.

The 2009 study found that the composition of residential (single-family) waste broke down into the following: 37.3 percent organics, 20.4 percent paper, 13.4 percent plastic, 9.6 percent construction and demolition, 4.6 percent metals, 2.6 percent problem materials, 1.5 percent glass, 0.1 percent household hazardous, and 10.6 percent other waste. The 2002 residential breakdown was significantly different: 26.3 percent organics, 26.1 percent paper, 10.9 percent plastic, 12.3 percent construction and demolition, 5.8 percent metals, 4.9 percent problem materials, 2.5 percent glass, 0.2 percent household hazardous waste, and 10.9 percent other waste. Plastic and organic residential waste had risen considerably since 2002, while recyclable materials had declined; household hazardous waste remained at a practically static low level.

The 10 most prevalent residential categories in 2002 were (1) food, 206,363 tons (13.4 percent); (2) untreated wood, 115,732 tons (7.5 percent); (3) mixed recyclable paper, 103,462 tons (6.7 percent); (4) compostable paper, 95,567 tons (6.2 percent); (5) plastic film, 67,876 tons (4.4 percent); (6) bulky items, 59,157 tons (3.9 percent); (7) newsprint, 58,027 tons (3.8 percent); (8) diapers, 56,054 tons (3.7 percent); (9) textiles, 54,826 tons (3.6 percent); and (10) composite/other plastic, 50,388 tons (3.3 percent).

The 10 most prevalent categories in 2009 were (1) food scraps, 251,423 tons (17.5 percent); (2) compostable paper, 103,706 tons (7.2 percent); (3) yard waste under six inches, 93,431 tons (6.5 percent); (4) composite/other plastic, 77,765 tons (5.4 percent); (5) untreated wood, 67,415 tons (4.7 percent); (6) plastic film, 65,779 tons (4.6 percent); (7) bottom fines/dirt, 64,140 tons (4.5 percent); (8) carpet, 54,052 tons (3.8 percent); (9) diapers, 48,759 tons (3.4 percent); and (10) animal waste/kitty litter, 41,322 tons (2.9 percent). The biggest changes noted between 2002 and 2009 were the absence of newspaper and yard waste in 2009.

The 2009 study found that the composition of ICI waste broke down into the following: 26.4 percent

paper, 21.6 percent organics, 17.7 percent plastic, 10.3 percent construction and demolition, 4.3 percent metals, 2.8 percent problem materials, 3.2 percent glass, 0.4 percent household hazardous, and 13.3 percent other waste. The 2002 ICI breakdown had some differences: plastics increased from 14.6 percent to 17.7 percent; construction and demolition decreased from 15.5 percent to 10.3 percent; organics and paper did not change significantly.

The 10 most prevalent ICI categories in 2002 were (1) food, 277,650 tons (13.2 percent); (2) untreated wood, 213,143 tons (10.1 percent); (3) compostable paper, 131,327 tons (6.3 percent); (4) recyclable cardboard, 119,358 tons (5.7 percent); (5) plastic film, 115,426 tons (5.5 percent); (6) composite/other plastic, 112,161 tons (5.3 percent); (7) mixed recyclable paper, 92,036 tons (4.4 percent); (8) ferrous metals, 90,240 tons (4.3 percent); (9) other nonrecyclable paper, 86,024 tons (4.1 percent); and (10) carpet, 60,772 tons (2.6 percent).

The 10 most prevalent categories in 2009 were (1) food scraps, 239,546 tons (11.4 percent); (2) plastic film, 166,617 tons (7.9 percent); (3) other paper, 146,700 tons (7 percent); (4) uncoated OCC, 143,751 tons (6.8 percent); (5) untreated wood, 133,732 tons (6.3 percent); (6) composite/other plastic, 124,376 tons (5.9 percent); (7) compostable paper, 89,534 tons (4.2 percent); (8) bulky items, 87,517 tons (4.1 percent); (9) bottom fines/dirt, 66,239 tons (3.1 percent); and (10) textiles, 63,113 tons (3 percent). Between 2002 and 2009, food decreased in the ICI stream, unlike the residential stream, and corrugated cardboard remained persistently high in ICI waste.

Aztalan

Aztalan State Park is named after Wisconsin's most important archaeological site, a Middle-Mississippian village that flourished between 1000 and 1300 C.E. The site is thought to have cultural links with the Cahokia settlement-type site near East St. Louis, Illinois, where it is thought the colonists who built Aztalan originated. There have been many unsupported theories about the site since its discovery, beginning with its naming after the Aztecs, to whom it has no connection.

Key to answering many questions about the site's chronology and development was the discovery of the village's midden in a ravine by the riverbank. Multiple refuse pits in the village also provided important evidence. Excavation of the midden in 1984 by University of Wisconsin–Milwaukee archaeologists under Lynne Goldstein and John Richards revealed eight feet of stratified rubbish deposited over several centuries. During this time, the site transitioned from a small Woodland-period farm settlement to a major ritual and habitation complex of the Mississippian culture. The midden deposits had captured large amounts of soil eroding downslope from massive landscaping projects and changing farming methods. Artifacts recovered from the midden suggested that after Aztalan was settled, there was little or no contact with the Cahokia; there was no evidence for ongoing trade, and while items were similar to those from the Cahokia, they were made from local materials.

While there are formal burials at Aztalan, there have also been scattered and fragmentary human bones recovered from refuse pits, fire pits, along the stockade, and strewn across habitation surfaces. These have been interpreted as evidence of ritual, cannibalism, or necrosadism.

Environmentalism in Wisconsin

The U.S. ecologist and environmentalist Aldo Leopold (1887–1948) was a professor at the University of Wisconsin–Madison. His book, *A Sand County Almanac* (1949), was written in Sauk County, the title of the book referring to the sandy soil in Sauk County. This book is considered a landmark publication in environmental ethics and the American conservation movement. Relatively unnoticed with the first edition, the paperback edition became a bestseller during the dawn of increased environmental awareness in the 1970s. In a 1990 membership poll by the American Nature Study Society, *A Sand County Almanac* and *Silent Spring* by Rachel Carson were hailed as the two most significant environmental books of the 20th century. The land ethic perspective on environmental ethics is drawn from a chapter of the same name from Leopold's book.

The Aldo Leopold Shack and Farm in Baraboo was added to the National Register of Historic Places in 1978 and became a National Historic Landmark in 2009. Leopold bought the land in the early 1930s and converted a chicken coop into a farmhouse for his family to serve as a weekend

retreat. He wrote the *Almanac* and several other works here. The land had been left barren by deforestation, fires, and overfarming, and it was here that he field-tested his theories.

Born in Iowa, Leopold graduated in forestry and began his career with the Forest Service in Arizona and New Mexico before being transferred to Wisconsin in 1924. His 1933 appointment as professor of game management in the Agricultural Economics Department at the University of Wisconsin–Madison was the first professorship of its kind. In the 1930s, Leopold was recognized as the nation's greatest expert on wildlife management and had redefined the concept of "wilderness," founding the Wilderness Society in 1935. He died of a heart attack in 1948 while fighting a wildfire on a neighbor's land.

Gaylord Nelson (1916–2005), the 35th governor of Wisconsin, was the main founder of Earth Day. After the culmination of his political career, he was counselor of the Wilderness Society. Nelson started his political career in 1948 as Dane County state senator, served two terms as governor from 1958, and represented Wisconsin for 18 years after being elected to the U.S. Senate in 1962. Always a passionate environmentalist, during his time as governor, Nelson created the Outdoor Recreation Acquisition Program, where a cent from every pack of cigarettes sold paid for the acquisition of one million acres of Wisconsin park land. As a senator, Nelson masterminded and traveled with President John F. Kennedy on the conservation tour in 1963, legislated to create national hiking-trail systems, and worked on environmental legislation such as the Wilderness Act, the Environmental Protection Act, the Clean Air Act, and the Clean Water Act.

The first Earth Day was held on April 22, 1970. An environmental teach-in, it was based on the effective Vietnam War teach-ins that were then being held and was inspired by the 1969 Santa Barbara oil spill. Over 20 million people participated in the first Earth Day. In 1990, Earth Day became an international event, and in 2009, the United Nations designated April 22 International Mother Earth Day. In 1995, Nelson received the Presidential Medal of Freedom and was recognized by President Bill Clinton for his environmental work. The Gaylord Nelson Institute for Environmental Studies at the University of Wisconsin–Madison, the Gaylord Nelson Wilderness in the Apostle Islands National Lakeshore, and the Governor Nelson State Park are all named in his honor.

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See Also: Archaeological Techniques, Modern Day; Colorado; Earth Day; Environmentalism.

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WMX Technologies

By the early 1990s, Waste Management, Inc., based in Oak Brook, Illinois, was the largest waste disposal company in the United States. Robust stock prices allowed the company to achieve phenomenal growth through acquisitions and expand beyond solid and hazardous waste removal into engineering, construction, and environmental consulting. To reflect its expanding business, the company, supported by the board of directors, proposed changing the name from Waste Management, Inc., to WMX Technologies. The change was approved at the May 1993 shareholders' meeting, but its name, along with the growth that fueled it, was to have only a brief four-year lifes pan. When the WMX name was approved, Dean L. Buntrock was CEO, and Phillip Rooney served as president and chief operating officer. The conglomerate included nine independently managed businesses, including the North American operations

of Waste Management, which accounted for over 50 percent of the company's revenue; Waste Management International; Chemical Waste Management; Rust International, Inc., specializing in environmental and infrastructure engineering; Wheelaborator Technologies, Inc., which transformed solid waste into clean energy; and WMX Technologies and Services, Inc. Chemical Waste Management, Rust International, Wheelaborator, and Waste Management International were all publicly traded companies, with WMX holding controlling ownership.

Subsequent to the company's new incarnation, it continued its growth-by-acquisition strategy, gaining control of companies such as CRInc., a Massachusetts recycling facility, and ReSource NE, Inc., a New York City waste disposal firm. WMX repurchased shares of Chemical Waste Management and Rust International, Inc. Other divisions were seeing signs of success; Wheelaborator won a valuable 20-year contract from the city of San Diego to build and manage a sludge-processing plant. WMX was selling off other units during this time. In 1994, OHM International acquired a 40-percent stake in Rust International, Inc. (By 1998, OHM was taken over by Raytheon.) Despite the flurry of buying and selling, WMX stock underperformed relative to expectations. The company was cannibalizing its own business, as households and businesses opted to recycle, rather than send trash to landfills. Since the recycling business was not as profitable as landfill disposal, WMX did not recoup the losses. Meanwhile, the firm was investing significant resources into capital projects such as extensive data management and collection centers. Large investor groups, such as Lens, Inc., owning 750,000 shares and George Soros's Soros investor group with a 5.2 percent stake in WMX, pressured the firm to boost revenue and stock prices, which had fallen to around $25 a share from a high of over $45 in 1992.

Crisis

Rooney, who had been with the company since 1969, became CEO in June 1996. Taking over the helm of the troubled company, he vowed to refocus operations and sell off units not related to one of their four core competencies: waste disposal, incineration, water treatment, and consulting. He expected to gain over $1 billion from the sale of underperforming assets and to reduce spending. However, Rooney's tenure was plagued with scandal. In late 1996, WMX was ordered by a federal judge to pay more than $90 million for back royalties owed to a partner in a hazardous waste landfill site located in Emelle, Alabama. Indications of irregular accounting practices emerged, and both employees and investors questioned the lack of independence among board members.

By 1997, there was broad recognition that WMX Technologies' diversification strategy had failed, and pressure from the Soros investor group and Lens, Inc., intensified. Neither of the aggressive investor groups felt that management was moving quickly enough to reorient the company around its core competencies and improve its financial performance. Despite an announcement by Rooney that the company was retrenching, an announcement dubbed "WMX Tuesday" by the *Wall Street Journal*, stock prices failed to rebound. Investors were underwhelmed by Rooney's plans, which were basically more of the same: more divestment, decreasing international investment, and employee reductions. Soros was prepared for a proxy fight; he submitted paperwork to the Securities and Exchange Commission announcing his intent to nominate four challengers to the board nominees proposed by WMX leadership. Less than a week later, Rooney, after less than a year in the top post, announced that he would resign as CEO, and the company indicated that it would replace two incumbent board members. Soros dropped the proxy fight. Rooney still generated ire among investors when it was revealed that he would be paid $2.5 million a year through 2002.

During the May 1997 annual meeting, over 80 percent of voting shareholders approved jettisoning the name WMX Technologies in favor of returning to the original Waste Management, Inc. In the summer of 1997, newly rechristened Waste Management, Inc., hired Ronald LeMay, a former Sprint executive, as CEO. Criticized for failing to purchase shares, keeping his family in their Kansas City home, and not recruiting management talent, LeMay lasted only four months, resigning just days after third-quarter results showed a 28 percent drop in share price from the previous year. The same day LeMay resigned, WMX's chief financial officer, John D. Sanford, tendered his resignation, leading

to even lower stock prices. Speculation was rife that LeMay jumped ship due to massive financial problems hidden by accounting irregularities.

Steve Miller, a turnaround expert who had been on the search committee to hire LeMay, was appointed interim chairman and CEO. Soon after LeMay's departure, Miller announced another restructuring plan that eliminated 20 percent of support staff and included expected annual savings of $100 million. Dean Buntrock severed remaining ties to the company by resigning from the Waste Management board. Meanwhile, the accounting investigation instigated by LeMay continued, and in February 1998, the company restated earnings from 1992 to 1996. The admission that profits were overstated by over $3.5 billion was at the time the largest earnings restatement in history. With no strong candidates for CEO and an attractive offer from USA Waste Services CEO John Drury, in 1998, Waste Management, Inc., was sold to the younger, smaller firm. USA Waste Services retained the name of the larger company and located the headquarters of the joined companies in Houston, Texas. By 2002, the extent of the financial irregularities perpetuated by the former WMX Technologies was outlined in an SEC suit against Dean Buntrock and five other top officers. The complaint alleged a systematic scheme to defraud investors, including avoiding depreciation expenses, assigning arbitrary salvage values, failing to record decreases in the values of landfills, inflating reserves, and improperly capitalizing expenses. The suit was settled in 2005, with the officers and Waste Management, Inc., paying over $30 million in fines.

Although the name WMX Technologies was created to better represent an expanding conglomerate with expertise in multiple businesses, it became instead associated with failed strategies, declining profits, poor management, and, ultimately, fraud. Despite the blemish of the WMX years, Waste Management, Inc., has successfully reinvented itself and today remains a leader in the waste industry.

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See Also: Browning-Ferris Industries; Landfills, Modern; Recycling; Resource Conservation and Recovery Act; Solid Waste Disposal Act.

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Wood

Wood is a solid, fibrous tissue of cellular structure obtained from trees and shrubs, a natural composite of cellulose fibers in a lignin matrix. It has been used since early prehistory as a fuel and as a material for constructing structures and artifacts. Although ubiquitous in the past, wood rarely survives in the archaeological record. Some have argued that part—or all of—the Stone Age should be called the Wood Age, as stone tools are an aid to cutting and working wood. Aimé Michel and Michel Noël argued that the Neolithic was the Wood Age based on the number of wooden artifacts from this period that have been recovered from bogs and lakes and their level of technical sophistication. Wood use declined but is now increasing again in the early 21st century because of environmental concerns. However, 21st-century usage must take into account issues such as ecosystem awareness and sustainability.

Burial in moist aerated soils will usually lead to complete nonsurvival of wood. Acidic or highly alkaline deposition environments break up the cellulose content, leaving wood soft and caseous. Typically, archaeological wood survives sealed in a waterlogged environment where anoxic conditions inhibit microbial activity. Waterlogged wood is inevitably weakened to some degree and must be kept wet as loss of water content will lead to irreversible damage as surface tension effects in the water pull the wood's structure apart. Deep burial

below the level at which bacteria are active can also preserve wood, such as the remains of three medieval bridges buried under river-deposited sand and gravel and excavated from Hemington Quarry, Leicestershire.

Some of the largest wooden structures recovered from the archaeological record are shipwrecks and the remains of docks and bridges. These are preserved initially by waterlogging but often become buried by sediments, such as the Hemington bridges. Many factors are involved in determining the preservation level.

The *Mary Rose,* for example, a 16th-century warship that sank in the Solent, was partially preserved by sinking broadside onto the current, which then deposited silts inside the ship and scoured a pit into which part of the wreck fell and was sealed by a shelly seabed that formed over the wreck in the late 17th century. Another factor conferring preservation was the speed and angle of sinking, which embedded the ship deep into the seabed clays.

Wood Fuel

Burning wood is the largest use of energy from a solid fuel biomass in the early 21st century. The use of wood as a fuel is as old as the technology required to light it. Pyrotechnology, the ability to light and control fire, was a major milestone in human cultural evolution. Fire brings nutritional benefits, extends hours of activity beyond daylight, and provides warmth and protection from predators and insects. Archaeological evidence for the earliest controlled use of fire is a contentious issue, confused by the traces of wildfires and the possibility of torches being lit from naturally occurring fires to utilize fire, without truly controlling it. It is widely accepted that *Homo erectus* and later members of the *Homo* genus had controlled the use of fire, but evidence put forward for use by earlier human ancestors is regarded as inconclusive or doubtful.

In 2004, John Gowlett summarized that there were two groups of early fire evidence: an African group from around 1 million years ago and a European and Asian group from around 500,000 B.C.E. The earlier African group was often dismissed as the result of natural fires, while the later Eurasian group was believed to indicate the controlled use of fire. The same year, evidence from Gesher Benot Ya'aqov, Israel, indicated the controlled use of fire around 750,000 B.C.E. by *H. erectus* or *H. ergaster*.

Wood is the most readily available fuel, since dead wood can simply be picked up. However, this coarse woody debris (CWD) or habitat (CWH) provides an important habitat for flora and fauna and a source of nutrients for the ecosystem. Since the 1970s, woodland managers have been encouraged to let it stay on the forest floor.

Faggots of coppiced woods were a popular form of wood fuel throughout history, until the adoption of the metal stove during the Industrial Revolution. Stoves offered the convenience of increased control and efficiency with less smoke, but they required maintenance, were prone to cracking, and wood had to be chopped to fit into them. For this reason, wood was replaced by other fuels in many areas and settings. The 1973 oil crisis and growing environmental concerns turned attention back to using wood as a fuel.

Combustion products of wood include wood ash, which can be used as fertilizer and in manufacturing. Wood smoke is irritating, potentially hazardous, and is responsible for a high percentage of particulate air pollution. The environmental impact of burning wood is a subject of some debate based on balancing carbon neutrality against particles given off during combustion. Since the late 1990s, compressed wood-pulp pellets have risen in popularity as a cleaner alternative, usually produced as a by-product of wood transformation.

Wood Items

Wood tools have been used since the Lower Palaeolithic by modern humans and their hominin ancestors. In addition, the preparation and use of sticks by Tanzanian chimpanzees to extract termites from a nest is accepted as nonhuman cultural behavior. Ethnology has shown that appropriately shaped branches and twigs used as expedient tools by both hunter-gatherers and agriculturalists are almost indistinguishable from ecofacts, once discarded. Early wood tools include a worked wooden point from Clacton-on-Sea, Essex, from around 400,000 B.C.E. and associated with the Clactonian industry, and possible worked digging sticks and a club from the Late Acheulian site at Kalambo Falls, Zambia,

radiocarbon-dated to around 300,000 B.C.E. Both sites are Lower Palaeolithic and their stone tool industries may have coexisted; they are attributed to *Homo erectus*.

Furniture is thought to originate with the beginning of sedentism in the Neolithic period. The settlement site of Durrington Walls (believed to be contemporary with the adjacent Stonehenge) features postholes, slots, and impressions interpreted as traces of wooden furniture within houses. The earliest surviving wooden furniture is found interred as grave goods in ancient Egyptian tombs, preserved by the extremes of aridity and lack of sunlight.

The reduction of atmospheric changes along the desert edge has also helped preserve wood from the Egyptian tombs. Wood coffins were introduced in the First Dynasty (3100–2890 B.C.E.) and the earliest surviving furniture is also from the 3rd millennium B.C.E. Most furniture was wooden, until the mid-century modern style began using plastics and fiberglass after World War II.

Prior to cheap metals and plastic, most everyday items—decorative and functional—were made from wood, known under the generic name of *treen* and distinct from furniture, large boxes, and barrels. In the decade following World War II, polypropylene and high-density polyethylene were developed, and new plastics began to edge out the existing plastics and traditional materials, including wood. The introduction of large-scale production saw the price of the new plastics drop dramatically. Treen has been neglected in the studies of archaeologists and cultural historians; its study was advanced by Edward Pinto (1901–72), who wrote the definitive book on the subject. His treen collection was bought by Birmingham Museum and Art Gallery in 1965.

Green furniture is now produced, often marked with a tree symbol. Wood used in green furniture is from sustainable forests; the item must be low in toxic materials, manufactured locally to the source of materials, and be durable enough to have a long use-life. The item should also be easy to repair and disassemble into its constituent parts for recycling.

Wood Construction

In favorable conditions, wooden constructions can last for hundreds of years. The 6th-century pagoda of the Horyu-ji Temple, Ikaruga, Japan, is believed to be the world's oldest wooden structure. Wooden constructions are, however, susceptible to attack from fungus and beetles. Simple wooden dwellings, such as prehistoric roundhouses, are thought to have a life span of around 50 years, after which they must be rebuilt. Evidence from the Cucuteni-Trypillian and other southeast European cultures shows routine house burning during the Neolithic and Copper Ages, believed to have been done intentionally for practical or ritual reasons.

Due to its abundance, durability, and pliability, wood remains a popular material for construction. In densely urbanized areas, however, overbuilding with wood may produce fire hazards. During the late 19th and early 20th centuries, several growing cities adopted steel-frame buildings in partial response to devastating fires. Cities also developed modern fire departments, and buildings constructed with wood incorporated fire-safety measures, including sprinkler systems and asbestos (which produced other public safety issues).

Around the world, timber-framed housing is still common in the early 21st century. Even when buildings are made from other materials, timber can still be found in roof construction, door frames, and cladding. At some point or time, most construction elements have been made from wood. Water pipes, for example, have been made from wood since the Roman period; although the practice fell from favor in the 19th century, it was reinstated during World War II.

Engineered wood (also called "human-made" or "composite" wood) is also used in construction; this is a modern concept exemplified by products such as glue-laminated timber (glulam). First used in the mid-19th century, the technique uses multiple layers of timber glued together. With proven sustainability, glulam allows smaller pieces of wood to be amalgamated into a timber that is stronger than solid wood of the same dimensions. Other engineered woods include laminated veneer lumber (LVL), parallam, and I-joists, which enjoy several advantages over conventional timber—mechanically, economically, and environmentally. The principle also allows wood that would not be suitable for construction in its native form to be used by being broken down by mechanical or chemical means and being reconstituted in materials such

as medium-density fiberboard (MDF), chipboard, hardboard, and oriented strand board (OSB).

Wood Supply

Silviculture is the science of tree husbandry, while forestry is the science of forest management. China seems to have the longest history of forest management, originating with the landowning class of the Han Dynasty. Forest management in the Western world developed during the medieval period, when royalty controlled most forestry, which they used primarily for hunting. Systematic forest management is thought to have begun in the 16th century. It is known that the Venetians implemented strict rules to control the forests on the Croatian island of Cres, which supplied most of Venice's firewood. Schools of forestry were established in early 19th-century Germany and France. However, most forestry legislation evolved in Western nations in the late 20th century in response to growing environmental concerns and the increasing capacity of logging companies for mass deforestation.

Two traditional silviculture methods used since antiquity are pollarding and coppicing. Coppicing involves repeatedly cutting a young tree down close to the ground—as many trees will reshoot when cut down,—then harvesting the multiple new shoots that grow back. This is usually done in different sections of a forest in rotation; the differing ages of tree growth present then encourage biodiversity. Regularly coppiced trees remain in the juvenile stage and will never die of old age, while the base, or stool, can reach enormous diameters—up to 18 feet—in medieval coppices from Essex, England. Wood from coppicing was used for fuel, charcoal, and thinner construction timbers, such as poles, wattles, and fencing. Timber used to build the Sweet Track in Somerset, England, in 3807 B.C.E. is thought to be coppiced. Pollarding is similar to coppicing but involves removing the upper branches, which promotes a denser growth of branches and foliage. In addition, timber and fuel pollards were used to produce feed for livestock from the leafy branches.

Due to its abundance, durability, and pliability, wood (known as lumber when used in construction in North America) has been a popular construction material for centuries. In densely urbanized areas, however, overbuilding with wood may produce fire hazards. In 1871, the Great Chicago Fire quickly destroyed 17,500 buildings due to their reliance on wood construction. Partially in response to disasters like this, several growing cities in the late 19th and early 20th century adopted steel-frame buildings and instituted fire departments.

For some marginal populations in places with little tree cover, wood washed ashore as marine debris, called driftwood, can be an important source of wood. For the Inuit, driftwood originating in the Mackenzie River was the main source of wood before contact with European traders. In Norse mythology, the first humans, Askr and Embla, were created from driftwood; Scandinavia has alpine, arctic, and exposure treelines beyond which trees cannot grow. Conversely, on some shorelines, driftwood can be a major problem. Burning driftwood is discouraged as it produces carcinogenic polychlorinated dibenzodioxins (PCDDs), a phenomenon well known when organic compounds combust in the presence of chlorine, which, in this case, has accumulated from soaking in seawater.

Sustainable forest management (SFM) involves forest management in line with the principles of sustainable development. Increases in environmental awareness and the resultant consumer demand for green products allowed forest certification to appear in the 1990s. There are now more than 50 certification bodies worldwide. These independent organizations set the standards of forest management, which auditors then use to assess forestry operations and issue certificates. Wood grown in a managed forest that meets the required management standard then becomes certified wood.

Recycling of wood and building timber is not a new practice, but it has become popular on a larger, industrial scale since the increase in environmentalism in the early 1990s. Timber recycling is the most environmentally sound source of timber and is particularly prominent in Australia, where there are many derelict, large wooden structures. Drawbacks include labor and logistic issues of denailing and refinishing wood, as well as the reduced size of the resultant timber. David Nash, CEO of Nash Timbers, personally stopped the Australian government's procedure of firing old timber railway bridges. On a smaller scale, "urban lumberjacking," which involves individual scavenging for discarded wood that can be used for construction or fuel, is now practiced and is based on a similar ethic as dumpster diving. While this is not a new development, the term rebrands a behavior born out of poverty as a carbon-neutral green activity. The term *urban lumberjack* is also used for commercial timber recovery businesses and describes a fashion trend.

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See Also: Certified Products (Fair Trade or Organic); Furniture; Magazines and Newspapers; Paper Products; Street Scavenging and Trash Picking.

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Worms

Vermicomposting is the conversion of biodegradable matter—usually the organic fraction of garbage—to compost. It is undertaken by earthworms and bacteria under aerobic conditions. As the worms process the waste, the nutrients found in it are converted to a more bioavailable form, making the resulting compost attractive as a soil amendment or fertilizer.

Process

Worms and bacteria work in symbiosis to degrade organic matter and produce compost. Overall, vermicomposting can be illustrated as:

organic waste + oxygen + worms + compost + water + carbon dioxide = more worms.

The process has multiple steps. First, worms create tunnels through the organic matter; this network allows both oxygen to enter the pile and carbon dioxide to exit. As they create paths through the waste, the worms coat their tunnels with a mucous, which

creates a favorable environment for microbes. The worms also consume organic waste and use their gizzard to grind it into small pieces; this action greatly increases the waste's surface area, which facilitates its degradation by bacteria. Bacteria are able to metabolize many substances that the worms cannot. The worm excretes casts (homogenous pellets that are the building blocks for the compost). Each pellet is coated with a gelatinous membrane, which provides structural cohesion to the compost pile and encourages the growth of bacteria. As the worms digest the waste, nutrients present in the waste are converted to forms that are more bioavailable to plants. When provided with enough food, the worms multiply. Though humans benefit from the use of vermicomposting as a waste management strategy, this process occurs naturally in the environment.

Unlike conventional composting, which relies solely on microbial action to degrade the organic waste, vermicomposting is mediated by microbes and worms and does not result in increased temperature in the compost pile. In order for the composting process to occur effectively, the conditions in the pile must mirror those of the worms' natural habitat.

Ideal Conditions and Uses for Vermicompost

The exact conditions leading to an effective worm-mediated composting process depend on the species of earthworm involved. However, it has been widely observed that temperatures of 13–22 degrees Celsius (55–72 degrees Fahrenheit) are conducive to worms feeding on organic matter and producing casts. The substrate should be fairly moist (50–80 percent moisture), of neutral pH (seven to eight), and should have a carbon-to-nitrogen ratio (C:N) between 15:1 and 35:1. Because composting is an aerobic process, the organic matter must be exposed to oxygen. Additionally, there should be a barrier around the compost pile to prevent intrusion by insects or predators.

Worms are prolific eaters; they are able to consume several times their own weight each day. As they consume the waste, the worms increase the surface area of the waste, turning and aerating it. So, unlike conventional composting, there is no need to force aeration or mixing of the substrate.

Epigeic species—those that stay near the surface of soils and consume humus-like material—are the most suitable decomposers of organic waste. *Eisenia foetida* and *Lumbricus rubellus* are two commonly used species for vermicomposting; these are found in nature in soils with high organic concentration, and they are quite fecund.

Vermicomposting is an organic waste management strategy that utilizes the nutrients contained and minimizes the amount of waste that needs disposing. It also creates two useful products: castings (the compost) and earthworms. The castings can be used as an organic soil amendment or as a fertilizer. As a soil amendment, vermicompost has been shown to improve the water retention capacity of the soil, have a higher microbial population than regular compost, and contain enzymes and hormones that discourage pathogens and encourage plant growth. The earthworms produced can be used live as a bait for fishing or as stock for further vermicomposting, or they can be used in dried form as a soil amendment or as animal feed.

Disadvantages

Using worms to produce compost carries on-site risks and risks associated with use of the castings. The composting facility may carry disease vectors if the piles are not properly protected, and the compost may produce nutrient-rich runoff if the facility is not properly designed. Using the compost can pose risks if the waste used as a feed contains harmful compounds, such as heavy metals or chlorinated hydrocarbons. The compost may also contain pathogens.

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See Also: Anaerobic Digestion; Composting; Organic Waste; Sludge Worms.

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Wyoming

Because of a series of dry basin floors across the Continental Divide, Wyoming is named from a Native American word meaning "big river flats." The word is a Munsee Delaware Indian word, however, not from the local Shoshone or Arapaho Indians. The least populous state, with only 544,270 people as of 2009 and no large cities; the capital, Cheyenne, has a population of only 50,000. More than 91 percent of Wyoming is classed as rural.

Statistics and Ranking

The 16th Nationwide Survey of MSW Management in the United States found that, in 2006, Wyoming generated an estimated 684,690 tons of municipal solid waste (MSW), placing it 49th in a survey of the 50 states and the capital district. Of this tonnage, 73,200 tons were recycled, placing Wyoming 48th in the ranking of recycled MSW tonnage. Based on the 2006 population of 512,757, this is an estimated 1.38 tons of MSW generated per person per year (ranking joint 18th). Wyoming landfilled 611,490 tons in the state's 51 landfills (47th ranking), and only 590 tons were exported, the lowest reported exportation of MSW in the United States. Landfill tipping fees across Wyoming ranged from $30 to $80 per ton, where the cheapest and most expensive average landfill fees in the United States were $15 and $96, respectively. As of 2006, Wyoming was increasing its landfill capacity but had no waste-to-energy (WTE) facilities, and it was ranked ninth out of 44 respondent states for number of landfills. Only lead-acid batteries were reported as being banned from Wyoming landfills.

Taking Sublette County as an example of a typical rural Wyoming county, the $2.47 million waste management budget for 2010–11 consists of three major divisions: general waste management by way of landfill/balefill (65.3 percent); transfer station (31.6 percent); and recycling (3.1 percent). The landfill also accepts refuse from Teton County. The recycling budget is divided between the Tri-Town recycling program and the county-operated program in Pinedale. The waste management problems encountered in a rural county include unsecured loads arriving at the Sublette County Landfill, causing litter and road safety problems, and medical waste arriving in garbage trucks. Neither Sublette County landfill or transfer station has a licence for medical waste, and it poses a risk to staff. Every month, Sublette County sends a 30-gallon can of clinical waste to Salt Lake City, Utah, for incineration.

Economy

Wyoming is renowned as a state of cowboys and mountain men, and historically, agriculture has been a key part of the state's economy, although of lesser importance in the early 21st century. Main agricultural interests are cattle, alfalfa, hay, and sugar beets. Along with tourism, the leading industries are mining and public utilities. Coal deposits underlie 55 percent of the state, with the greatest concentration in the Powder River basin on the northeastern high plain. Wyoming leads the United States in coal production and has the largest coal mine on the continent, Black Thunder. Wyoming also contains 70 percent of the known global supply of bentonite, an absorbent clay used to seal subsurface spent-nuclear-fuel disposal systems and to quarantine metal pollution in groundwater; it is also used to line the base of landfills.

Strict regulations mean that strip mining no longer has the devastating environmental effect it once had, the key piece of legislation being the 1977 Surface Mining Control and Reclamation Act (SMCRA). Excavated prairie land is reinstated with overburden, graded, and replaced to match the original landscape, recreating contours, rocky outcrops, and even meandering streams. The rolling hills and vegetation of Wyoming are easily reconstructed, unlike the forests and other complex ecosystems found elsewhere. Twenty-one species of native plants are then seeded and left to grow for a minimum of three years without artificial fertilizer or watering. This process creates a reclaimed environment that provides four times more vegetation and fattens cattle faster than natural rangeland. The Carter Mining Company estimated that it would take 30 acres or less of reclaimed land to graze one animal unit

(cow and calf), compared to 41 acres prior to mining. The Wyoming Game and Fish Department has also designated substantial areas of reclaimed mine land as range for the Rochelle Hills elk herd. The reclamation operations have developed techniques to provide habitats in the reclaimed areas. Large rocks are separated from mine waste and piled on the new landscape to provide shelter for small mammals. Artificial nest sites for burrowing owls are planted, dead trees are placed for nesting birds, and kestrel boxes are put up. Significant wetlands have also been created, and refuse mining material, such as pipe, used tires, and scrap metal, is recycled to create goose nesting sites.

Historical Archaeology

Wyoming has had a boom-and-bust economic history, with many abandoned settlements; others are reduced to isolated hamlets, which continue a fraught existence. The uranium boomtowns of the 1950s to the 1980s have collapsed because of cheaper uranium mined abroad. Previous booms have included gold (1860s) and oil (1884–1982). The historical archaeology of Wyoming includes many site types connected to this industry, which are often scatters of refuse from drill sites, camp sites, and tool hearths. Site 48CR1679, an isolated tool hearth, consists of a three-foot-square firebrick hearth and a wide scatter of ash, coal, nails, firebrick, and metal and asbestos fragments. On the treeless plains, historic oil and gas sites are often scavenged for reusable building materials, particularly, the large timbers from cable tool drilling rigs.

Site 48CR2143, a short-term drilling camp from the early 1920s in Carbon County, was archaeologically recorded in 1981. This was one of the first oil and gas camps in Wyoming to be investigated archaeologically. As is usually seen with temporary work settlements of the period, the only apparent evidence of the habitation area was two dump deposits, numerous smaller concentrations of coal and cinders associated with artifacts, and a two-by-three-meter depression containing timber remains that is thought to be the site of latrines. A high density of surface finds of firebrick, cinders, pipes, fittings, tools, and planking characterizes the remains of the working area. The concentrations can be matched to the various known activities carried out on a drill site, and the remains of the drilling rig (derrick timbers, walking beam, and sections of wheel) are scattered across the area.

Bears

Wyoming is bear habitat. In the mountainous western area of the state, there are black and grizzly (or brown) bears. These are often attracted to garbage cans and dumpsters to feed, which becomes habit-forming and increases the chance of human-bear contact. Bear-proof bins must have recessed, self-closing lids, which reduce odor, and latches that cannot be reached by claws.

The bins and their hinges and latches must be able to resist the several thousand pounds of force that a bear can apply, should afford protection against tipping. Trash bins and recycling bins in the area also have to be bear-proof. Curbside garbage collection in bear habitat usually has to be curtailed in favor of communal bear-proof dumpsters as the curbside rubbish invites bears into residential areas. Bear-proof enclosures for commercial and large residential building, bins are also offered by manufacturers of bear-proof refuse containers and storage lockers. These are small, reinforced shelters to protect and restrict access to garbage left out for collection. Forest campsite food and garbage is particularly vulnerable to bears, and some Wyoming forests have mandatory food storage orders.

Food and garbage must be stored in bear-resistant containers or hung in a tree 100 yards from camp, 10 feet above ground, and four feet from the trunk. Hunters dumping entrails from field-dressed kills also attract bears—this should never be done near a trail.

Landfills are also an attractive feeding site for Wyoming bears, although the food they find is often unsuitable, unhealthy, or lethal. At the Clark landfill in Park County, the dead-animal pit has been targeted by grizzly bears, as has happened elsewhere. Authorities are often unwilling to spend large amounts of tax money on electric fencing when landfills only have a year or two of their life span remaining; instead, attendants are armed with bear spray and carry out a sweep of the premises every morning. Two grizzly bears were captured in the Clark landfill by the Game and Fish Department, one each in May and June 2010.

Two people were killed by grizzly bears within 50 miles of the landfill in the first three quarters of 2010. Bears will tear down unelectrified fence around landfills or try to dig under fencelines. Even sealed landfills will be subjected to repeated break-in attempts if left fenced. Retired landfills are recommended to be left unfenced because the bears will move off in search of food when they realize that none is within reach on the former landfill site.

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See Also: Archaeology of Garbage; Landfills, Modern; Mineral Waste; Mining Law.

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Yardwaste

One can imagine the variety of waste that is produced by the interaction of humans with the urban ecosystem. Dead trees and tree limbs, leaf falls, weeds, dead plants, old sod, grass clippings, and an innumerable variety of other materials comprise this category of waste. Lawn and garden refuse does not include inorganic yard waste, such as lawn furniture, outdoor play equipment, fences, and poles.

Historically, most lawn and garden wastes were managed by individual property owners or property managers. If not reused in some way, the wastes were usually burned or composted on site. The unique smell of burning leaves often permeated neighborhoods during fall months. However, in the environmentally conscious society of the 21st century, burning of lawn and garden waste is seen as a hazard, particularly when it is burned with household garbage. Therefore, lawn and garden waste is managed by municipal waste handlers.

Collection, Reuse, and Recycling

Collection of lawn and garden waste is often done in communities on special days or at designated collection centers. The reason for separate collection policies is that this waste is not allowed within most landfills that manage municipal garbage. Communities often limit the amount or size of waste that can be picked up or dropped off without a special fee.

There are a variety of ways that communities can handle the waste once it is received. For example, the refuse may be taken to a landfill, composted for future use, or processed and turned into mulch. Some communities offer, free of charge, the mulch produced from yardwaste. In other cases, the mulch is resold to produce a revenue stream for the community.

The growing interest in urban sustainability has caused waste managers to reexamine lawn and garden waste management. As there is greater emphasis on managing waste within the household, managers are urging residents to compost grass clippings and other yardwastes. In addition, there is growing interest in using lawn and garden refuse to develop fuels. Various companies are willing to collect yardwaste for cities or organizations for free. They recycle the waste into mulch or other products and resell the material for a profit. Some garden purists prefer not to utilize these and other mixed-mulch products because they often contain seeds and garden diseases, which may harm plant

species. The production of lawn and garden wastes varies geographically throughout the planet—from hemisphere to hemisphere, inside city limits, and within individual communities. For example, the climate of north-central Europe is conducive to the growth of deciduous hardwood trees that discard their leaves each fall and can lose their limbs in ice storms. This results in a waste stream of thousands of tons of leaves and fallen branches, requiring specialized management.

In contrast, the lawn and garden waste stream in southeast Asia, where perennial trees dominate, varies significantly. In this region, seasonal tropical storms cause significant damage to trees, thereby providing a distinctly unique, but large, garden and lawn waste stream.

Even within the limits of a city, lawn and garden wastes can vary greatly. In newly developed areas, where trees are relatively immature, grass clippings will dominate; but, in older portions of cities, grass clippings, leaves, and tree limbs may be present. This geographic variability requires individualized planning for waste management. There is growing concern over the chemical composition of yardwaste, particularly grass clippings, leaves, weeds, and garden waste because individual homeowners may use fertilizers, pesticides, and herbicides that remain with the waste stream.

An additional concern is the presence of roots or seeds of exotic plants that can be transplanted to other areas in the production of mulch. Indeed, there are many efforts in place to eliminate exotic plants from many areas of the world, and municipal lawn and garden waste reuse has been criticized by those involved with protecting native plants and ecosystems practice that expands the distribution of nonnative plants.

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See Also: Composting; Construction and Demolition Waste; Organic Waste; Pesticides.

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Zero Waste

Zero waste is the term used to describe a worldwide philosophical movement dedicated to rethinking the very idea of waste. While there are many variations in the interpretation of what zero waste means, the unifying idea is that human systems should emulate the rest of nature by only producing wastes that can be recycled into new resources, with no residual wastes that are hazardous or require landfilling. Other synonymous terms are commonly used to refer to the same concept, such as *zero emissions*, *biomimicry*, and *waste=food*; however, *zero waste* is probably the most widely known term used around the world to describe efforts to eradicate waste as people currently know it. Zero waste initiatives have sprung up all over the world, with many towns, cities, states, and even nations declaring zero waste goals with specific deadlines. Many of these earliest deadlines began to arrive in 2010, which means that there will likely be a great deal of examination and discourse about the feasibility of zero waste over the course of the 21st century.

The zero waste movement emerged from a multitude of grassroots sources around the 1990s in response to worldwide growth in the amounts of waste being generated. With traditional waste management practices increasingly failing to address waste-related problems (such as pollution from landfills and incinerators) and the shortage of available space to site these facilities, zero waste emerged as an alternative philosophy for people searching for better solutions.

Definitions

Zero waste is interpreted in significantly different ways. The literal definition is less-commonly used: it refers to the complete absence of waste. The problem with this definition is based on simple science: all living organisms produce waste as part of their processes, and it is not conceivable that humans could be an exception to this rule. As long as humans continue to exist on Earth, they are going to generate wastes of some sort and amount. For this reason, most zero waste initiatives are based upon more metaphorical definitions of the term.

Local governments embarking upon zero waste initiatives often use the term *zero waste* to suggest a goal of minimizing waste. Present levels of waste are universally understood to be too high, so this means that even if some residual waste levels are unavoidable, then there must be some very significant reduction in waste in order to achieve zero waste.

Other jurisdictions have been more specific, though. A commonly declared zero waste goal is "zero waste to landfill," which implicitly allows for residual wastes that might be dealt with via recycling—but perhaps also via other processes, such as incineration, which are also inherently problematic.

Whichever definition of the term is used, the common theme of zero waste thinking is that of a paradigm shift, from the traditional view that waste is merely an external by-product of a one-way, linear system, to one where waste is instead viewed as a resource that is part of a closed-loop system. In this respect, all waste management practices that "close the loop" to any extent, such as reuse or recycling of materials, can be thought of as being zero waste practices.

Canberra, Australia, was the first city in the world to officially declare a zero waste goal in 1996. Since then, communities all around the globe have followed suit with their own zero waste initiatives. This includes numerous towns and cities across the United States, Europe, and elsewhere in the developed world. New Zealand was the first country to have the majority of its local councils adopt zero waste goals, and Scotland announced its own national zero waste plan in 2010.

Zero waste initiatives have, as of 2010, been concentrated mainly in developed countries, where the highest levels of waste generation are found. However, with the trend in many developing countries toward increased development, waste levels are likely to rise accordingly; in turn, zero waste will likely gain increased attention in these places as well.

Meanwhile, Canberra's deadline for zero waste in 2010 arrived, and the results are that although recycling rates have climbed as high as 75 percent, overall increases in the incoming waste stream have resulted in a net increase of waste to landfill. In North America, zero waste cities, such as New York, Toronto, and Vancouver, continue to export waste over hundreds of miles to distant landfill sites, as the last local landfills in those places have filled to capacity. The ideals of zero waste have been embraced by millions of people around the world; however, it remains to be seen how successful the movement can be in practice.

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See Also: Definition of Waste; Externalities; Landfills, Modern; Recycling; Waste as Food.

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Glossary

Abandoned well: A well that has been permanently discontinued or that is in a state of such disrepair that it cannot be used for its intended purpose.

Abatement: Reducing the degree or intensity of, or eliminating, pollution.

Acid rain: Any form of precipitation containing high levels of sulfuric and nitric acids.

Activated sludge: Product that results when primary effluent is mixed with bacteria-laden sludge and then agitated and aerated to promote biological treatment, speeding the breakdown of organic matter in raw sewage undergoing secondary waste treatment.

Adhesives: Substances that hold at least two materials together by surface attachment. They pose a particular problem for recycling efforts, as adhesives often clump together, damaging recycling machinery.

Adulterants: Chemical impurities or substances that by law do not belong in a food or pesticide.

Affected landfill: Under the Clean Air Act, landfills that meet criteria for capacity, age, and emissions rates set by the Environmental Protection Agency (EPA). They are required to collect and combust their gas emissions.

Agricultural waste: Poultry and livestock manure, and residual materials in liquid or solid form generated from the production and marketing of poultry, livestock, or fur-bearing animals; also includes grain, vegetable, and fruit harvest residue.

Anaerobic digestion: A form of waste treatment that serves as an alternative to other costly methods of waste treatment.

Avoided cost: A term used in waste management to represent monetary savings through the diversion of waste from disposal to a form of reprocessing such as recycling or composting.

Backyard composting: Diversion of organic food waste and yard trimmings from the municipal waste

stream by composting them in one's yard through controlled decomposition of organic matter by bacteria and fungi into a humus-like product. It is considered source reduction, not recycling, because the composted materials never enter the municipal waste stream.

Bar screen: In wastewater treatment, a device used to remove large solids.

Barge: A flat-bottomed boat used for transfer of heavy goods that is sometimes used for the disposal of waste.

Biodegradable: Matter capable of being decomposed by bacteria or other biological means.

Bubonic plague: A bacterial disease that is caused by infection through rat carriers and that wreaked havoc on multiple continents during three separate epidemics.

Carbon dioxide: A chemical compound (CO_2) that in the second half of the 20th century was claimed by scientists to be contributing to global warming. Since the Industrial Revolution in the 1700s, human activities, such as the burning of oil, coal, and gas, and deforestation, have increased CO_2 concentrations in the atmosphere. In 2005, global atmospheric concentrations of CO_2 were 35 percent higher than they were before the Industrial Revolution.

Celluloid: The first modern plastic, celluloid was patented by John Wesley Hyatt, who envisioned the material as a synthetic replacement for scarce natural resources, such as ivory and tortoiseshell. Later, the plastic material would become closely associated with the development of the motion picture industry.

Coal ash: A noncombustible by-product left over from the burning of coal. It is composed of two parts: airborne particles called fly ash and heavier particles called bottom ash that settle on the floors of coal-fired furnaces.

Cloaca Maxima: Literally meaning "greatest sewer" in Latin, the Cloaca Maxima, constructed in Rome, was the largest sewer system in the ancient world.

Composting: The decomposition and stabilization of the organic fraction of municipal solid waste carried out by a microbial community under controlled, aerobic conditions.

Downcycling: The reprocessing of material into a new product of reduced quality or value.

Dump digging: The practice of excavating old garbage sites.

Dumpster diving: The practice of combing through large metal trash containers, either for treasure hunting, can collecting, or food foraging.

Emissions: Gases or particles pumped into the air by various sources.

Environmental Protection Agency (EPA): U.S. governmental agency that was established in 1970 with the purpose of safeguarding and/or improving America's environment and human health relating to the environment.

E-waste: Electronic waste or Waste Electrical and Electronic Equipment (WEEE). Discarded, surplus, obsolete, or broken electrical or electronic devices.

Fly-tipping: Refers to the illegal dumping of waste anywhere other than an officially licensed site such as a landfill or municipal tip.

Freeganism: A loosely bound movement of individuals who protest consumer society and the market economy by living a life that produces no demand for goods.

Garbage art: Art created from materials including post-consumer and other waste, collected debris, or objects previously used for other purposes.

Garblogging: The growing body of work by environmentally conscious bloggers (writers of online weblogs) that addresses the political, environmen-

tal, personal, or social impact of waste, trash, garbage, and refuse.

Gluttony: The practice of eating or drinking in excess, and in such a manner as to lose control of one's mental and physical faculties, or to do great harm to the body.

Hoarding: The excessive acquisition of relatively worthless things to the extent that it compromises the living space and/or daily activities of the affected person. Hoarding, which often starts in adolescence and worsens with age, is a diagnosable condition when it becomes compulsive, and there are five different levels describing the severity of a hoarder's condition.

Household hazardous waste: A variety of commercial products used in the home, such as cleaning supplies, pesticides, and pool chemicals, that are dangerous to human health or the environment and end up within the waste stream.

Human waste: Refers broadly to the by-products of human physiological processes, most commonly to urine and feces, but also to sweat, phlegm, and flatus, among other bodily excretions.

Incinerator: A facility designed for the efficient, controlled combustion of wastes at a high temperature.

Incinerator waste: Residues that result from controlled incineration activities in large facilities.

Junk mail: Unsolicited mail that is sent to people through the postal system. Junk mail may include letters, catalogs, and flyers from companies, credit card applications from banks, CDs, other forms of merchandising materials, and correspondence from politicians, candidates, and other organizations.

LULU: Acronym meaning "locally unwanted land use" or "locally undesirable land use" that refers to land use such as a dump that is useful to society, but objectionable to its neighbors.

Methane: A gas (CH_4) that is over 20 times more effective in trapping heat in the atmosphere than carbon dioxide, methane is emitted into the atmosphere from several activities, including fossil fuel production, biomass burning, and waste management. In the United States, the largest methane emissions come from the decomposition of wastes in landfills, ruminant digestion and manure management associated with domestic livestock, natural gas and oil systems, and coal mining.

NIMBY: Acronym meaning Not in My Backyard that refers to efforts by local grassroots organizations to oppose the construction of undesirable buildings or facilities such as landfills or junkyards.

Open dump: A site where wastes are deposited on land or are burned or buried without supervision and without precautions regarding human health or environment. Open dumps are usually characterized by no planning, responsible person on site, no access control, control of waste deposition, or confinement of waste body, and uncontrolled burning.

Organic waste: Waste of plant and animal origin.

Overconsumption: A way of living in which the lifestyle patterns of human beings lead to an accelerated expenditure of natural resources.

PAYT: Acronym meaning "pay as you throw" that refers to programs where residents are charged for the collection of municipal solid waste based on the amount they throw away. This creates a direct economic incentive to recycle more and to generate less waste.

Plastics: A variety of synthetic materials used to manufacture everyday products such as beverage containers, toys, and furniture. The largest category of plastics is found in containers and packaging (e.g., soft-drink bottles, lids, and shampoo bottles), but they also are found in durable (e.g., appliances, and furniture) and nondurable goods (e.g., diapers, trash bags, cups and utensils, and medical devices). The recycling rate for different types of plastic varies greatly, and plastics have grown rapidly as a share of the municipal solid waste stream since 1960.

Post-consumer waste: The part of the waste stream that individuals and households dispose of rather than recycling or reusing in some manner.

Pre-consumer waste: Material that would have become trash if it were not diverted from the waste stream during the manufacturing process.

Rendering: The process by which bones, butcher's waste, offal, animal carcasses, and waste meats are converted into products including grease (the oily liquid from melted fat), tallow (defined as somewhat-hardened animal fats), glycerin, and fertilizer.

Rubbish theory: A body of thought that addresses how the value of material objects is socially constructed and deconstructed.

Sand filters: Devices that remove some suspended solids from sewage. Air and bacteria decompose additional wastes filtering through the sand so that cleaner water drains from the bed.

Sanitary landfills: Engineered land burial facilities for the disposal of solid waste. They are distinct from open dumps in that they are intended to contain waste with liners designed as barriers to prevent leachate from contaminating local groundwater.

Sanitary sewers: Underground pipes that carry off only domestic or industrial waste, not stormwater.

Sewage sludge: Sludge produced at a publicly owned treatment works, the disposal of which is regulated under the Clean Water Act.

Sewer: A channel or conduit that carries wastewater and stormwater runoff from the source to a treatment plant or receiving stream. Sanitary sewers carry household, industrial, and commercial waste. Storm sewers carry runoff from rain or snow. Combined sewers handle both.

Sewerage: The entire system of sewage collection, treatment, and disposal.

Sierra Club: Founded in 1892 by John Muir, the club now includes chapters in all 50 states.

Sludge: A semisolid residue from any of a number of air or water treatment processes; can be a hazardous waste.

Sludgeworm: Freshwater sediment–dwelling worms known for their resistance and adaptation to polluted environments.

Slums: Residential areas filled with overcrowded, poor, or informal houses with inadequate access to safe water and sanitation and insecurity of tenure.

Smog: Air pollution typically associated with oxidants.

Space debris: The wide assortment of human-made objects found in orbit around the Earth and for which there is no current use.

Toxic Waste: A waste that can produce injury if inhaled, swallowed, or absorbed through the skin.

Trash: Material considered worthless or offensive that is thrown away. Generally defined as dry waste material, but, in common usage, it is a synonym for garbage, rubbish, or refuse.

Trash-to-energy: Burning trash to produce energy.

Treated regulated medical waste: Medical waste treated to substantially reduce or eliminate its pathogenicity but that has not yet been destroyed.

Treated wastewater: Wastewater that has been subjected to one or more physical, chemical, and biological processes to reduce its potential of being a health hazard.

Treatment plant: A structure built to treat wastewater before discharging it into the environment.

Urban runoff: Stormwater from city streets and adjacent domestic or commercial properties that carries pollutants of various kinds into the sewer systems and receiving waters.

Used oil: Spent motor oil from passenger cars and trucks collected at specified locations for recycling

(not included in the category of municipal solid waste).

Vehicle miles traveled (VMT): A measure of the extent of motor vehicle operation; the total number of vehicle miles traveled within a specific geographic area over a given period of time.

Waste: Unwanted materials left over from a manufacturing process or refuse from places of human or animal habitation.

Waste characterization: Identification of chemical and microbiological constituents of a waste material.

Waste exchange: Arrangement in which companies exchange their wastes for the benefit of both parties.

Waste feed: The continuous or intermittent flow of wastes into an incinerator.

Waste generation: The weight or volume of materials and products that enter the waste stream before recycling, composting, landfilling, or combustion takes place. Also can represent the amount of waste generated by a given source or category of sources.

Waste load allocation: The maximum load of pollutants each discharger of waste is allowed to release into a particular waterway. Discharge limits are usually required for each specific water quality criterion being, or expected to be, violated. Additionally, the portion of a stream's total assimilative capacity assigned to an individual discharge.

Waste minimization: Measures or techniques that reduce the amount of wastes generated during industrial production processes; term is also applied to recycling and other efforts to reduce the amount of waste going into the waste stream.

Waste piles: Noncontainerized, lined or unlined accumulations of solid, nonflowing waste.

Waste reduction: Using source reduction, recycling, or composting to prevent or reduce waste generation.

Waste stream: The total flow of solid waste from homes, businesses, institutions, and manufacturing plants that is recycled, burned, or disposed of in landfills, or segments thereof such as the "residential waste stream" or the "recyclable waste stream."

Waste treatment lagoon: Impoundment made by excavation or earth fill for treatment of wastewater.

Waste treatment plant: A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water.

Waste treatment stream: The continuous movement of waste from generator to treater and disposer.

Waste-heat recovery: Recovering heat discharged as a by-product of one process to provide heat needed by a second process.

Waste-to-energy facility/municipal-waste combustor: Facility where recovered municipal solid waste is converted into a usable form of energy, usually via combustion.

Wastewater: The spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter.

Wastewater infrastructure: The plan or network for the collection, treatment, and disposal of sewage in a community. The level of treatment will depend on the size of the community, type of discharge, and/or designated use of the receiving water.

Wastewater operations and maintenance: Actions taken after construction to ensure that facilities constructed to treat wastewater will be operated, maintained, and managed to reach prescribed effluent levels in an optimum manner.

Wastewater treatment plan: A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water. Most treatments include chlorination to attain safe drinking water standards.

Source: Environmental Protection Agency.

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Appendix

Garbology 101

William L. Rathje

Editor's Note: The following is from William Rathje's manuscript *Garbology 101*, which, he emphasizes, is a work in progress. It is printed here with the kind permission of Dr. Rathje and with the hope it may illuminate readers' minds about garbage.

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Foreplay

How Garbage Got to Be an "-ology"

Every year thousands of new words, like "incentivize" and "dumbing down," fight for that place in the word limelight we call "dictionaries." But attaining "dictionary-worthiness" (another nonofficial word, but you know what I mean) isn't easy. In fact, out of every 1,000 newly minted words, only a handful survive.

Imagine, then, my surprise when a word coined in the late 1970s to describe the work of the Garbage Project became enshrined in the 1990s in that thoroughbred of dictionaries, *The Oxford Dictionary and Usage Guide to the English Language*. *The American Heritage Dictionary* followed suit, and half a dozen more have piled on since.

The entry itself usually looks something like this: garbology (gär bol'i jê), *n.* orig. *U.S.* Also garbageology. (f. GARB(AGE *sb.* + -OLOGY; cf. GARBOLOGIST.); and the succinct definition is "term for the scientific study of the refuse of a modern society." O.K. Just about every noun seeking respect has dressed itself up in the starched suffix –ology, like, say, "hamburgerology." But most of these endeavors don't get as far as the *New Yorker* cartoon spoof with the word "canteloupology" under a man looking intently at a canteloupe. Why, then, did *garbology* make the prime cut?

Simply put, the word was right for the times. It epitomizes (1) the way *garbologists*—garbage people like you and me—have *made a difference* because we deal with garbage dilemmas in a systematic and scientific manner; but more important, it epitomizes (2) a positive way our society has come to look at itself today—garbage and all.

The new vision of garbage began creeping into the American consciousness on the first Earth Day in 1970, with its mantra that extolled recycling. Soon industry was touting incineration in the same glowing terms. During the next decade, sources as authoritative as *Science* magazine proclaimed that there was "Gold in Garbage." The problem was perceived as: rapidly growing mountains of discards; the solution was perceived as: recycle or burn it for a profit! What more could any red-blooded American ask?

There was only one hitch—all but a few of the thousands of idealistic recyclers who opened their doors in April 1970 were quickly shaken out of business, and most of the big-enough-to-heat-Detroit-sized incinerators followed suit. Clearly, garbage was something important that we didn't yet understand.

Meanwhile . . . without any hoopla, America's underground economy had been stood on its head. The 1800s had been a boom time for rag pickers because household garbage was rife with old textiles that mills needed to produce paper. But early in this century, the freshly christened transcontinental railroad brought cheap lumber from the west to the east, not coincidentally, just as the mills figured out how to make paper out of wood.

That left garbage pickers without a valuable to pick, and the trade of garbage scavenging languished until the 1970s. By then, battalions of pre-prepared foods and a newly inspired desire for fresh-looking produce flooded America with both profits and supermarket dumpsters laden with "not-consumer-acceptable-but-still-edible" wastes, such as dented cans and slightly browning lettuce. The monetary incentives attached to recyclables also led the hungry underclass back to garbage. In fact, street people began to stake out personal territories where the garbage is rich in rewards.

But again, something was wrong. Yes, some of the waste was salvaged, but why were the mountains of waste there in the first place, and why wasn't more of it benefiting millions of the even more needy? Again, it seemed, we didn't understand garbage.

Meanwhile . . . there was a third type of interest in everyday discards that became prominent in the early 1970s—garbage "Peeping Toms." Since time immemorial, law enforcement organizations have searched through garbage for evidence. That technique was exploited by A. J. Weberman, a self-proclaimed "Garbage Guerrilla," who wrote a cover article for *Esquire* magazine in 1971. In it, Weberman displayed refuse he had swiped from the homes of Bob Dylan, Neil Simon, and other celebrities of the day. Reporters quickly took up the practice of swiping refuse, and similar behavior appeared on just about every cop and whodunit TV series, from *The Rockford Files* to *Law & Order*.

What probably kept this garbage avocation from surviving much past the 1980s was simple: the artifacts hidden in celebrities' refuse were, by and large, the same kinds of mundane things we all throw away (Dylan's garbage contained soiled diapers and Simon's, a half-eaten bagel). Besides, if you only sort through a bag or two, you probably won't find many astonishing insights. From my experience, those only come after sorting through thousands of samples and looking for non-person-specific patterns that characterize neighborhoods.

Meanwhile . . . such systematic sampling, sorting and recording of garbage appeared in what might seem like a parallel universe to "Peeping Tom" refuse poking. Its roots stretch back more than 100 years to the first archaeologists who excavated ancient artifacts to shed light on humanity's dim past. What archaeologists dug up was mostly old garbage, but the passing centuries had tinged it with both grandeur and mystery. Using discards, archaeologists opened a window on ancient human behavior. It wasn't much of a leap to realize that our own fresh garbage provided an equally clear window onto our contemporary behavior, one that reported what we actually did rather than what we just said we did. The study of garbage was a "material sociology" of American society.

Early market researchers exploited it as such. In a now legendary study, household refuse collected from Andover, Massachusetts, was searched for Campbell's Soup cans that had just appeared in markets. The cans weren't found where expected, in the rubbish of the rich, who had servants to make soup for them. Instead, the empty cans were spotted in the refuse of the middle class, who had little free time and less help. To judge from their garbage, the middle class enjoyed the convenience of canned soup . . . and the marketing of convenience to everyday families began in earnest, restructuring the form and content of the most critical relationships within American families.

When I started the Garbage Project's academic study of fresh municipal solid waste (MSW) in Tucson, Arizona, in the spring of 1973, I wasn't thinking in such big-picture terms. I just wanted to give freshmen at the University of Arizona a chance to experience, hands-on, the panorama of behaviors archaeologists could reconstruct from everyday garbage.

We began by focusing on food waste because the large quantities that we recorded were so shocking. Then, we expanded to diet and nutrition, recycling and household hazardous waste discards, brand loyalty and consumer responses to new products, and on and on . . . .

Our unexpected discoveries attracted considerable media attention, due in no small part, I'm sure,

to the fact that clean-cut university students were hand sorting and recording yucky garbage. But that made the students and our results "real."

Now all the "meanwhiles" began to come together. Three were especially memorable to me.

The first occurred in 1971, well before the Garbage Project, when Charles Kuralt interviewed a can-tosser named Frenchy Benguerel in Kenwood, California, as part of his "On the Road" series for the *CBS Evening News*.

Kuralt didn't interview Frenchy as a garbageman or a "Peeping Tom"; he interviewed Frenchy as a chronicler of neighborhood lifestyles, concerned about waste and recycling, for sure, but just as interested in the overall frequency of hair coloring and alcohol containers.

Directly related to that image of Frenchy as a neighborhood sociologist is the "Grin 'N Bear It" cartoon that I believe coined the term *garbology*. It pictured two bedraggled hobos picking through the contents of a garbage can, as one says, "*Garbology* is becoming a science, Arnold . . . And, just think, we were pioneers in the field."

Finally, in the spring of 1987, the "garbage barge" sailed out from Long Island, New York, and into history. The *Mobro 4000* was a riveting "wake-up call" (another term in dictionary purgatory). Before the garbage barge, when someone I sat next to on an airplane asked me what I did, I would change the subject to avoid puzzled looks. After the garbage barge, there was no problem. Everyone immediately got that "I-understand-why-studying-garbage-is-important" look on their face.

We have the same look on our faces today. We all understand that to make a difference—to recycle efficiently, to burn safely, and to cut down on waste in all MSW management—we need systematic, scientific studies to design waste handling systems and consumer education programs that work as they are supposed to.

It seems that just about everyone is now a self-styled *garbologist*, from dumpster divers to people who test the strength of garbage cans. And, now and then, don't all of us who place our garbage out for collection, claim *garbology* expertise? In fact, the term has experienced such wide circulation that it has appeared at a National Spelling Bee, on the TV game show *Jeopardy*, and now and again in *Time* and other national news magazines.

I believe that this is a good sign for both garbage people and our nation as a whole.

Even though it brings smiles, maybe even smirks, to people's faces, the term *garbology* means that Americans are no longer turning a blind eye to MSW. In fact, without exception, garbage is being taken far more seriously—even die-hard litterers feel either more guilty or more afraid of fines. At the same time, most of the lay public is aware of the basic refuse problem and is becoming more garbage literate. Not everyone, by far, knows what "post-consumer recycled content" or "source reduction" mean for sure, but they are all beginning to believe that they should know. After all, any self-respecting *garbologist* would know.

Eleven Off-the-Record Rules for Dealing With the Media

Because of its color, texture, smell, and reputation, garbage has always attracted the media. The problem, of course, is that MSW folks who have cooperated with the media have often gotten *burned!* I came to realize that sad fact over the past 28 years based on a number of contacts—probably more than 1,000—between the media and the Garbage Project. As a result, I have compiled 11 off-the-record rules for dealing with the media. Take them for what they are worth:

Rule no. 1: Nothing is ever "off-the-record." Let's begin with an interview by *Harper's*. They: "So you sort the garbage at the dump." Me: "Off-the-record, please, sanitation people don't like people to use the word 'dump.'" I then explained that they work really hard to add layers of cover soil every day on top of the garbage to create a "sanitary landfill." I also mentioned that all the landfills I knew of were vented for methane gas and that the more recent landfills were all heavily lined to prevent leaks. So, after a two-hour interview about the Garbage Project, the headline was: "GARBAGEMEN GET REALLY STEAMED IF YOU CALL THEIR GARBAGE A 'DUMP,'" and then they didn't explain why in the article.

Rule no. 2: The less factual support there is for a statement, the more the media will use it. In 1971, before the Garbage Project officially started, a stu-

dent analyzed two bags of trash and concluded that the bag from a low-income neighborhood showed more expenditures on educational toys and household cleaners than the bag of garbage from an upper-income neighborhood. In 1973, when the Garbage Project was officially beginning, I mentioned the differences between those two bags as an example of the kind of issues we could study. A reporter from *Psychology Today* reported the "results" as facts and so has nearly everyone else who has done an "in-depth" report and found one of the early articles . . . no matter what I have said in protest. Ah, the rigor of the media!

Rule no. 3: Nothing in a reporter's conduct or character will give you any clue to the nature of the final story. I remember so well the first national TV news reporter who did a story on us for *NBC Nightly News*—Gail "something." Now there was a bad attitude! She did a quick face-to-face interview with me about 60 feet from our garbage sorting area and then locked herself in her rental car while her crew filmed close-ups of actual garbage sorters. She thought that sorting was yucky, but her story was great—done well and with respect!

On the other hand, we were extremely pleased when the staff of the *Bill Moyers' Creativity* series for PBS television wanted to do a story. Bill Moyers is a class act! Imagine our surprise when the show prominently mentioned "dirty diapers" and "black lace panties" as our more significant finds! That was what we expected from *National Enquirer*.

By the way, only *National Enquirer, Midnight, Ladies' Home Journal, National Geographic*, and *Reader's Digest* ever had staff people call us to check the facts reporters put in stories in print, and only *National Enquirer* and *Midnight* ever changed anything based on what I told them.

Rule no. 4: Always have your own point of view ready—you'll like yours better than anything media folks have in mind. You probably have a few good reasons why you are doing what you are doing. Be sure to tell the reporter; he or she may not have spent years trying to figure them out. Once you've been interviewed by someone who thinks you dispose of radioactive waste or by someone who wants to know what people in general think about aid to El Salvador based on what kinds of garbage people throw out in Tucson or Milwaukee, you'll see what I mean.

Tell the reporter that you don't know anything about radioactive waste or people's views on foreign aid. You'll sound boring, but rather than lose all the time they've already spent with you—maybe 20 minutes—they'll want to know what you think is interesting to talk about.

Rule no. 5: You will never be able to edit, or even view, the final version. Even if the reporter gives you an advanced copy—which is exceedingly rare—there is always some media person further up the food chain who will misinterpret what you said or did. For example, a graduate student was once interviewed by a newspaper reporter about a Garbage Project study of alcohol consumption. Following the student's request, the reporter gave him a full copy of his story—as submitted to his editor. It was a good story. Imagine our surprise when the newspaper article that was printed the next day was not. The editor cut out important parts (for example, assurances of anonymity to sampled households) and changed the wording from evenhanded to what I considered ethnic slurs. The Garbage Project survived without damage—perhaps because no one quite understood the new cut-and-paste editing job.

Rule no. 6: Media people have a hard time counting beyond "one." The media has always considered the Garbage Project a one-man-show. In fact, there are hundreds of people involved—student sorters, quality-control people, data analysts and managers, nutritionists, solid waste managers, market researchers, sociologists, health specialists, alcohol researchers, microbiologists, specialists in toxic substances, word processing specialists, and people to answer phone calls, faxes, and the mail and e-mail. For 27 years, there was also Wilson W. Hughes, my codirector, who designed and ran all garbage-sorting operations since the project started. For more than two and a half decades, Wilson *was* the heart of the Garbage Project, but he was often not mentioned at all in reporters' stories. One *Wall Street Journal* reporter spent four days with us, usually in Wilson's company. The result? I was the focus of his front-page story; Wilson's name didn't even appear.

Rule no. 7: Never tell anyone what to say to a reporter—whatever they say on their own will be far more interesting. Although I was very worried about

what students might say when the first reporters began to show up, I can now confess that I learned as much from the students' answers as the reporters did. "I sort garbage to relax. It gives me a fresh outlook on life." "Diapers aren't the worst. The worst ever is raw, rancid chicken." "The most bizarre thing I've found in garbage? That would have to be a frozen lizard. See, if bags are kept overnight they are stored in the freezer over there. Anyway, I put the lizard on the ground in the sun, and it thawed out in about fifteen minutes and ran away." By the way, I checked up on that story myself and found three other witnesses!

Rule no. 8: Always put on a happy face. Defensiveness is like fresh blood. If you have anything to hide, the media will most likely find it . . . if they figure you are worth the trouble. But two things will save you: (1) whatever they find will probably not be bad enough to keep anyone's attention, and (2) we Americans just seem to have some kind of moral conflict with scuttling anyone who is always smiling. One example is Bill Clinton. And always remember what happened to the people who were far more somber or even grumpy, such as, say, Richard Nixon.

Rule no. 9: Give media people plenty of freedom. They may like what you're doing, but not as much as they like their own free time. Most media people who have flown into Tucson to do a Garbage Project story have something else they want to do besides talk to garbage people—such as drive out and take photographs of the desert, drop in on an old school chum, or drink beer and eat chili for breakfast. One reporter was an exception. He loved the Garbage Project and stuck to us like glue. He actually sorted garbage (another first), he attended three special sorting sessions, he partied with us, and—oh, yes—he was fired from his job two months later.

Rule no. 10: If reporters are good, they are quick and even enjoyable. Bad reporters take forever. I remember especially well one reporter for an evening TV news magazine in Seattle. When he met me at my hotel, he was wearing a tuxedo and white gloves. I knew I was in for trouble. He drove me to a new Seattle transfer station.

Once there, this icon of fashion decided it would catch the viewers' attention if we did our interview standing in the slime at the bottom of one of the pits where the garbage was dumped. You guessed it! As we talked and filmed, a garbage truck dumped a load of debris right over us. I was resigned to my fate (a good rule in itself), but not the interviewer, who crouched to protect his rented tuxedo.

Sadly, I guess he didn't know about the water spigots that spray down each load that is dumped. As he stood up slowly, a pile of dirty paperboard boxes was pushed over on him by a stream of water that washed us both off pretty good— the media can be all wet, but it is rarely dull.

Rule no. 11: Whatever else, whenever you are out celebrating solid waste managers' contribution to humanity, drink a toast to the media . . . No matter their inconveniences, when it comes to getting a message to the public, they're worth it!

Garbage and Society

A Garbage Census

Most archaeologists have an inferiority complex—and who can blame them. Researchers who study today's societies spend their time asking "live" residents questions about what is going on and "waste" very little time looking at smelly garbage for answers. But for archaeologists, who study "dead" civilizations, garbage is about all that is left to answer their questions.

What's an archaeologist to do? Answer: Realize something that all can tossers, haulers, and all others who deal with discards on a daily basis know—that there is as much or more "reality" in garbage than in answers to interview-surveys or questionnaires.

That reality came home to roost at the Garbage Project when, in 1986, the Census Bureau asked the Garbage Project (the project) to help solve one of its chronic problems: *undercounting*. The bureau, by most accounts, has done a near-perfect job of counting mainstream Americans, but by the same accounts, its enumerators have been missing a large share of adult males among undocumented aliens and residents of urban ghettos (especially in areas where the presence of an adult male in a household

can affect welfare checks)—exactly those who don't want to be counted.

The Census Bureau came to the Garbage Project to see whether data derived from refuse could reliably be used to check the bureau's counts in problem neighborhoods. The project's job was to find out if it was possible to roughly reconstruct a neighborhood's population by age and sex simply on the basis of what that neighborhood threw away.

To an archaeologist, of course, the idea of using garbage to reconstruct population characteristics was not in the least bizarre. For most, population estimates are just the number of identified dwellings multiplied by some "magic number" that is an educated guess at the average number of residents per household.

The Garbage Project's first concern was to develop an analysis format that completely protected anonymity—no names or addresses were recorded and garbage was analyzed only by whole neighborhoods. Once anonymity was assured, the study for the Census Bureau became a search for a magic number—a multiplier that, when applied to quantities of particular kinds of garbage, would yield accurate population estimates. We began by analyzing a mass of computerized evidence acquired during studies of food consumption and garbage production from about 200 households where all residents were known by age and sex. The data were compiled by actually sorting, counting, weighing, and recording the garbage from these households (with each household's permission) over a five-week period.

The project's first task was to find the magic number for modern America that would turn a quantity of garbage into an overall population estimate.

The study quickly determined that if you multiplied a constant (the magic number) by the weight of all the garbage collected from a set number of households over a specific period of time—minus the weight of yard wastes, which varied greatly between inner city and suburbs, etc.—you could accurately estimate the number of people who lived in those households. It turned out that the categories "total solid waste" and "plastic" had the best predictive power.

The equation based on "total solid waste" is, however, less universally reliable than the one for "plastic." This is because children are responsible for less garbage overall than adults. Plastic, however, is another story. During any given period of time, every man, woman, and child seems to generate about the same amount of plastic—usually in the form of many small items. Plastic is America's great garbage equalizer!

For a neighborhood of 100 households, the projected population estimate derived from the average of "total solid waste" and "plastic" results, applied to one week's worth of garbage, was accurate to within plus or minus 2.5 percent. That is considerably better than the Census Bureau can do in many places. Overall population is only one demographic characteristic, however. What about estimates of age and sex?

This turned out to be a trickier proposition. The easiest subpopulation to identify is infants. Disposable diapers are a convenient marker, and infants go through so many of them in a week that infant diapers are an ideal item for establishing correlations.

Infant-size disposable diapers are exclusively worn by infants. But when it comes to distinguishing between men and women, or middle-aged and elderly adults, there are fewer exclusives. For example, disposable razors may indicate the presence of men, but don't necessarily do so, since women use them as well. Those items that are "near" exclusives, such as fat cigars and men's jockey shorts, are discarded very infrequently and therefore have little predictive value.

It took a considerable amount of work, but the Garbage Project staff eventually came up with an equation for estimating the number of children in a population. The estimate is based on the average rate of discard of toys and toy packages and children's clothes and packages. It was also possible to derive equations for estimating the proportion of adult women in a population, based on the number of discarded female-hygiene products, cosmetics, and women's clothing items.

Finding serviceable material correlates for estimating the proportion of adult men—the Census Bureau's ultimate objective—proved more elusive. Men are not totally invisible in garbage, but garbage is an unreliable indicator of their live-in presence. Women may drink and eat like men. They smoke cigarettes. They sometimes wear men's clothing and cologne. Even the presence of male contraceptive

packaging is at best uncertain evidence of a long-term male household member.

In the end, the best way to get a figure for the number of adult men in a given neighborhood turns out to be a backdoor procedure. First, find the total neighborhood population. Next, subtract the estimates for infants, children, and adult women from the total population estimate. The result is an estimate of the adult male population, and it has an accuracy of better than plus or minus 10 percent—and the Census Bureau has been accused of being off in its counts of males by 40 percent or more in minority neighborhoods.

A garbage "census" would clearly be a usable snapshot of low-income neighborhoods. As it happened, however, the Garbage Project never got the chance.

In 1988, the director of the Census Bureau's Center for Survey Methods Research decided that, from a public relations standpoint, "it is risky for the government to hire someone to analyze garbage." A year later, the bureau announced its decision not to adjust the 1990 census to compensate for the expected undercount, a decision that stayed in place in 2000. Recently, accounts have emerged that the "rich" are getting harder to count as well—their rate of return of census forms has plummeted and "gated" communities have not been easy for census takers to swing open.

Whatever, the Garbage Project stood ready for 2010!

Summertime, and the Livin' Is . . .

. . . wasteful? Sometimes it can be. Take "the cookout."

"Cookout" hosts fall easy prey to the "Good Provider Syndrome"—they prepare much more food than their guests will ever eat. For most everyday meals, the leftovers can be gleaned, stored, and served again; but cookout foods are different—they seem less deserving of conservation after a few hours over untended coals or under oppressive heat, splashes of pool water, buzzing-whining insects, and the misdirected sprays of repellents that seem more noxious to revelers' noses than to targeted pests. Then there are the huge quantities of condiments, which no matter how carefully they are separated for self-dispensing, always end up as six containers of the same reddish-yellowish-greenish-goo-with-little-lumps.

There are no easy answers to this kind of food waste. One option is to place smaller portions out in the first place, be willing to replenish any supplies that run low, and be equally willing to allow a few pseudo-friends to think that you're being cheap with the goodies.

Of course, the waste of some cookout foods seem predestined. Why is it, for example, that hot dogs are almost always packaged in sets of 10 and hot dog buns are invariably bundled in sets of eight? I know the reasons behind the decisions are logical within the realm of each product category. Once you've sold hot dogs in packs of 10, it is hard to "go back" to packs of eight when the price differential is not great—people will still buy the 10-packs because the price is lower per hot dog. A package that has five buns across would be unwieldy; and, if the buns are stacked in three layers, what do you do with the odd bun that's left over? But, come on, guys. Where's American ingenuity when we need it?

But that's just the food, which is much less than half of cookout discards by volume. Don't forget all of those soggy/greasy napkins or the disposable paper/plastic plates on which much of the food is stuck. But, waste-wise, drink containers are the worst. Cookout attendees transform into addlepated amnesiacs who can't, for the life of them, remember where they put their last beverage—so they trudge back to the dispenser for another. The result is that a cookout for 15 to 20 friends can easily leave every raised horizontal surface in a backyard covered with 50 or more cans or cups, all partially full of some kind of fluid. While parties at home for 70 or more guests are extremely rare events, a biweekly garbage pickup in Tucson that includes more than 70 disposable cups is not all that uncommon. (Note: if smokers have participated in the festivities, many of the abandoned cans and cups will have become cigarette depositories, which raise an unbelievable stench to the heavens. I can appreciate the aroma of a good cigar and of cigarettes under certain circumstances, but even heavy smokers are appalled at the aroma of cigarettes floating in flat sodas or stale beer!)

"Cookout amnesia" is one of the reasons why the flow of the household refuse stream is so much

heavier in the summer than in the winter. In the past, much of the blame for this was placed on cans and bottles that once held beverages, but many of those containers are now recycled and the tidal wave of summer solid wastes has not abated.

The summer "cookout," for example, is one of the clearest cases where recycling alone just doesn't cut the mustard, literally—no recycler wants plates drenched in a ketchup-mustard-relish mix or cups still awash with soda, beer, or goodness-knows-what.

At this point, source reduction can step to the fore. I toyed with the usual scenario of suggesting that those planning cookouts should lay out their regular plates, silverware, glasses, etc., and wash them. But I wouldn't use that kind of stuff outside myself. No. The answer has to be the same as it is with most solid waste problems—convincing people to take responsibility for their own actions.

Disposables serve a useful purpose at cookouts; but except for the occasional "act of God," one set of plates and utensils and one drinking vessel should be enough for any attendee. This kind of sanity, of course, is rarely encountered when sorting through household refuse. The usual scenario is far more cups than plates, most often at a ratio of 1.5 or more cups to every plate. How can this ratio be reduced and discard sanity be restored? With a little inconvenience (not much, really) and maybe a little added fun.

Try tethering a few magic markers (don't just leave the magic markers out loose) at critical implement-dispensing points. Ask each guest to mark their cups—nothing complex, just an initial or a symbol. Each guest will only have to do this once. In this day of AIDS and Ebola, most people are willing to play along. Think, for a minute. If disposable cup use is averaged across all households, then the quantity discarded is equal to each household throwing out one disposable cup every week; but in reality many refuse pickups have no paper cups, while about one-third of the refuse pickups with disposable cups contain more than 20. If cookout/party guests use just one less cup per person per cookout, because they can identify their own from among a raft of others, this simple act could reduce summer garbage by literally millions of disposables. There are, at present, about 70 disposable cups discarded every year from every household; that places disposable cup discards nationally in the billions. Some magic markers and some forethought might reduce this number significantly.

Now, if we can just figure out how to keep the magic markers from getting trashed in the process!

I've got it! How about asking one of your kids or a neighbor's kid to do the marking? The added side benefit to this is that kids may enjoy the game, especially if they are trying to "save the Earth." Even better, if any of your guests think that the idea is a little weird, you can explain that it's the kid's school science project . . . and maybe it should be.

Forget the X-Mess

The start of the new year seems to me to be a propitious time to ponder our garbage woes. The media and concerned environmental, government, and citizen groups have identified a litany of causes of rampant refuse:

1. Overpackaging, especially nonfunctional peripherals whose purpose is to attract attention.
2. Disposables, nondurables bought for one brief use followed soon by discard.
3. Nonrecyclables, items that are not easily recyclable, such as multimaterial packages or materials that are impervious to reprocessing or composting.
4. Overconsumption, the "buy, buy, buy" mentality that leads to peripatetic exploitation of limited natural resources to satisfy largely artificial desires.

The list continues, of course, but these four causes embody the public perception of the prime culprits responsible for the "Garbage Crisis." Obviously such self-serving wastefulness must be eliminated. The most visible responses have been bans, mandatory recycling legislation, and various high-minded goals for refuse reduction. Despite this sound and fury, however, the American garbage juggernaut rolls on undeterred, while some recycling programs are mired in "gluts" of recyclables and most waste reduction schemes drift along without tangible results.

What is needed in America now is a potent focus for action, an unequivocal example of the way we

can each make significant garbage reductions. To this end, I offer a modest proposal: There is one yearly holiday of outrageous conspicuous consumption that carries upon its back the full embodiment of all the garbage glut culprits—X-mess, the material encumbrances of Christmas. Get rid of them! Keep the "spirit" of Christmas, but forget the X-mess.

The rationale is child's play; pointing to X-mess X-cesses in garbage generation is easier than finding refuse in a landfill.

No. 1. Overpackaging: Ribbons, bows, bells, sprigs of this and that, cut-outs, gift cards and envelopes, and all the wrapping paper itself are piled one on another on top of already existing packages that are clearly sufficient in themselves to contain and protect their contents. Talk about superfluous overpackaging! It is true that some people methodically save and reuse wrappings, but down at the garbage sorting yard we have yet to find post-X-mess trash without substantial quantities of ripped and mangled wrappings. The environmentally responsible message: say NO to X-mess wraps and associated doodads.

No. 2. Disposables: If there is anything garbage sorters find more than X-mess wrappings, it is X-mess cards. Each year the U.S. Post Office shuffles more than 2.5 billion around the country. Many are sincere yuletide greetings from dear friends, others are from acquaintances who hardly know each other, and almost as many more are solicitations in the guise of salutations from insurance salesmen or realtors. Even the most refuse-reduction-minded environmental groups send out greetings—on recycled paper, of course, but they still use inks nonetheless. And virtually all of these paper sentiments (except the ones plasticized or lacquered onto placemats and TV dinner trays) find themselves joining yesterday's newspapers in the trash. The environmentally responsible message: send X-mess cards sparingly.

No. 3. Nonrecyclables: Multimaterial items are usually difficult to recycle; and X-mess wrappings are virtually all multimaterial commodities—a potpourri of plastic films and coats applied to a variety of paper stocks, covered with tapes and adhesives, and topped with a multitude of mixed-media confabulations. Recycling? Is that a joke?

Have you even wondered why X-mess trees are referred to as "live"? After all, these green symbols of nature and rebirth have been doomed to an artificially prolonged death under an odd assemblage of trinkets and flashing lights in our living rooms. And when their short use-"life" is over, they're garbage history. Once the vast forest of X-mess trees that come to adorn garbage cans at each year's end was noticed, the solution seemed obvious—composting.

But experience found X-mess trees often seemed intractable to rapid degradation. In many communities they are now mulched; but their sap has sometimes gummed up even those works. As a result, some compost operations won't accept X-mess trees, and the only semi-"natural" component of X-mess grandiosity has become a small thorn in green waste's side.

The environmentally responsible message: if you must have an X-mess tree, decorate a tree in your yard, buy a potted tree to decorate and plant it in your yard later, or buy a "fake" reusable X-mess tree; and, once again, don't wrap.

No. 4. Overconsumption: X-mess has become the most sacred and supreme legitimization there is for buying things we really don't need. Actually, the X-mess superconsumption ruse is a clever one. You buy extravagant gewgaws for others; they buy extravagant gewgaws for you. The guilt of conspicuous consumption is smothered and dissipated within the act of gift giving in the Christmas spirit of love and generosity.

Few people need most of what they get for X-mess. In fact, Joel Waldfogel, a Yale professor of economics, calculated that last Christmas gifts worth as much a $1 billion were unwanted and doomed to attic, basement, garage, or garbage oblivion—that musical tie rack, for example. X-mess's almost divinely blessed presents are like giving grossly fattening foods to someone who is overweight. Wait a minute! They are not *like* that; at X-mess, such gifts are commonplace. The environmentally responsible message: shun the giving and getting of X-mess things; instead, show love and caring by giving of your time—it is far more precious and will not end up in a trash bin.

These are all good reasons to relieve the blithe "Spirit of Christmas" of its heavy material trap-

pings, so many of which are just garbage waiting to happen. Keep the spirit, but get rid of the mess.

I have just reread the preceding lines, and I wonder whether I can be really serious. No glorious excesses at Christmas? I will admit to being in the grip of a post-Christmas letdown, heightened by the arrival of late Christmas cards sandwiched in-between charge-card bills. Maybe I'm a Grinch because I didn't get the toy garbage truck I wanted. Hum, come to think of it, all is not lost—there's always next X-mess.

Princess Di & Mother Teresa . . . Staying Alive in a Material World

To most archaeology buffs, the treasures in Tut's tomb are synonymous with ancient Egypt, and the life-size army of clay figures that surrounds the tomb of the first emperor epitomizes China's past. In fact, nothing seems to strike a more resonant chord for the public than the elaborate monument and elegant burial goods surrounding an individual interment. Today, our society is rather different. We memorialize our most important dead with mass-merchandized items that often quickly enter our waste stream.

I was first stuck with this irony as I watched parts of two funerals that were televised "live" worldwide within a matter of days of each other in 1997: the September 6th burial service for 36-year-old Princess Diana, who was killed in a Paris car crash and the September 8th farewell for Mother Teresa, who died at 87 of a heart attack in Calcutta.

These two world-stage women were memorialized by vast quantities of mass-marketed materials. Once they are discarded, as almost all of them will be sooner or later, archaeologists in the future will dig them up. What will they think of these two women based on their refuse legacy.

Today's landfills, which rival arid deserts in preserving the most fragile of objects, are one important key. At least in landfills in the United States and England, a short-lived supernova of Di-marked materials (tabloids, newspapers, magazines, and, in England, plastic margarine tubs emblazoned with her signature) will be generously dispersed within a few layers of solid wastes. Even if only relatively indestructible materials survive, such as souvenir coffee mugs or the commemorative portrait plate with a 22-karat gold border that was prophetically titled "Diana Forever," Princess Di will be gaudily visible. In contrast, Mother Teresa's immediate material traces, in the form of holy cards, posters, and medals, are more likely to be saved as religious heirlooms and enter garbage—or, as my colleagues call it, "the archaeological record"—only sporadically over time.

The dichotomy between the archaeological celebrity achieved by Princess Di and Mother Teresa may be even more striking, since at present it seems that they and their paraphernalia appeal primarily to two distinct populations—Mother Teresa to the inhabitants of less-materially developed nations and Diana to those of us who are materially better off.

This contrast in material traces was hardly foretold in their burial rites which were similar in several ways: (1) both women were referred to as being either a "saint" or "saintly" (2) both interments were "covered" by global media as well as hundreds of thousands of local mourners and security forces, (3) both women were given "state" funerals, and (4) hordes of the world's mighty and nearly so (such as Hillary Rodham Clinton) flocked to both interments.

Despite these similarities, there were significant differences as well. For example, this past summer Di's final resting place was opened for tours—the admission charge to the Althrop estate, where Di is ensconced in an unmarked grave on a small island near a memorial temple, is $15.75. Well over a year later, the concrete slab over Mother Teresa in Mission House in Calcutta is not open to the public and may never be.

There are also major contrasts in the manner in which Mother Teresa and Princess Di achieved "sainthood."

Calcutta's Reverend Mother did it by "the book." Although arrows, knives, fire, lions, and upside-down crucifixion didn't martyr her, she did wash her own clothes by hand and, most often, ate simple food cooked over a dung fire. In 1950 she founded the Missionaries of Calcutta, and, throughout the next 47 years, drove herself to accomplish its goals. After a life of humbling herself to help God's most wretched and thereby winning a Nobel Peace Prize, how much time can elapse before canonization officially elevates Mother Teresa beyond the realm of mere mortals?

At the other end of the spectrum, Diana achieved popular saintdom in spite of "the book." The epitaph in her memorial temple, a quote from an interview she gave to a French newspaper, reads "whoever is in distress can call on me, I will come running wherever they are." This role of international champion of society's most vulnerable was fixed in the public's mind by the media long before her demise. But so was a life that embodied a panoply of human frailties that were rudely exposed week after week in supermarket tabloids: the anorexia, the affair, the cheating husband, the divorce, the kiss-and-tell TV interviews, the slightly rumpled playboy suitor, his intoxicated driver, and, of course, the ever-present, ever-irritating paparazzi.

In spite of all this, Di's final send-off, one that has been rivaled only by the observances for the assassinated President John F. Kennedy, gave unexpected substance to the public's emotional response to the princess. As sociologist Al Bergesen (University of Arizona) observed, Diana is a saint-in-the-making the old-fashioned way: "coronated by the people, not by a jury of experts." Why the instantaneous elevation of someone so flawed? Archaeologist Mark Leone (University of Maryland) suggested to me that "the notion of sainthood is very alive today, not because of Mother Teresa, but because of the contrast between Mother Teresa and Princess Di. Diana made herself a model of Christian behavior despite the fact that she sinned and, as an active participant of our material world, lived with the inevitability that she would sin again." My interpretation of these thoughts is that Diana was a living (or just deceased) handbook on *how to become a saint without renouncing—yeah, verily, while still fully embracing—worldly pleasures*.

At present, no one can tell whether Mother Teresa's memory will produce a garbage record for future archaeologists that rivals or even surpasses Princess Diana's.

Once sainted, Mother Teresa will surely continue to generate artifacts, especially in the third world. But how visible will Mother Teresa's material garbage heritage be to future archaeologists? The vast majority of her remembrances in materially deprived countries will be saved as heirlooms; those that aren't will be subject to scavenging and substantial decay in open dumps. On the other hand, a currently available "Mother Teresa Wall Hanging" (featuring a quote by the nun over a glowing kitsch village) and a "Mother Teresa Memorial Wooden Dollar" (in a limited LASER-engraved edition) represent the beginnings of the nun's own memorabilia industry in the United States, one whose remnants will be well preserved in dry landfills.

For Diana, a saint of the people in the highly industrialized world, there is no certainty of material continuity. Was her instantaneous elevation due to media puffery or to lasting public emotion? This question will be academically debated for some time. The only sure proof will be the number of future offerings of Di stuff in massive "limited," or just plain massive, editions, which will pump garbage into landfills in the next century and beyond. Regardless, the instantaneous eruption of Diana-related materials that already mark a garbage horizon around her death are currently the most appropriate symbol of the explosive sentimentality of our age, the economic machinery that feeds it with memorabilia, and the vast dimensions of the electronic and print media that is one of the most potent reasons we are so explosively sentimental.

Things have certainly changed from the days of Tut and Pacal, when the physical structure and accoutrements surrounding the burial were the key to lasting fame in the public arena. Today no edifice or offerings are required. The key to the dead "staying alive" in the present is the mass media and mass merchandisers who literally thrive by materially enshrining others' lives. Given these materials, the key to "staying alive" in the future is how rapidly a large number become entombed in the archaeologically esteemed realm of garbage. Ironically, that which is fleeting and discardable can pave the road to immortality.

Garbage Art

How often have you heard, "That piece of 'art' is really *garbage*!" From Robert Maplethorpe's sadomasochistic photographs to Damien Hirst's literal slices of a cow encased in plastic and lined up in a row like so many slices of bread, it is clear that what is good "art" is in the eye of the beholder.

Recently, I have begun to say that "art is garbage" more often and mean it literally; and, of course, *I* mean it as a compliment. Garbage art—

pieces of creative, colorful eclecticism and beauty constructed out of what would otherwise have been thrown away—is today at the cutting edge of the avant-garde art world. I was recently at the Works Gallery in Philadelphia for the opening of an exhibit of "recycled art" by 25 artists, where a set of coffee mugs reminded me that I was in need of the same. The four mugs, crafted from Maxwell House cannisters, were just the thing for a *garbologist*! My raised ardor was dampened only by the price—$400. Are the creators of recycled art crazy? The answer to that question also depends upon how you look at art from discards.

I was first introduced to "garbage art" in 1975 when the Garbage Project received equal time with a garbage artist on the first of a series of Bill Moyers's television shows on "Creativity"—it was the first in the series because Moyers figured that if people could be creative with garbage, they can be creative about anything. The Garbage Project also shared the spotlight with garbage art in an article in *National Geographic* in April 1983. (Actually, we didn't *share* the spotlight—much of the article, as well as the cover of the issue, centered on the fantastic collages of "found garbage" by the artist Larry Fuentes.)

To me, the most authentic and eloquent garbage art is the folk art of rural and materially impoverished people the world over. In these conditions, basic necessities are often fashioned out of richer folks' castoffs. The imagination and heart of the results is best illustrated in an exhibit and accompanying book (Harry N. Abrams publisher) titled *Recycled Re-Seen: Folk Art from the Global Scrap Heap* (designed by the Museum of International Folk Art in Santa Fe and now traveling). My personal favorite is a "water carrier" from Marrakech, Morocco, which fashions the rich black rubber of old tires and some silverish studs into the elegant shape of traditional copper canteens. The toys—something all children need—are equally marvelous—from a Citroën car constructed from the sheet steel of tin cans that were misprinted (in Johannesburg, South Africa) to a nonplaying plastic radio covered in fabric, beads, and plastic Coca-Cola bottle caps (created by an unknown Zulu, also in South Africa).

While less functional, garbage art in the industrialized world is no less dazzling. Aluminum cans are always a popular medium for creating anything from a 100-foot-long, three-story-high replica of the Basilica of St. Anthony (Padua, Italy, 3,245,000 cans) to a 15-foot-long American eagle, which required five different can smashing techniques to properly simulate the feathers (July 4, 1990, float of the College Church, Wheaton, Illinois, 11,000 cans). On a smaller scale, gallery shows of recycled art celebrate a never-ending range of creativity in sculptures (often forming animals out of discards), lamps and furniture festooned with further garbage appurtenances, and pieces of jewelry dangling everything from safety pins to pieces of phonograph records.

All of these garbage arts are wonderments. But what message are they sending to society at large? That we are wasteful. Sure, but to whom is that news? That many things that are discarded can be recycled or reused. Yes again, and right now 12,000 curbside programs across the country are filling the markets for recyclables to overflowing. But is garbage art going to utilize a sizable portion of recyclables itself? No. How many basilicas or giant eagles are we or our artists going to build each year? Besides, I believe that anyone who is regulary intimate with refuse would find many of the discards used by garbage artists to be in remarkably good shape—colors bright and shapes mostly undented with designs and logos that are usually rare and often already collector's items. Perhaps part of the art is painstakingly resurrecting raw refuse materials into usable condition. If so, who other than artists has the talent or the time?

And that brings me to price again and my question about the sanity of garbage artists. I can't answer the question for individual artists, but I believe I can for the role they are playing in our society. Yes, crazy like foxes.

In a book called *Rubbish Theory: The Creation and Destruction of Value*, Michael Thompson (Oxford University Press, 1979) proposed the idea that the value of particular artifacts goes through cycles. When an item is new and rare, it can be extremely pricey. Because only wealthy people can afford such an extravagance, it becomes associated with wealth and attains a patina of glitzy prestige. When everyone wants something, however, there is usually a manufacturer who will expand production capacity, thereby lowering the cost of each

item produced, and then mass-market the results. Once the coveted item begins to reach the masses, its downfall is sealed. Soon no one wants it, and it becomes "junk."

This is where rubbish theory caught my interest. The next and most critical step occurs when society's "trendy" people pick out pieces of junk as symbols of their own unique vision and style of life—the junk they select immediately stands out because it contrasts so markedly with everything else in the trendsetter's world. Such anointed artifacts then become the new "collectibles" and proceed through the cycle again—first salvaged from junkyards or garbage and then emulated in "replicas."

Where are recyclables in Thompson's scheme? As far as I can tell, they aren't. Once an artifact starts to make a comeback, it makes that comeback as the original artifact or as an "authentic" replica made from virgin materials. Yes, for devout collectors, one-of-a-kind Citroëns are great "finds." Nevertheless, while some folk arts have reached a few consumer catalogs, they are usually carvings from fresh wood or other virgin materials. Americans today are comfortable buying a newspaper or a soda can with recycled content, but as a statement of personal style and position, most people see recycled materials as something to wear to a costume party.

This condition seems to explain the fate of the clothier who marketed a completely "environmentally friendly line" as part of its fall 1993 "Ecollection." The centerpiece was a Donegal tweed gardener's jacket rewoven from "postconsumer sweaters." It failed miserably. Or consider the bumpy downhill ride taken by "Déjà Shoes"—a great name for sneakers and court shoes fabricated entirely out of recycled materials.

Such shoes are the pride of a few dedicated environmentalists I know, but the people who buy the vast majority of shoes are out to be shod with the ethos of a high- or low-end designer or superstar of sport. It's good to recycle, but in most social settings a personal style set by recyclables engenders no aura of elevated position.

Because of garbage art, I believe that attitude is about to change.

Recycled art has been commonplace in flea markets and swap meets for generations, but it is just now breaking into art galleries and catching the attention of their glittery clientele. As our most elite consumers pay "outrageous" prices for objets d'art made out of recyclables, clothing and other mass-market items will thrive on recyclables' newfound panache. Let garbage artists charge what they will—they will have earned it by thrusting recyclables into Thompson's scheme and opening a new mass market for a range of products made from what would otherwise fill up our landfills.

Now, how much do I want those coffee mugs?

America's Authentic Time Capsules

There are a limited number of people who respect refuse and what is done with it in our country. I can accept that, but one thing that particularly appalls me is that after landfills are appropriately covered over, designers outside the refuse industry go to extraordinary lengths to hide what landfills are—large deposits of relatively well-preserved garbage.

As an archaeologist who describes and interprets societies based upon both the nature and treatment of the material remnants their constituents leave behind, I believe that our landfills deserve the same respect as other time capsules—probably even more! I'll explain.

Recall the thousands of communities, interest groups, corporations, and families that busily squirreled away time capsules to mark their place as Father Time crossed the threshold into 2000.

All of these dedicated "capsulers" went to great efforts and along the way must have asked themselves, "Will my time capsule be found? Will the contents of my time capsule be preserved? Will the contents I picked provide people in the future with an accurate glimpse of our lives today?"

I have come up with some answers to these time capsule questions that provide ample reason to reconsider the role of landfills as crucial in presenting our society to the future.

The term *time capsule* was coined in 1939 to christen a torpedo-shaped seven-and-a-half-foot-long container interred 50 feet below Flushing Meadows Corona Park during the 1939 World's Fair. Westinghouse Electronic & Manufacturing Company, which was lagging badly behind its chief rival, General Electric, created the time capsule to attract publicity and spur sales (which it did!). The outer shell, meant

to be opened some 5,000 years in the future, was constructed of a copper-steel alloy enclosing a six-inch-thick Pyrex glass case. The inert gas inside surrounded 35 common household artifacts—including chewing gum, a fountain pen, a tobacco pouch, cosmetics—all carefully selected to give future folks a glimpse of American life 1930s style.

Time capsules probably date back to the carefully laid-out caches that dedicated the first human-made structures (the descendants of these caches are the items placed in the cornerstones of modern buildings). But the first such legacy that clearly had posterity in mind was bequeathed by Esarhaddon, the 7th-century B.C.E. King of Bablyonia, Assyria, and Egypt. Contents included not only a list of his conquests but additional inscribed clay tablets that described many aspects of his entire civilization.

The golden age of time capsules, in which some pundits insist we now live, began in 1938, when Thornwell Jacobs, president of Atlanta's Ogelthorpe University, began filling his 2,000-cubic-foot "Crypt of Civilization"—a kind of Noah's Ark of Depression-era knowledge and technology. Among its thousands of contents are dental floss, the phonograph voices of Adolf Hitler and Popeye the Sailor Man, a toaster, William Shakespeare's known works, and a carefully sealed ampoule of Budweiser beer in honor of the beer (long since evaporated) that was left in pots in Egyptian tombs. The crypt is supposed to be opened in 8113.

When the crypt was sealed on May 25, 1940, Jacobs opined that we "are the first generation equipped to perform our archaeological duty to the future." Following Jacobs's lead, the *1990 Guiness Book of World Records* called his capsule "the first successful attempt to bury a record for any future inhabitants or visitors to the plant Earth."

By the early 1950s, the interment of time capsules, like much else in America, was a mass phenomenon—a consequence, perhaps, of the psychological shadow cast by the dropping of "the bomb" at the end of World War II, although the trend also correlates with the postwar upsurge in building permits. As the millennium approached, Paul Hudson, a history professor who cofounded the International Time Capsule Society and has now registered more than 1,400 deposits, said, "America is going Time Capsule crazy."

Millennium capsules ranged in scope from large-scale to diminutive. In New Zealand, for example, a huge "Millennium Vault" stuffed with the bric-a-brac of everyday life was buried beneath a pyramid covered by a bronze relief depicting 1,000 years of the island's history. Half a world away, in Winslow, Arkansas, machinist Lane Baumgardner produced what he called the "U.S. Time Capsule," a massive complex of four pyramids that arose between Fayetteville and Fort Smith, that was capable of safeguarding 25,000 1-foot-by-2-foot troves of objects, 500 from each state, that would let the future know, "I was here in 2000!"

At this do-it-yourself level, quite a number of companies and individuals shared Baumgardner's vision. Future Packaging & Preservation, a company in Covina, California, sold upscale capsules for "professional preservation." Just before the millennium, business was booming, with sales—at $5,200 each for a 30-inch-long, 14-inch-wide capsule filled with silica gel or preservation gases—expected to reach at least 50,000 before January 2000.

Because of companies like The Time Machine, Inc., a more-modest personal time capsule was offered within the financial reach of most Americans. For a mere $19.95, the capsule consisted of a stainless steel box—about the size and consistency of a tin for Christmas cookies—with pamphlets suggesting contents and a chart "telling how long various materials will last when buried" that reckoned that a VCR tape would endure 10 to 15 years.

Does this "time capsule mania" mean a windfall for archaeologists? In fact, for a number of reasons, the odds against doing one's personalized "archaeological duty" are substantial.

Will the Time Capsule Be Found?

Take the townspeople of Wilkinsburg, Pennsylvania. To commemorate their centennial, in 1986 they decided to exhume a time capsule buried only 25 years earlier. Unfortunately, the capsule had been laid to rest by a select committee, all of whose members were dead. "Chick" Ake, 87, recalls that the committee met in secret session to decide where to bury the time capsule and that subsequently they "didn't tell anyone." After days of digging turned up nothing, Chick Ake wrote in his diary: "Oh, well."

Wilkinsburg's time capsule, along with a myriad others, including 17 deposited in and around Corona, California, and the *M*A*S*H* TV show's capsule buried in 1983 under a Twentieth Century Fox parking lot, have yet to be found.

Unusual? Not really. Professor Hudson's rough estimate is that at least 1,000 time capsules are filled and forgotten for every one that successfully conveys its cargo to future generations.

Will the Contents of the Time Capsule Be Preserved? Due to unanticipated consequences, when a capsule is ceremoniously unearthed, the upshot is often disappointing. Upon completion of the Empire State Building in 1931, a time capsule was deposited in the basement. When it was exhumed 50 years later, it was filled with water—the contents had dissolved. Again, not unusual. Oh, well.

Will the contents of time capsules provide people in the future with an accurate glimpse of our lives?

Even if burial sites did not vanish and materials did not decay, we lack the necessary prescience to anticipate what those in the future may most want to know.

In 1986, I attended the public exhumation in Tucson, Arizona, of a time capsule buried 25 years before at the "Grand Opening" of Campbell Plaza, the first air-conditioned strip mall in the United States. A former mayor was on hand as the master of ceremonies, and three television crews recorded the proceedings. The occasion turned out to be a disappointment. The capsule contained only a faded local newspaper (in worse condition than many I've witnessed being excavated from the bowels of landfills) and some business cards. A short while later, in 1989, a time capsule that had been in Boston's Faneuil Hall since 1889 was found. Its contents: a couple of crumbling newspapers and the business cards of city officials. A century of earth-trembling innovations in American lifeways was commemorated by the same pedestrian contents. Oh, well.

Somehow, the most compelling aspect of time capsules seems to be the burying of them, the marking of our spot. At some level, conscious or not, most time capsules seem intended less as messages from ourselves to the future than as messages from ourselves—self-congratulatory or cynically commercial—to ourselves.

In its most common and rudimentary form, the time capsule offers the sustaining, if for most it is an illusory, reassurance that those associated with its contents have won some small niche in history. As such, most capsules embody personal identities, not the large-scale changes in our culture. But perhaps capsules have been as they should be. For the first 5,000 years of civilization, a lasting material legacy that identified an individual was reserved for the most politically powerful of the rich and famous of their time, like King Tut. Today's "personal-sized" time capsules democratize the chance—no matter that it is one in 1,000—that something material from a particular individual will be immortalized in some museum. For future archaeologists these artifacts will add an interesting footnote on personal hubris in the 20th century.

But for those who worry that the rest of our culture's story won't be told, I have good news. The authentic time capsules of American society are not a few bits and pieces of particular lives and interests that are rather arbitrarily selected—just as Egyptian texts were biased because scribes wrote down what was in pharaoh's best interest. The artifacts that will fully represent the way we lived are currently safely stored inside mega–time capsules, which we call landfills. Inside are accreted and preserved most of the billions of material remains we discard in our daily lives—the good, the bad, and the ugly from all our activities at work and at school, at home and at play, with friends and with family . . . the empty container of "reduced fat" double Dutch chocolate ice cream, the half-full container of pesticide, and the "recyclable" aluminum can that someone didn't recycle. And no larger landfill exists than the 3,000 acres of Fresh Kills, perched on Staten Island only a few miles from the Westinghouse time capsule. It is the myriad anonymous remains of the day that formed Fresh Kills that will tell the future about 20th-century American lifestyles—not what Westinghouse or Ogelthorpe University selected for their own self-serving purposes.

Furthermore, landfills are the most ideal time capsules because they won't get lost; for the most part, their contents will be preserved; and, when decades from now archaeologists dig into them,

the exhumed treasures will give the future an unbiased glimpse of the material realities of 20th-century life.

So, if you collect garbage or manage a landfill or are involved in anything similar, the next time someone asks you what you do, tell them that you bury and maintain the contents of the largest time capsule in _____ (fill in the blank). As an archaeologist, I believe that is a really important job . . . and anyone who has ever been curious about what was buried in any other Time Capsule must surely agree!

Current Events

The World Trade Center Atrocity

I am an archaeologist, a garbologist, and something of a solid waste specialist, and I have always believed that all such workers can make valuable contributions to modern society. But on the morning of September 11, 2001, I couldn't think of a single thing any such specialists could do to change the unfolding catastrophic events and relieve anyone's suffering.

I am still not sure just how useful people with my specialties can be in the aftermath of those unimaginable terrorist acts, but I know that we can do and say some things that are relevant.

On Sunday, September 16, Professor Tom McGovern, head of the Bioarchaeology Laboratory at Hunter College in New York City, sent an e-mail to scores of archaeologists. "After hearing of disaster workers in Lower Manhattan combing through buckets of debris by hand," it began, "Dr. Sophia Perdikaris has contacted the FBI Evidence Recovery Center . . . and offered the help of archaeologically trained sieving teams to speed the work. The FBI is very interested in getting our help, and has asked Dr. Perdikaris to organize teams."

Volunteers were needed with experience in supervising screening teams, along with a hard hat, respirator, goggles, work gloves, heavy boots, and any available screens. A day and a half later, 600 archaeologists from the tri-state area (New York, New Jersey, and Pennsylvania) had volunteered. Archaeologists are often called detectives of the past. That's right, but the same skills and equipment can be applied to contemporary crimes—and, as every archaeologist knows, screening will find many more tiny pieces of evidence than will sifting debris and ash by hand.

Another area of special expertise among archaeologists is memorials that have lasted millennia. As an archaeologist, I have learned that most of the longest-lived monuments of the past—from the Great Pyramids of Egypt to the intricate temples of the Classic Maya—were raised as memorials and resting places for the most honored dead. But not all recent memorials can stand the cruel tests of modern times.

In 1995, an elegant, rose-colored granite circle was laid in an open space between the two World Trade Center (WTC) towers. Carved into it were the names of the six people killed by the 1993 terrorist bomb at the World Trade Center. No one knows what shape that monument will be in when it is finally dug out from under the rubble. But a more important question is: what can be done now to suitably mark for the ages the passing of these six victims of terrorism —and the thousands more who have now joined them?

Certainly there will be a memorial where the WTC once stood, but public sentiment seems to also require a structure that functions much as the World Trade Center did at the site, something to stand as a symbol that the United States will not be intimidated. But shouldn't there also be a separate, grand, and long-lasting monument that reminds us of the bravery and the suffering of the victims and their families?

As both an archaeologist and someone familiar with modern solid waste handling, I believe that one means of honoring these victims is provided by the site the FBI is using to analyze the World Trade Center debris: Fresh Kills Landfill on Staten Island, which was officially closed last March. As someone who has dug 14 cores from Fresh Kills to learn about its insides, I can tell you that this refuse repository is a very special place itself. The landfill's unfortunate name (which comes from the Dutch word for a small stream, *kill*) will be changed in the closure process that transforms the site from

mounds of waste to a community resource for recreation, education, and remembrance.

The World Trade Center was easily visible from Fresh Kills. In fact, the opening photo in a *National Geographic* story on landfills captured an image of the giant twin towers looming behind a bulldozer spreading refuse at the landfill.

And now the victims and Fresh Kills are intimately linked in another way. As uncomfortable as it may make us feel, the shattered remains of many of the terrorists' victims will likely go with the World Trade Center debris to its final disposal site. This fact makes all the debris very special. It should not be just buried and forgotten.

And there is a huge mass of material to dispose of—or to use in building a commanding memorial. Based on a standard rule of thumb used by demolition contractors, the debris will be in the range of 60 million cubic feet, and this doesn't count family pictures, diplomas, and photos of honor, and a myriad knickknacks, as well as the tens of thousands of desks they rested upon. All of the construction steel in the debris is being recycled, and all personal items will be returned to relatives, but that will still leave 30 million or so of cubic feet of material—that is about the same volume as the largest archaeological monument in the New World, the Temple of the Sun at the archaeological site of Teotihuacan outside Mexico City.

An inspiring memorial of a vicious and tragic day could be built at Fresh Kills out of these hallowed artifacts. Just as the sunken and untouched USS *Arizona* represents the victims of Pearl Harbor's day of infamy, so would the WTC debris represent the victims of terrorism and the indomitable spirit of America.

There is historical precedent from ancient times for such a memorial. In 409 B.C.E., the Athenians built a great mound out of stones, debris, weapons, armor, and their fallen soldiers after the battle of Marathon, where an invading Persian army was defeated. That mound literally and visually commemorated the fighting spirit of Athens and its allies.

Clearly, something memorable could be fashioned from the WTC debris. And given the immense size of the landfill site—3,000 acres—the positioning of the monument could be memorable as well. The monument would have its own clearly separate space with the skyline of New York behind it, where the memorial will not intrude on other facilities and open areas, but visitors can have their own secluded space for private thoughts.

The remains for the memorial will be mainly concrete and ash. And as archaeologists know from experience, if it is not deeply buried, that ash will begin to support plant life. Thus, the ash and concrete will symbolize regeneration by turning green with new life every spring.

Some might find a landfill an unfitting place for a memorial. But Fresh Kills enshrines an honorable material legacy, one that represents the "remains of the day" of millions of New Yorkers between 1948 and 2001. This anonymous refuse holds remnants of all that New Yorkers did with family and friends, at work and school, at play and at home. It is a fitting place to memorialize the terrorist victims who, until September 11, 2001, were like you and me, living out their version of the American Dream.

All Americans, and especially those of us who are familiar with handling solid waste, could be proud of their part in honoring a memorial with that resonance.

Scavenging the Big Apple's Core

Mexico City has at least 10,000 *pepenadores* (literally, "vultures" or "scavengers"). Cairo has it's *zabaleen*, mostly Coptic Christians who glean the dumps. Manila has residents who specialize in picking trash on "Smokey Mountain."

Bombay has more than 100,000 scavengers who scrounge daily at the world's largest open dump. Everywhere in the world, the fringes of society recover reusable and recyclable discards. Is the United States any different?

No. Every major city has a cadre of scavengers who follow regular rounds to pick over garbage after it is placed out for collection. In America it isn't easy for highly professional waste collectors or recyclers to appreciate the scavenging lifestyle. This is especially true because many scavengers see garbage collectors as rivals who ruthlessly carry away unpicked treasures.

Nonetheless, solid waste professionals can gain some worthwhile understanding of scavengers by meeting them up close and personal. Today, there is an easy way to be introduced—a new video called

Tossed and Found. Producer-director Donald Blank has burrowed into the underbelly of New York City to display 44 minutes of conversations with the denizens of the megalopolis' teeming underground economy. Blank's video has succeeded in immortalizing many elements of the urban scavengers' world:

Good super/bad super scenarios: Ralph, a middle-aged Hispanic, is a super with an "attitude" toward the homeless: "These people live in the street . . . break all the bags and throw the garbage in the streets . . . Its very inconvenient and very annoying that we can't get no help from nobody in this situation."

This doesn't bother Jorge, a 40-ish Hispanic, as he carefully picks through a large nest of garbage cans lined up at streetside (and not on Ralph's block). Jorge explains how one particular super helps him out: "All year round he tries to save the cans for me . . . he tells me when to come. So I get up by 4 so I can be there at 6 and he holds the cans for me."

Most scavengers are like Jorge and get along well with supers. For example, Bernard, a 20-ish African American, says that he has had a set territory and a set schedule for three years and "all the supers that I work with, they really expect me to be there"—for the cans and for odd jobs.

The police are somewhere in the middle between Ralph and superintendent-friendly scavengers. As the video notes, "scavenging is illegal but not enforced." "The police," says Eric, a 20-ish African American who has his finds laid out on the sidewalk for sale, "they're the big hassle. Its not a big hassle, though. They're pretty understanding guys. The majority of 'em 'll give you warning." Besides, like most scavengers, Eric provides a dual service—selling what he picks and taking items people don't want. He estimates that 50 percent of his wares are "donated."

Different supers, different points of view, the cops in between, and one happy Jorge. ". . . bicycles, furniture that's still good, televisions, radios," he gloats. "All this stuff they throw away . . . that they could give to somebody. I find it. I fix it, and I keep it for myself. At least I have something.

"I got plenty cans, I got books, I got beer even," continues Jorge as he smiles and holds up a full bottle of Moosehead. "The cans and bottles. I take 'em all to the store and I make my money this way. At least its an honest dollar."

Rags to riches: "I scavenge the roads," beams Hubcap Joe, an early-30s Anglo. Standing by his car he continues, "This is approximately the same spot I picked up my first cap when I was 5 or 6 years old."

Back at his storefront he reports that when he finds a cap that comes off "really clean with no dents and scratches . . . I let out a scream that you could probably hear in Kansas." Then, leaning back in his chair, he recalls that one Sunday he collected 125 caps from one highway alone . . . "my car was full."

A surprisingly large number of successful pickers concentrate on books. Philip first centered his collecting on cans, but then specialized in the books that helpful supers donated. He sells his books to street vendors, specialty bookstores, and "you know, collectors." And the money, he says, is good: "I've made more doing this than I made in nine-to-five jobs. I mean, there're times when I've made $500 in a day. Some people don't make that in a week."

The entrepreneurial underdog: One mid-30s African American works part-time in a bookstore during the day. At night he sells the books the store doesn't want and those he scavenges from trash.

"In comparison, you can say Barnes and Noble is the big fish; I'm the little fish," he states matter-of-factly. "Its now after midnight and Barnes and Noble is closed. I'm still open. I keep my show on the road and reap in a little capital. That way I may be able to catch up with Barnes and Noble in the very near future." I'd like to find this guy the next time I want something to read.

Carlos, a Hispanic in his 20s, never went to school. He can't read, but he taught himself how to understand electronic schematics. He scrounges computers from office building and electronics store dumpsters. He says simply, "I find 'em, and I put 'em back together and sell 'em." Now there's a skill for the next millenium!

Save-the-world environmentalism: Joe, an African American with a distinguished graying beard, picks wire, brass, copper, and other metals at demolition sites and likes to talk about the value of his services. "Recycling is very important, you know—for the earth, for tomorrow, for the children. What we're saving, what lots of people are wasting, we're reusing it all over again."

Then one of Joe's colleagues adds with great pride, "The wire I save today becomes the electronics of tomorrow."

The adventure and the peril: Tom, an Anglo who looks great for being 50, first went out picking with his father. "It was always exciting to go with him . . . and you kinda shop . . . It's a form of adventure," he says.

Right. Tom notes wistfully that some dumpsters are two stories high and you can get badly cut if you fall climbing in or "get trapped in there with nobody around . . . or get into a bin with someone who doesn't like you. You know, that decides that this is their bin . . . This can be dangerous." Right, again!

But what Tom dislikes the most are people who scream "Get a job!" or "What are you, a dog?" "Its economics," says Tom, ". . . I live off this."

Because I'm a garbage archaeologist, I could really relate to Tom when he picked a large oriental fan out of a bin and said thoughtfully. "I feel like I dug up something from, you know, like Mt. Vesuvius and Pompeii."

Love among the bins: Rob, a 40-ish African American, and Lisa, an African American in her 20s, are a picking couple. They met at their work. "I saw him, and I said, 'Ooooh! I like that . . . the rest is history,'" smiles Lisa shyly. "I can't get rid of him; he can't get rid of me." Lisa's only complaint is that sometimes Rob makes her go to work when she doesn't feel like it. "I don't want her to be in the rotunda," explains Rob. "I just don't want her to be laying down on her butt and doing nothing." Then off they go on their rounds, Rob pushing their shopping cart with Lisa riding on top of the large bag of cans wedged inside.

Some level of redemption: Craig explains that when he got out of prison he was angry and thought he was going to explode like "nitro!" "What changed me is that . . . I don't want to go to jail no more . . . I want to get by without robbing people. (Scavenging) I make a good living." He says that people avoid him because he picks through garbage—"and it hurts, especially from black people. They think that a person who picks up cans and bottles is a crackhead. Well, I don't blame 'em," Craig says, "because a lot of people are crackheads."

But Craig is a songwriter who is saving his money for studio time, and he intones one of his songs:

Before you can love me, you got to love yourself
In this world you're gonna need someone's help

Some of New York City's scavengers are would-be songwriters, some struggling entrepreneurs, some crackheads, some in love, some just trying to get by. As one nameless scavenger says, "There're all kinds of homeless out here." But the ones who scavenge are proud of their "hussle." And everyday, in spite of cold or snow or dark of night, the scavengers are not just sitting on their butts doing nothing.

The Mayor's New Clothes

The recent comments of New York City's mayor suggesting a possible suspension of some recycling activities for 18 months while at the same time advocating the construction of a waste-to-energy burn facility has raised something of a local firestorm.

If any New Yorker asked me what I thought about these comments, from my position as an ardent supporter of recycling and not such a friend of incineration, perhaps surprisingly, I would say, give the mayor a break for awhile. Here's why.

Based on 29 years of hands-on "archaeological" refuse analysis and not just accepting on face value what people report or assume is discarded, I have learned that talk about garbage and the *actual* garbage being talked about are often two different things. From this perspective, what people say about refuse is often figuratively "talking trash," a contemporary personification of the Emperor's New Clothes.

From this perspective: let Mayor Bloomberg say what he likes about garbage. If he is as cunning as he could be, the refuse results will likely be very different—thank goodness—from all of the negative expectations.

My rationale is based on a few key principles of waste management:

Long-term, successful—usually meaning cost-effective—waste management, including recycling, is based on *flexibility*. Ask any of the middlemen who broker recyclables. Access to alternative buyers gives them the leverage they need to keep their revenues above their costs.

Flexibility is also at the heart of "integrated" waste disposal systems, often touted by the Environmental Protection Agency (EPA) and currently

common throughout Japan, an island with plenty of incentive to safely and efficiently dispose of its waste. There, each community divides discards into types and destines some to small, but comprehensive recycling facilities, some to petite-sized waste-to-energy burners, and the rest to rationally sized landfills.

These measured measures are not the United States' style. The American way has been an almost messianic quest for a single "silver bullet" that will recycle everything down to nothing or burn everything in a waste-to-energy plant large enough to heat Detroit or bury everything in a Valhalla-sized landfill. But so far, no silver bullet.

Perhaps the closest any community has come is New York City and its Fresh Kills Landfill, a mega-refuse burial ground founded in 1947 within the Big Apple's own boundaries. This famous/infamous facility that was supposed to be "temporary"—three years of operation tops—ended up the largest landfill in the world and crowned New York as the master of its own waste destiny, albeit often in violation of environmental laws, for more than 50 years.

But Fresh Kills has rarely been recognized as a blessing. For one thing, the landfill has been a highly visible and olfactory thorn in Staten Island's side, symbolizing the power and status differences among boroughs. In addition, perhaps because the Kills was always there in the past, planning where the garbage would go in a post-Kills world has been lame at best.

Once Fresh Kills was closed—whether in the name of social justice for the surrounding populace, or for the environmental protection of Staten Island, or for political advantage (as some have suggested)—the city lost most of its waste disposal leverage. What little leverage could have been left had vanished when the landfill closure deal struck in 1996 included scrubbing the only incinerator that was nearing physical viability, if only in the planning process.

So how is anyone to negotiate with the prescient organizations that knew that the city's waste disposal alternatives were nonexistent and so had built megalandfills in Virginia, Pennsylvania, and elsewhere for New York's unremitting 22 million daily tons of waste without a home? At a great disadvantage, that's how!

As a result, the city has been hit by a financial tsunami. For a time before Kills' end, part of its refuse exited the city at a reasonable cost. With the *for sure* closure of New York's one reasonably priced waste disposal alternative, the floodgates opened, nay, were launched into the stratosphere. In fact, landfill tipping fees all along the Eastern Seaboard doubled. No one doubts the trend will continue; some even suggest that New York City's disposal tab will quickly explode to half-a-billion dollars a year.

In the midst of an extraordinary financial crunch based on unforeseen causes, what's a mayor to do? Answer: Find some viable long-term option, but in the meantime float some options that will make Eastern Seaboard landfill operators think twice about jacking up their prices any further.

Don't forget that the megalandfills designed to cash in on New York's (and perhaps other megalopolises') waste glut have cost big bucks to site and build. In addition, it may be hard to believe, but on the East Coast there is currently much more waste disposal space to fill than there is garbage to fill it. Thus, if New York City has disposal alternatives, the brokers of landfill space will set their financial sights lower to get the rubbish they need to remain solvent.

The mayor must be given the flexibility to explore all options—and there are, in fact, many to explore.

At the top of the list would be a "waste minimization" education campaign—to tell people how to conveniently "use less stuff," such as buying concentrates and products in refillable packages and in easily crushable versus rigid packages (coffee in foil-wrapped bricks versus steel cans).

The "waste minimization" campaign would achieve the best results if it were tied to a "unit pricing" or "pay-as-you-throw" policy. Waste collection and disposal is now a service derived only from generic city taxes, so there is no incentive for individuals to cut discards. Like water bills, the price of garbage collection in the Big Apple cannot be linked to individual residences, but it can be cued to buildings. While this situation would not be ideal, some incentive to reduce discards would come into play along with appropriately measured payments to the city for garbage services.

Except for the cost of implementation, the mayor should not have too much trouble with these two

proposals. The next tier of options will be rougher because they are embedded in politics.

Benjamin Miller, past director of policy planning for the New York City Department of Sanitation and author of *Fat of the Land: Garbage of New York, the Last Two Hundred Years* (2000), has suggested placing refuse disposal at Fresh Kills back on the table (including, of course, a buffer around the sacrosanct remains of the WTC). Sadly, this would be an insult to all those Staten Islanders who don't work at the landfill, but, technically, Fresh Kills could receive refuse for another 10 years—Fresh Kills has, in fact, been retrofitted with retaining walls sunk into the dense clay underneath the garbage to contain, then collect and clean leachate. Just the possibility of another decade of disposal at the Kills, however improbable, would make New York City waste disposal a ball game again.

Ben Miller has also proposed creating a New York State regional landfill. Why let Pennsylvania and Virginia get all the jobs and New Yorkers' money? More than a decade ago, BFI conducted an examination of a significant portion of the land in the state looking for safe potential sites—not over aquifers, etc., etc. The company determined that only 1 percent of the land investigated met their stringent criteria. All the same, that 1 percent was some 200 square miles in area! Now the really tough options.

Consider (the operational word is *consider*) temporarily (oops!, does the siting of Fresh Kills come to mind?) cutting back on recycling by excluding bottles and cans and the city would keep the $.05 levy on each. This is a tough sell since (a) the central nerve of the environmental movement is arguably recycling and (b) given the immense complexities of collecting materials within the city's intricate political and physical infrastructure, New York City is doing a great job if you accept that recycling efficiency isn't measured by making money; recycling efficiency means that recycling costs less than exporting and burying recyclables.

Consider (again) building new incinerators. Gasp! Stopped and even killed more than once before, can the specter rise again? That question, of course, is the subject of endless debate. Incineration facilities, even ones that generate energy, are the most scientifically and politically contentious players on the garbage disposal stage. The mayor is correct that emissions control has improved considerably over the past decade. But, Allen Hershkowitz, a senior research scientist at the National Resources Defense Council, is equally accurate when he stresses that all of the new devices are there because of a better understanding of potential dangers that are also there. And some of those dangers, such as mercury emissions, are still not fully eliminated, at least, to the satisfaction of potent advocacy groups and many residents who may have to live near a burner. But the mayor, wrong-headed as he may be, can still explore the option, right?

Finally, Mr. Doherty, the man in charge of New York City's Department of Sanitation, recently suggested that trash could cross borough boundaries to take advantage of better prices on hauling waste for export. To an outlander, such as myself, this seems quite reasonable; but I know that to many New Yorkers it is anything but.

All of these options are likely to create problems for the mayor—big problems. So is spending tens and maybe hundreds of millions of dollars more on exporting garbage.

As any successful scrap dealer or Japanese waste official will tell you, the garbage game is about the skillful portrayal—not necessarily the actual use of—options. Talking options will give the mayor leverage to lower export costs and also provide everyone with an opportunity to vent on all sides of every proposal. If the mayor looks like he is getting too far with the wrong propositions, jump in with both feet—I will be there right beside you.

Until then, allow the mayor a little latitude to parade some new clothes!

Travelin' Trash

Surely you haven't forgotten the "garbage barge" that was pushed and pulled into history by the tugboat *Break of Dawn* in the spring of 1987. For more than a month, we all followed the forlorn barge down the East Coast, around the Caribbean, and back again as it searched for a final resting place for 3,000 tons of Long Island garbage. For many, plotting the floating trash's daily progress—or lack of it—became an obsession, as if they feared the wandering waste might end up in their

neighborhood. Whatever their concerns, Americans found the odyssey so striking that it ignited a garbage crisis.

And now it has been refueled again. This time, the objects of our attention are the trucks that are hauling refuse from the Bronx to Virginia, where politicians and citizens alike express outrage that, every day, some 3,000 tons of New York City's garbage are filling megalandfills in their countryside. New York's mayor Rudolph W. Giuliani has, of course, only made matters worse by suggesting that because of all the amenities the Big Apple offers, visitors shouldn't be surprised if some of the city's garbage follows them home.

What all this goes to show is that we have not learned the real lessons of that garbage crisis a decade ago. We are still trying to cure the disease by micromanaging its disposal. We certainly haven't realized how safe modern landfills are. And, despite the sound and fury of environmental watchdogs and some well-meaning efforts to recycle, there is practically no effort being directed at preventive medicine—at decreasing the amount of garbage we produce in the first place.

In other words, we are still missing the boat.

As director of the University of Arizona's Garbage Project, I have been encouraging my staff and students to study modern garbage—hands-on—for some 25 years now, as if we were archaeologists itemizing the remains of Pompeii. All across the United States, we have painstakingly sorted through fresh refuse and dug up and examined trash that has been buried in landfills for decades. The intimacy of our approach has given us a unique perspective on garbage and its peregrinations. We know that garbage has been traveling long distances for years. Once in a while, a story about it captures the public's attention. Shortly after following the voyages of the garbage barge, for example, the media latched onto the *Khian Sea*, a merchant ship loaded with incinerator ash from Philadelphia. It plied the seas to southeast Asia where, like the garbage barge, it was not allowed to unload at any port. Nonetheless, it somehow returned to the United States—newly named and empty.

Traveling garbage is simply a fact of American life. Depressed rural areas are willing to accept garbage from crowded urban centers, and the urban centers are willing to pay for that privilege. Trucking companies are happy to haul garbage out in their 18-wheelers, and happy to haul produce or other commodities back in their trucks. In this way, the garbage of the crowded East Coast has been distributed to landfills nationwide, including many in rural areas of the midwest. (The result is an archaeologist's nightmare, by the way: imagine digging up the remains of lox and bagels, a weekday *New York Times*, and a number of used New York subway schedules in a landfill in rural Illinois or the picturesque reaches of Montana.)

But you don't have to have an archaeologist's sensibility to realize that one man's trash is another man's treasure. Today, in fact, there are many parts of our nation that are garbage-poor and trash-starved. One of them is Virginia. Another is New Jersey, where I have actually heard officials say, "There's just not enough garbage."

That's because, in New Jersey, the garbage crisis has been turned on its head. The reasons behind this conundrum involve major components of politics, the law, and economics and are therefore convoluted or nonsensical. What happened is that the state government did its environmental duty at the beginning of the garbage crisis by mandating recycling and requiring every county to create local facilities to dispose of its own waste—no New Jersey garbage barges! The counties took this responsibility seriously; many built state-of-the-art, environmentally friendly waste disposal facilities. The cost was high, but that was to be expected, and each county planned for servicing its debt based on the quantity of local garbage that it expected would be arriving for disposal. But the best-laid plans . . . .

Meanwhile, in anticipation of a garbage glut, some areas of New York and Pennsylvania had found their new refuse facilities could handle more garbage than the local communities were producing. To bring in new business, they lowered their "tipping fee," and many of New Jersey's cities and private haulers found the prices too tempting to ignore. New Jersey counties then tried to keep the garbage at home by enforcing "flow controls," but in 1994 the Supreme Court ruled that such regulations interfered with interstate commerce. The result is that New Jersey counties have drastically lowered their fees to compete for garbage—and are continuing to have trouble servicing their debts. Yes, trash-starved!

That's also the story with the privately operated incinerators in Virginia—the nation's second-largest importer of garbage at 3 million tons a year. The communities that sponsored them were up to their eyeballs in both debt and agreements to provide specified amounts of garbage to waste facilities or face stiff penalties. So, just like other waste-to-energy plants before them, the Virginia incinerators began taking in nonhazardous industrial waste from out of state. And, just as at other plants before, there turned out to be some toxic materials mixed in with the rest, and the result was employee discomfort and, perhaps, some inappropriate emissions.

Monitoring the in-state and out-of-state industrial wastes that arrive at incinerators is an important concern of mine, since the incinerators were designed primarily to handle local municipal wastes from homes, schools, small businesses, and so on. And, as I understand it, Virginia's General Assembly is taking steps to improve its monitoring regimen—a move that seems prudent.

The other concern in Virginia is that disposal companies saw an opportunity to build and fill megalandfills in rural areas—areas that wanted revenues from waste disposal to cut taxes and pay for schools and more—where large landowners were not making economic use of their holdings. But there's a major misunderstanding here, too.

Many of the television and newspaper stories I've seen suggest that Virginia's landfills pose a serious environmental threat. One even notes that owners "had a free hand in building megalandfills, as long as they met environmental standards." But from a garbologist's standpoint, just how free was that hand? There were very few details about the design of Virginia's new megalandfills in the articles I've seen, so I made a few calls.

If the megafill in Charles City County, a poor rural community about a half-hour east of Richmond, is anything to go by, I wouldn't be worried about my home or family if I lived nearby. First, the landfill, which opened in 1990 before most of the others, has a double composite plastic 60-millimeter liner as well as a clay liner and drainage layers, all of which guard against leakage into the outside environment. There is also a system to collect leachate (fluids that reach the bottom of the landfill), and most of the trapped leachate is delivered to a sewage treatment plant nearby for cleaning. The landfill has methane wells regularly drilled to vent or collect methane gas for further use. In addition, the 289-acre landfill is surrounded by a 700-acre buffer. Finally, having spent 25 years in the waste arena, I was not surprised to learn that the landfill's manager, Lee Wilson, has a degree in civil engineering and decided to get into the waste business "to minimize the environmental impacts of our garbage." It may sound corny, but a lot of people in the waste industry believe in that.

All of this effort is designed to protect the immediate area outside the site from our cities' refuse—and they work. Take household waste. Today, hundreds of communities have "household hazardous waste" collection programs that allow people to drop off or place out for pickup unused paints and pesticides, used motor oil, batteries, and so forth. They represent about two-thirds of 1 percent by weight of what households discard—and remember that the actual hazardous ingredients themselves are a significantly smaller part. This material, dispersed among a mass of soda cans, milk cartons, meat trays and cereal boxes, does not strike me as particularly dangerous when ensconced in a landfill built like Charles City County's.

In fact, I believe that the garbage sites in the United States are the safest waste disposal facilities in the history of the world. So what's wrong with people making an honest dollar from disposing of garbage?

The primary objection is that nobody wants a landfill in his or her backyard. They have real concerns about traffic and noise and litter from trucks. But our waste has to go somewhere. And instead of worrying about where all the garbage goes, all of us—New Yorkers, Virginians, and Arizonans alike—should be asking, "Where does all the garbage come from—and how can we decrease it?"

Ironically enough, one of the reasons we don't ask those questions is because of a misperception about recycling. Most people believe that recycling means saving resources and cutting down on garbage. And they are correct—to a point. But recycling itself does not save resources. It simply delays the exploitation of new resources. Paper—our most commonly recycled commodity—can be recycled only a few times until the fibers are too short for new products. Then it's back to cutting down trees. Further, recycling itself consumes considerable resources (collecting

recyclables separately from garbage, transporting them, processing them, returning them to stores), and it generates considerable waste (the sludge of inks and other additives extracted from old paper before it can be made into new, for example). But the most frustrating and damaging element of recycling is that recyclers may feel that since they are doing the right thing for the environment by recycling, they have no compunctions about how much they consume. And the truth is that, even though we are recycling ever-greater quantities of materials, we are tossing out more and more garbage at the same time.

In fact, the EPA places recycling only third in its hierarchy of proper waste utilization. "Reuse," which comes in second, means making further use of items within the home (jam jars and empty margarine tubs become containers for leftovers) and not burdening the recycling or disposal systems. "Source reduction," number one, means preventive medicine—using less stuff by buying products and packaging that will generate less waste in the first place.

We need source reduction to win the hearts and minds of Americans in the same way recycling has. That's because of what I call "Parkinson's Law of Garbage" (garbage will expand to fill up the space available for its disposal). The Garbage Project first documented this behavior in Tucson when the city introduced mechanized pickup, and each household received a standardized 90-gallon plastic bin—about twice the size of the galvanized can most people had used previously. In short order, the quantity of refuse each household discarded nearly doubled! The increase was not in everyday items—in food or packaging for household cleaners. It was in discretionary items such as old clothes that might have been resold or donated to charities, yard waste that might have been composted, household hazardous wastes that might have been taken to a community collection site, and even recyclables.

What's the answer? I like the "Seattle Solution"—what the EPA calls "Pay as You Throw." There, each household is given a small garbage container. If residents need larger containers, they can choose to pay for them. This cost-based strategy seems to be working: Seattle officials report a drop in the amount of garbage collected.

But Seattle and dozens of other cities that have installed similar programs are still in the minority. This is why I believe that we have missed the message of the garbage barge when we focus on traveling trash and where it ends up. Of course, no one wants to be a dumping ground for New York's garbage—or for Tucson's. But once it is produced, trash has to go someplace; and, in this day of heightened environmental protection, economies of scale select strongly for those megalandfills. There is no fighting economics and history as they push us toward far fewer and far larger—but far safer—waste disposal sites. That is, unless we can decide upon some way to use less stuff.

The Littlest Irony

Superconsumption in the United States is symbolized by any number of material artifacts—cars that transport only one individual as they consume gas and emit residues, fat newspapers delivered to millions of homes across America today to replace the ones delivered yesterday, gaudy high-top sport shoes—the kind with designer logos, layering, embossing, a variety of colors, and sometimes flashing lights—that kids have been known to kill for, and multi-room, multistoried mansions crowded on the hill, dale, and lake of hitherto unfettered ecozones for the pleasure and comfort of middle-class families.

Of course, the list could go on and on. But to me, one of the smallest of our possessions is both symbolic of and a highly significant contributor to the material monkey on our backs—the credit card!

The credit card is something many of us "superconsume." I have friends who carry up to twelve because some credit cards are for business, some for pleasure, some for the side benefits—airline miles, phone minutes, on and on—and some just for prestige. And nearly every establishment of consumption accepts these plastic icons of purchasing power without question.

But the credit card is far more than a method of payment. *The credit card is probably the greatest single-handed facilitator of superconsumption ever invented by man or woman.* You do not need to have the physical wherewithal on your person to pay for the material goods you covet because the seller will take your plastic. So many stores won't want to

take personal checks, but they'll slide through your card while they push their store's own credit card on you to make upcoming purchases even easier. When in need or desire, who questions your future ability to pay for a purchase as long as you have not overshot your credit card's expenditure ceiling? And the so-called "elite cards," such as American Express, don't even have credit ceilings.

Credit cards have become an American staple because they make money for those who issue them when consumers buy ahead of their ability or willingness to pay and, as a result, extend their payments and pay interest on their debt. Such business ventures are so lucrative that every major promoter of consumption wants a part of the action. Banks have now aligned themselves with virtually every well-known name in the field of consumption—gasoline stations, automobile manufacturers, airlines, superstores and fancy department stores, and so on—all in the hope of cashing in on the bonanza of credit card interest due to superconsumption.

As a result, in my view, nothing symbolizes or promotes superconsumption as much as credit cards.

Imagine, then, my surprise, when I recently discovered that some environmental groups are themselves cashing in on the role of credit cards in consumption by offering their own credit cards. The first two I heard of were the Environmental Defense Fund in the United States and Greenpeace in England.

Let me be perfectly clear about what bothers me in this picture. Although I hope that consumers will make informed decisions with the environment in mind, I am not against people buying what they need or even what they want. I have and use credit cards, and although I try to avoid interest payments, I understand why they accrue on extended bills. What I have trouble accepting is a credit card sponsored by an environmental group, because sponsoring a credit card means that the more the carrier of that card consumes, the more that environmental group will profit!

In fact, in England, Greenpeace receives $8.45 for each new holder of a Greenpeace credit card and 25 cents for every $100 chalked up on the card. The more cardholders charge, the more Greenpeace profits.

What happened to the "reduce" part of the environmentalists' strategy for cutting pollution and garbage?

The contradiction between Greenpeace's environmental mission and credit for consumer consumption seems to have gone unnoticed. In fact, all of the media attention was focused on the fact that credit cards are normally made of PVC plastic, and Greenpeace, which is at war with PVC, would have none of it.

"We have been considering offering our supporters a credit card for some time, but it would have been wrong for a charity like ourselves to issue a card made of PVC," said Peter Melchett, executive director of Greenpeace, in a news release. But it isn't wrong for them to profit from a credit card made of "Biopol," or polyhydroxyaokanoic acid (PHA), because according to Monsanto, its manufacturer, Biopol plastic is biodegradable. Biodegradable, that is, if the credit card ends up in a well-managed composting facility instead of a landfill. In a landfill, Biopol will degrade no faster than paper—and that is very slow indeed.

I find this whole scenario disconcerting.

I am, by trade, an archaeologist. As such, I despise looters who profit from the wanton destruction of archaeological sites to steal antiquities and sell them to private collectors who hide them away from the public. If the concept of *source reduction*—buying and using less so that less garbage is produced—means anything to environmental groups, then issuing their own credit card seems to me like an archaeologist selling artifacts to private collectors in order to raise funds for archaeological research. If pressed, such an archaeologist might say that his or her site was not destroyed by the undocumented and clumsy digging of looters. But much of the public value of any "sold" find—in research and in public display—is lost forever. In the same way, once raw materials are extracted to be manufactured into new products, the environment they came from can never be put back the way it was.

Of course, someone might argue that looting will go on no matter what; therefore, why not support archaeologists with it. My response would be that archaeologists should concentrate their time and energies on educating the public about the heritage that looting destroys. Archaeologists can't do that

while they sell their finds privately! Selling archaeological remains to benefit archaeologists could raise a lot of money, but no legitimate archaeologists would do such a thing.

That makes me wonder how any serious environmental group can preach against consumer excesses while it profits from the unpaid balances on credit cards.

SUV to SUV

If you are reading this, you are concerned about waste. So am I, so when I read in the August 26 (2002) *Time* magazine about an innovative "eco-minded thinker" who is "a visionary, a prophet, even a zealot" who "dreams of a world without waste," I was hooked. I had to read architect and ecodesigner extraordinaire William McDonough's new book (*Cradle to Crade: Remaking the Way We Make Things*, coauthored with Michael Braungart, and published in 2002 by North Point Press, New York) to find out how his ground-breaking ideas were going to make our waste-handling jobs easier.

I know that being called a "visionary" and a "prophet" gives an author some room to be obscure or outlandish. But I have now read the book, and I'm still at a loss as to what to make of it; so I thought I'd share my confusion about McDonough's waste cutting-edge ideas with you.

From the get go, Mr. McDonough's viewpoint is different from most of the "ecothinking" with which I am familiar. First, he dismisses recycling—according to the book, it should be called "downcycling," since recycled items are usually incorporated in lower-performance confabulations, such as white office paper becoming part of lower grade newsprint or paperboard. Second, he equally dismisses source reduction—according to him, we should be celebrating nature's bounty and not bemoaning our misperception that it has limits. From a pro-environment stance, at first McDonough sounds negative, but he claims he is far from that!

In fact, what he has been doing is designing for major manufacturers production plants that celebrate nature's abundance, human creativity, and "fun"—with lots of openness enhanced by skylights and sod on the same roofs to grow flowers, be a sanctuary for birds, and decrease torrential runoff.

But his exuberance doesn't stop at architecture. It overflows into a myriad of specific products that he believes exemplify "ecoeffectiveness"; and in the book, he and Braungart proclaim a grand manifesto that will not yield to source reduction, or "using less stuff." Instead, the authors "see a world of abundance, no limits. In the midst of a great deal of talk about reducing the human ecological footprint, we offer a different vision. What if humans designed products and systems that celebrate an abundance of human creativity, culture, and productivity? That are so intelligent and safe, our species leaves an ecological footprint to delight in, not lament?" "Instead of trying to be less bad, let's be 100 percent good."

I don't want to sound even a muted dissonant chord in the face of such an optimistic symphony of human beneficence, but I do have some concerns.

First, such a flamboyant scheme requires that you know the territory, just as Mr. McDonough gets to know firsthand the people and the surroundings of the plants he designs. As far as "waste," which he wants to turn into "techno-nutrients" (whatever that means?), he seems just a little off the mark in the areas with which I am familiar. He believes, like many others before the Garbage Project's landfill digs, that "conventional disposable diapers (are) one of the largest single sources of solid waste in landfills." No, try one of many small sources of landfilled solid wastes—way, way, way behind C&D (something architect McDonough should know firsthand); way, way behind newspapers; way behind tires; and even behind lots of kinds of packaging and dozens of other products, including phonebooks.

"Imagine," write McDonough and Braungart, "what you would come upon today at a typical landfill." To be candid, I believe that their imagination is as close to a typical landfill as McDonough and Braungart have ever come. The first nine items the authors mention are relatively rare at best. Is this the kind of research that comprehensive product redesigns should be based upon?

Second, how about their concept of nonindustrial societies—ideas that echo the rather idealized view of the "noble savage" from 300 years ago. The authors write: a more prosperous design would allow products "to be used the way Native

Americans used a buffalo carcass, optimizing every element, from tongue to tail." McDonough and Braungart are correct as far as they go, but as surprising as it may seem, waste is a common story among ancient hunters.

At the archaeological site of Olsen Chubbuck, in Colorado, a band of Native American hunters stampeded a herd of *Bison occidentalis* (giant bison) into an arroyo some 8,500 years ago. One-hundred and eighty-five animals died. Of these, only 35 (19 percent) were completely butchered. Another 55 percent were picked over for a limb or a heart or a tongue. The last 50 (another 27 percent) were left just as they fell.

Given this scenario, it is not surprising that by some estimates, 70 percent of the large mammals in North America (including *Bison occidentalis*) were hunted to extinction by ancient Native Americans. Is this the ecoeffective model that *Cradle to Cradle* would emulate?

But the above comments are not really fair to Mr. McDonough. I'm an archaeologist, so I know more than most about the material realities of "waste" within past societies; and, in particular, I'm a "garbage" archaeologist, so I know modern refuse. So, let's leave the areas of my expertise.

On page 76, the authors open the gates: "Our concept of ecoeffectiveness means working on the right things—on the right products and services and systems—instead of making the wrong things less bad."

O.K., then I have a couple of questions: Why has Mr. McDonough spent so much time designing "ecoeffective" facilities to make automobiles, arguably one of the most un-ecoeffective artifacts ever created by humans? As the authors congratulate McDonough for creating an ecoeffective workplace for Ford Motor Company employees to make more and more cars, I hear the refrain of country-western singer-songwriter Jerry Reid:

> *Oh, Lord, Mr. Ford, how I wish that you could see*
> *What your simple horseless carriage has become.*
> *It seems your contribution to man, to say the least, got a little outta hand.*
> *Oh, Lord, Mr. Ford, what have you done?*

Then I noticed the cover of *Cradle to Cradle*. There, in front of my wondering eyes appeared what many environmentalists consider their bane—an SUV (actually two)—a ponderous (most weigh more than two tons) gas-guzzling and pollution-emitting machine! What a surprise from authors who seem to consider most everything else around today hazardous: "Even something as benign and necessary as clean drinking water can be lethal if you are submerged in it for more than a couple of minutes" (page 45). Are they laughing at themselves here?

McDonough and Braungart do "imagine" cars that purify the air and produce drinking water (page 91). O.K.! But who is working on that? I don't know, so let's take a look at an example of a serious ecoeffective product that McDonough and Braungart have actually designed: their book.

First, it is made of plastic (polypropylene with talc fillers to be more exact), but it exudes the same offgasses as paper books.

Second, according to Mr. McDonough, their "book of the future" can be "reclaimed by the publishing industry in a simple one-step process" . . . and "books become books become books . . ." That is, if you can cost-effectively collect the books separately, which is the major drawback that has kept this kind of eco-ideal recycling from happening before in the waste industry. You could upgrade all recycling totally if you could figure out a way to collect only one specific type of product or item *en mass*! It's the mix that kills! How do you collect just *Cradle to Cradle*?

Third, the small tome is unusually heavy, at 1.24 pounds versus a similar-length paperback book at 0.75 pounds—that is, the "book of the future" weighs 63.4 percent more than today's paperback. This all returns to the argument above about what McDonough's "remaking the way we make things" is all about.

He writes that "although the book you hold in your hands is not yet that book (his 'ecoeffective version'), it is a step in that direction" (page 71). But I cannot figure out why McDonough wants to replace traditional paper books.

He says that old-style books used heavy metal inks—O.K., bad. He further asserts that ecoefficient recycled-paper books use soy-based inks that are

dull and the paper is so off-white, that the books are hard to read. I guess I hadn't noticed, but its still not optimal. But if McDonough and Braungart's book becomes a bestseller, imagine the extra pollutants generated from transporting it all across the country at almost two-thirds extra weight! If you ever pick up *Cradle to Cradle* for disposal, you will know exactly how heavyweight some of Mr. McDonough's "ecothinking" is.

CRTs as Hazardous Waste: Babies and Bath Water?

What did your children look at longer today: you or a CRT (otherwise known as a cathode ray tube or "picture tube" of a TV or computer monitor)?

The CRT would be a safe bet. A 1999 Kaiser Family Foundation study found that children spent an average of 5.5 hours a day, a whopping 38 hours a week, ogling the fare on a "boob tube." Even more surprising, at least to me, the study found that 65 percent of kids over age 8 have TVs in their bedrooms. Who says that familiarity breeds contempt?

Why should you or I care as solid waste professionals? According to the state of California (as well as Massachusetts and Florida), it is not only some of the weird content of what is shown on TVs or acted out in computer games or extolled on Websites that can harm your children. No, indeed. The danger is far more immediate and physical, and even worse than exposure to half-empty containers of household pesticide or oven cleaner. That's because CRTs are a hazardous waste when "spent" and not in "continued use."

In California, this state of affairs was as of March 20, 2001. In a formal letter, Ms. Peggy Harris, P.E., chief of the State Regulatory Programs Division, Hazardous Waste Management Program, Department of Toxic Substances Control of California, noted that CRT glass contains concentrations of lead "that cause them to exhibit the characteristic of toxicity under both federal and State law." In addition, many CRTs' glass contains high levels of barium. Therefore, Ms. Harris conspicuously concludes not once, but twice, that "when discarded, CRTs are identified as a hazardous waste" and therefore the disposal of waste CRTs in municipal landfills "has always been prohibited in California" and, of course, still is!—even though most landfill managers didn't realize it. Further, Ms. Harris reminded us all that California law does not contain exemptions for household or small quantity generators. Thus, all households, charities, and small recyclers that find themselves in possession of at least one "spent" CRT must manage it as a full-fledged hazardous waste in "*accordance with all applicable requirements, including generator, transporter, and facility requirements*," a brain-numbing cacophony of very complex and even more expensive mandatory safeguards.

When I arrived in California on March 30, 2001, the sound of jaws dropping was still plainly audible!

One reason for the shock among waste managers is that once again, the regulatory horse is following industry's cart—a cart obviously with a spiffy new engine. Several studies have concluded the obvious: the faster the pace of innovation, the sooner your brand new computer platform will no longer be state of the art. Estimates vary, but there seems to be consensus that by 2005 more than 300 million personal computers manufactured after 1985 will be obsolete.

Leaving aside the thorny issues of how you determine when a computer or television is obsolete if it is still running, and how you collect accurate data from tens of thousands of small businesses and charities, what's going to happen to all these electronic units that will no longer be used at their first home?

Stanford Resources, Inc., in a "baseline report" for the National Safety Council (NSC), collected data from 123 firms and through the wonders of numbers concluded that of the 20.6 million units that became obsolete in 1998, only 2.3 million—or 11 percent—were "recycled"—meaning for this study that they were donated to schools or charities, repaired and/or refurbished, and put back to work in a new location.

What about the other 89 percent? Some were smelted for heavy metals and other valuables (not considered "recycling" for the NSC study), while others found themselves in landfills.

For the sake of being realistic, everyone other than Stanford Resources, Inc., seems to agree that the vast majority are still currently stored in home basements or attics or office storerooms. This is due to what the Garbage Project calls the "pack rat syndrome"—Americans hate to throw anything away

when it still works, and people buy new computers for new capabilities and features, not because the old one breaks.

Despite the "pack rat" in so many of us, discard is just a matter of time. It is the image of stored CRTs poised to be unleashed as an incredibly massive tidal wave that has regulators so worried.

I, personally, am not so worried. After storing it carefully for four years, I became ready to dispose of my IBM Thinkpad 755c laptop. I have sent this antique to a school for Tibetan refugee children in Nepal. It will no doubt have quite an adventure there. But I also looked up electronics recycling for San Francisco on the Internet and found 228 entries. While nearly half were small businesses, 122 were charities—there were 40 Salvation Army stores alone. Considering CRTs a hazardous waste suddenly creates a rather severe problem in this rather idyllic scene. Most small businesses and charities don't now have, and can't afford to buy, all the bells and whistles and special storage facilities and equipment necessary to properly handle a confirmed hazardous waste. That's not such a big problem for large corporations that can afford all the trimmings when donating a large number of still-functioning PCs to nearby schools, but it will wreak havoc on the current reuse "recycling" of CRTs through small frys—the place where most "not in continued use" home computers are—or, in California, should I say "were"—likely to wind up.

This, then, is the problem in a nutshell: if CRTs must be treated as a hazardous waste, it will be much more difficult to find a means to repair/refurbish them for reuse. Householders with no reputable outlet may take to dumping old TVs and PCs beside the road or stuffing the unwanted objects into the bottom of trash cans that are picked up and dumped by mechanized systems.

But why are we in this bind? In what way are CRTs so hazardous? Aren't you a little worried about your child, or even yourself, spending so much time in close proximity to a verifiable hazardous waste?

While some hazardous wastes are never tested, CRTs were subjected to the EPA's standard toxicity test—the Toxicity Characteristic Leaching Procedure. This TCLP was designed to simulate leaching conditions that may exist under landfill conditions.

To get down to cases, Professor Tim Townsend of the University of Florida, Gainesville's Department of Environmental Engineering, and graduate student Steve Musson collected 36 cathode ray tubes. They broke them. No, they actually crushed them into very small particles—less than 9.5 mm in any direction. The pieces were next placed in a TCLP solution designated by the EPA and tumbled for 18 hours, after which the solution was tested for lead. For 21 of the CRTs, the resulting leachate exceeded the hazardous waste standard of 5 milligrams of lead per liter, with concentrations averaging 18.5 milligrams per liter.

At this point, I have to ask myself how the CRTs are going to create a hazard during transportation or even long-term storage. If you dropped one and it broke, you'd have a much higher risk of getting cut by the leaded glass than of getting lead poisoning. By the way, the leaded glass is there to protect viewers from X-rays generated in the picture-making process. Also note that while a variety of toxics used in computer electronics have been identified as replaceable by a nontoxic alternative by consumer and environmental-concern groups, as far as I am aware, this is has not been the case with the lead in CRT glass.

Note further that items dumped into landfills are not usually ground to smithereens.

In fact, if you want to talk about risks from TV and PC CRTs, how about those for children who are exposed to computers at school and to computers and TVs at home:

Child obesity has been linked to watching CRTs more than five hours a day. Check the national average watching time for children mentioned in the opening of this piece.

Playing violent computer games has been linked, especially among boys, to increased aggression.

There is a significant danger of musculoskeletal injuries if work stations are not designed especially for children.

There are a variety of physical symptoms that the American Optometric Association has lumped together as a significant disability called "computer vision syndrome."

All of these seem like much more meaningful risk factors in our society today than not treating CRTs as a full-blown hazardous waste.

Landfills & the Perfume of Garbage

Garbage Museums Mirror America

Garbage is what people use and then choose to discard. For more than 100 years, archaeologists have studied ancient garbage to glean from it insights into the ways people lived their lives in ancient times. I was trained as an archaeologist, and I firmly believe that modern garbage can provide us with similar insights into our own lifeways. What better way to obtain a new perspective on ourselves than to visit a garbage museum and see ourselves as we look through a garbage mirror?

As far as I know, the first garbage museum opened in 1989 at the environmental center in DeKrote State Park. The park is a part of the Hackensack Meadowlands of New Jersey and, very appropriately, abuts a three-square-mile expanse where more than 100 communities once dumped their garbage.

The entrance exhibit invites visitors to walk through a bright cavern formed by a jumble of trash hanging from the walls and ceiling. This construction was not the work of a sanitation professional; the designer, Robert Richardson, was a 30-year-old artist from Newark. Richardson's intentions included making visitors "feel" that garbage was about to engulf American society. "That's good," Richardson told one reporter.

The label which proclaims Richardson's display to be "the insides of a dump" probably seems redundant to most visitors. To them the cavern no doubt seems visually synonymous with the contents of American garbage in general, and thus with the contents of a typical landfill. Look: there are the empty boxes of Brillo and Tide, the plastic jugs, the steel and aluminum cans, the fast food packages, the disposable diaper cartons, the phonebooks and newspapers, and the tires—all things, assuredly, that do get thrown away and find their way to landfills.

But the "insides of a dump" label would be needed if sanitation workers from the Meadowland's one surviving landfill happened to wander over to the museum. The reason is that the museum's dump is not really much like any real-life garbage dump or landfill. If sanitation workers were asked to point out to visitors how the garbage they deal with every day differs from the garbage displayed in Robert Richardson's construction, they might make several points:

To begin with, there's no dirt mixed in with this garbage, and yet each day's deposit in their landfill is tucked away under a layer of cover dirt. True dumps are outlawed, but those that did exist (and still do) also have dirt aplenty. Second, where is the construction and demolition debris—the concrete, rebar, wallboard, lumber, and commercial packaging devices that fill roll-offs and litter the ground at construction sites and that take up 20 percent or more of the space inside most municipal landfills? Third, there seem to be no food or yard wastes or, for that matter, organic wastes of any kind—no grease-soaked newspapers, no discarded clumps of kitty litter, no bottles with cigarette butts floating in stale beer, no cereal boxes stuffed with chicken bones and skin stuck to a paper towel (our workers are really on a roll now!). Next, none of the garbage appears to have been crushed, even though most garbage in landfills looks as though it has been run over by a 40-ton compactor, which it often has. One last observation would surely be that the garbage on display gives off no characteristic smell—perhaps adding that the bouquet of a well-managed sanitary landfill is, to say the least, distinctive.

This DeKrote garbage museum confronts visitors with representations of contemporary MSW and MSW management that are, to say the least, somewhat distorted. At the end of the exhibit is a life-sized, three-dimensional tableau depicting a 20th-century American family blithely throwing away plastic cups and sheets of aluminum foil. Instead of faces, the display's human figures have mirrors, thereby inviting visitors to see themselves in similar situations. This scene suggests that it is fitting that the museum "dump" is not a rigorous abstraction from scientific data. Instead, as the mirrors on the display faces eerily suggest, what is being presented as reality to visitors is their very own fantasies. The result, inevitably, is a closed system of fantasy and shortsightedness that both hampers the effective disposal of garbage and leads to exaggerated fears of a garbage crisis.

How could this happen in a museum? Easy. In fact, it is surprising that it does not happen more often. What such institutions provide the public today are often the result of collaborations between, on one side, exhibit designers trained and mandated to educate the public to basic realities and, on the other, artists employed to make the experience more memorable and aesthetically pleasing by touching visitors' emotions. So far, so good.

There is, however, one problem. Realities are generic and can, theoretically, be presented in an impersonal, matter-of-fact manner. Feelings, on the other hand, are highly personalized and communicating them usually means viewing reality through some form of distortion; that distortion, in fact, is the art. Obviously, no facts can be presented without some bias in the way they are ordered, in the relative emphasis given to each, and so on. The problem is that the lasting message from a museum is a mix of fact and feeling. How can museums know what that mix should be?

I believe that the answer is simple: museums should consider the opinions of people who know solid waste. There are, of course, a great diversity of biases among those who become intimate with garbage; but unlike those of most artists, the biases of solid wastes' men and women are grounded in garbage realities. To provide a sense of the scale of the input I suggest from garbage people, I need give only a single example.

When one major city recently built a large transfer/recycling facility, artists were employed to design the planned visitor education center and to make certain that the overall plant design was sensitive to the local habitat and the public's educational experience. In this process, the artists focused their attention on the use of recycled materials—glassphalt for road and work surfaces and one wall built entirely of used bottles—but the artists' input was not what you might imagine: the artists *vetoed* the planned use of these recycled materials. Perhaps glassphalt and discarded bottles were not aesthetic enough! While I am not a judge of the aesthetic sensibilities of workers in the field of solid waste, I am confident that *not one of them* would have supported the artists' decision to nix the use of recycled materials—not when markets for recycled materials need to be built, not when people who separate their recyclables for drop-off or collection need to be educated to buy back recycled products.

I am not suggesting nit-picking the creative exuberance of artists; but someone with an understanding of solid waste problems needs to keep the educational focus on target and within a stone's throw of reality. The way a society presents garbage to itself in public does say quite a bit about that society. In our current situation, I believe that it is best to let garbage be garbage, landfills be landfills, and recycled be recycled!

The DeKorte Garbage Museum deserves more than the cavalier handling I have just awarded it. As the first of its kind, it deserves respect for treating a difficult subject seriously. Those exhibitions that follow equally deserve to be held to a higher standard based upon the educational needs perceived by the solid waste community.

All the News That's Fit to Dig Up

Do you happen to know the guy who has the newspaper with a "LINCOLN ASSASSINATED!" headline? He found it when someone was digging up his landfill (or dump) to put in methane wells (or make some other sort of modification). I have heard about him from any number of informal sources, but he hasn't been easy to locate. The reason is that each story I hear places the find at a different landfill, and no one is completely certain of the finder's name or what has become of the newspaper. After I heard the Lincoln Newspaper story a few times, I recognized it as a modern-day urban myth, like the lady who discovered that bees had built a hive in her bouffant hairdo or the grade schooler who chomped down on spiders' eggs hatching in his bubble gum.

I don't know whether there is any reality behind these myths, but they are widespread. I have retold the Lincoln Newspaper tale only to clearly separate it from the Garbage Project's recovery of old, datable and readable newspapers from landfills.

Since 1987 the Garbage Project has conducted digs at 14 landfills across North America—two in Arizona (one in Tucson and one in Phoenix), two in California (both near the San Francisco Bay), two in Illinois (both in greater Chicagoland), three in Florida (two near Naples and one by West Palm Beach), one in New York (Fresh Kills, New York City's land-

fill on Staten Island), and four in the Toronto Metro Area. The exhumed refuse was sorted and recorded by student researchers. Most were from the University of Arizona, but every dig outside of Tucson involved students from universities in the vicinity of the landfill that was excavated. Every one of them knew what a newspaper looked like.

The analysis of nearly 300 refuse samples led to a record of 2,425 identifiable newspapers that were both datable and readable—that is an average of 6.43 newspapers per sample. These newspapers were not mere bits and scraps. Out of 10 tons of refuse (excluding cover soil) extracted from landfills and analyzed, fully 1 ton (2,251 pounds to be precise) was easily identifiable as newsprint—that is an average weight of 0.93 pounds per newspaper. The newspapers extracted from each of the Garbage Project's 14 study landfills range from a low of 5.7 percent of refuse by weight (Durham Road Landfill, Fremont, California) to a high of 18.5 percent (Rio Salado Landfill, Tempe, Arizona). Nine of the 14 values for newsprint are higher than 13 percent, including the values for two landfills—one in Canada and one in Arizona—that received waste only during the 1950s. The weight percents for the newspapers from the three landfills that receive the most yearly rainfall (not surprisingly, all three are located in Florida) were 11.7 percent (Collier County Landfill), 14.7 percent (old Naples Airport Landfill), and 14.1 percent (Cross State Landfill, West Palm Beach). Overall, one pound out of every 10 in a sample of 19,314 pounds of landfilled refuse was newprint.

Like most people, I was suprised by these quantities; but as an archaeologist, they shouldn't have. All kinds of organics have survived intact for centuries in a wide variety of microenvironmental situations: from a peat bog in England, archaeologists have exhumed a 2,500-year-old "bog man" who was preserved down to stomach contents and nose hairs, from under a 400-year-old mud slide covering the Ozette site in Washington State they have extracted delicately carved wooden objects and from deposits in caves in the southwest and Mexico, sandals and baskets have been recovered that were woven more than 1,000 years ago. And how could I ever forget the work of Daniel Winthrop Ingersoll?

Dan and I were archaeology students at the same graduate school while he was excavating the Puddle Dock site in Portsmouth, New Hampshire. Puddle Dock was a waterway, with docks and wharfs, which was intentionally filled in sometime during 1899.

Using chemical barriers and sump pumps to keep groundwater from flooding his trenches into the original fill, Dan retrieved ceramics, glass bottles, koalin pipes, clay pigeons, and *newspapers*. The newspapers dated to August 1899 and carried stories reporting the Dreyfus case (the internationally infamous retrial of a French officer who had been framed on a charge of treason) and "troubles" at a nearby prison, as well as quotes for gold and silver prices, baseball scores, funeral notices, an intriguing variety of want ads, and even a color tabloid titled "Life in the Suburbs." If Dan Ingersoll could excavate newspapers from a waterlogged dump that was more than 80 years old, are newspapers preserved for 40 years in "dry" landfills all that newsworthy?

The newspapers of the Garbage Project exhumed from landfills contained another surprise for me. When I read a newspaper today, I am often tempted to say, "Oh, how times have changed from the simpler and more wholesome days of my youth." Reading newspapers printed over the past 40 years quickly rid me of this naïve notion: instead of today's Colombian cartels, in the 1950s the flow of drugs was blamed on "the Reds"; instead of the Near East as a hotbed of hostages, in the 1950s it was Asia—a story in March 1952 disclosed that the U.S. government paid $800,000 to Red China to release 12 Americans; even back in the 1950s conflicts in the Balkans made headlines, except instead of the Croats and the Serbs, it was the Greeks and the Bulgars—and the United Nations was enmeshed in the mess then as well; there were disagreements over teacher salaries and school bond issues on the same 1950s page that reported a meeting between "Churchill and President"; and, just as today, 1950s papers carried reports about floods in the midwest and concerns about falling groundwater levels in Arizona. The same kinds of stories filled our unearthed newspapers from the 1960s and 1970s and 1980s.

And just in case you think that solid waste problems have become complicated only in the last decade, here's a 1971 quote in "lawyerese" from

attorney Morris L. Gerst reported in a Phoenix newspaper under the headline "Sanitary Landfill Foes Ask (Gov.) Williams to Stop City Deal: I acknowledge that I am one of several legal representatives of hundreds of landowners. I acknowledge that we have an 'axe to grind' by reason of major damage to the value of several thousand acres of our nearby land."

Sound like NIMBY? As any archaeologist who keeps up to date on the past can tell you, one old cliché is accurate: The more things change the more they stay the same—and there will always be newspapers in our landfills to prove it.

O.J.'s Bag

O.J.'s bag—the fancy designer bag that prosecutors seemed to suggest (1) contained a bloody knife and clothing and (2) was dumped on the night of June 12/13 into a trash receptacle stationed at American Airlines' curbside loading/unloading zone at the Los Angeles Airport (FAA code name: LAX). I received several calls about it a few weeks ago. Believe it or not, I had anticipated this development in the O.J. case. After all, sooner or later, everything comes down to garbage.

I had also noted that the manager of the BKK Landfill, the most likely repository for trash from American Airlines' loading/unloading zone at LAX, was not optimistic about finding the bag—if, in fact, it ever really existed. I was not generally optimistic either.

As director of the Garbage Project, I have received many pleas for help from unfortunate souls who have lost to landfills everything from diamond rings (most often discarded mistakenly from a kitchen counter with newspapers and potato peelings) to priceless family heirlooms (such as a diary kept by an ancestor during the Civil War), and most tragically, parts of murdered family members. Those who arrive at a landfill to quest for their freshly discarded and interred valuables are many; those who return with their grail in hand are few.

Despite logistical nightmares, a full-press landfill search is not altogether hopeless—just expensive and labor intensive. Given enough time and money, however, just about anything that has been buried in a landfill—by intention or by mistake—can be recovered. Take an infamous South Carolina case: in February 1991 a local newspaper, the *Greenville News*, won a state Freedom of Information Act lawsuit against the University of South Carolina's Carolina Research and Development Foundation. The South Carolina Supreme Court ruled that the newspaper could review the foundation's financial records—records that would eventually help convict (in May 1991) former University of South Carolina president James Holderman of state tax evasion.

Trouble was, many of the documents that recorded disreputable financial dealings had been dumped into the Richland County Landfill in September 1988. During the intervening 30 months, the landfill had received about 480,000 tons of additional trash, which accounted for eight new refuse disposal cells at the burial site. Each of those cells measured about 1,000 feet long by 150 feet wide and 20 feet deep. To make matters worse, Richland County Landfill was a codisposal site where municipal sewage sludge was spread over each day's fresh refuse, partly to jump-start the biodegradation of organics such as paper.

That didn't stop Tim Smith and William Fox, two stubborn and gutsy *Greenville News* reporters, from mining the landfill for the journalistic equivalent of a mother lode. As a veteran of 15 landfill digs, I knew the odds were excellent that the documents were still intact and readable; but the odds of actually finding their burial site inside the landfill seemed to me to be beyond hopeless. Luckily, Smith and Fox didn't ask for my opinion.

Based on the advice and assistance of the landfill staff, the reporters began their search at the "crust" of demolition and cleanup debris spawned by Hurricane Hugo, which had hit South Carolina in September 1989. As digging progressed, the reporters rapidly assimilated the basic tricks of the archaeological excavation of landfills.

Donning gloves and masks, they followed a backhoe, systematically combing through mountains of refuse with shovels and rakes. By reading the dates on the numerous newspapers that were unearthed, they worked their way back in time toward September 1988.

Like The Garbage Project's staff, the reporters were surprised to find newspapers and other paper artifacts in near-pristine condition. The discovery

bouyed the searchers' hopes. For an entire week, a backhoe scooped refuse out of trenches. These wastes were examined, dated, and then reburied. As the backhoe crawled methodically onward, the equivalent of a football field was excavated to depths of 6 to 18 feet.

Oh, how I wish I could have been at Richland County Landfill in March 1991, when the crew hit pay dirt. The cardboard containers had largely dissolved, but the papers were still intact after 30 months of codisposal burial—soggy and smelly, but eminently readable.

As rewards for their diligence, the reporters and their editors won the AP Managing Editors' Public Service Award, the Investigative Reporters and Editors' Award, two awards from the Headliners Club, and the Seldon Ring Award, which included a hefty cash prize.

But probably the most fitting reward was justice: in addition to the former university president's conviction, the entire board of directors and two top executives resigned from the Carolina R & D Foundation, and new state laws were enacted to ensure public access to foundations receiving public money.

Given this lesson, perhaps I should be more optimistic about the chances of finding O.J.'s bag in an L.A. landfill—but I'm not. In the South Carolina case, the reporters knew for a fact that the documents in question had been buried in Richland County Landfill—they found and interviewed the men who transported and dumped them.

The problem with the O.J. case is that the bag may never have been buried in any landfill. In the first place, it may not ever have existed. Second, if it did exist, my bet is that either a self-appointed scavenger or the official LAX garbage collector reclaimed the bag from the trash without realizing its significance at the time.

If a search is ever mounted, now, with the case in the eye of this nation's biggest media storm ever, is not the time; there's no need to add another frenzied ring to the trial's media circus. If the bag is there and if there ever is a serious search—perhaps like the hunts for the Titanic or for Tut's Tomb—I know that some garbage archaeologist will be there when its found. Sooner or later, it all does come down to garbage!

The Great Landfill Cover-Up

An extraordinary cover-up has been going on at landfills—and it is nationwide in scope. The cover-up is the six or so inches of cover soil distributed over the working face in most landfills. Over the last decade, however, many operators have been experimenting with ADCs, or "alternative daily covers."

ADCs have been the subject of articles (see, for example, in *MSW Management*, Anne Magnuson's feature in September/October 1996, John A. Merritt's evaluation in March/April 1997, and the "Landfill Equipment" note in May/June 1997) and discussions throughout the industry. ADCs also bear more than their share of uncertainty. As Ms. Magnuson concluded, even though ADCs "are cheaper than dirt," confusion exists regarding government regulations and other issues.

Over the last 24 years, the Garbage Project has collected a large quantity of rather esoteric data on the composition of fresh household refuse and landfills full of old garbage. The uncertainty about the overall value of ADCs provides an opportunity for some of this odd information to become relevant in assessing the value of alternative daily covers.

We know for certain that most ADCs consume little or no space within landfills. To me the key issue is just how much of the precious space inside landfills does cover soil occupy. Several studies have been carried out by environmental consultants like Schillinger, Salerni, and Boyd, Inc., in their work to reclaim landfills in rural New York State. They reported that "conditions vary widely from landfill to landfill. The ratio of soil to trash can be 1:4 or 4:1." This conclusion was reached after 16,000 cubic yards of materials were shaken mechanically on a trommel with a three-inch screen, and a subsample of materials caught in one-half-inch screens was hand sorted.

But what about the materials that went through the screen? Were they mainly cover soil, or, as most often suggested, were they mainly degraded and decomposed refuse? In at least the 15 landfills the Garbage Project has excavated, that question can be answered with some certainty.

Garbage Project sorts have always begun with what is caught in a one-half-inch screen and work down from there. Subsamples of the "fines" that pass through the one-half-inch mesh have then

been "wet screened," or washed through first a one-quarter-inch screen and then through a one-eighth-inch screen. All of the materials that are caught in the screens are saved and carefully subdivided by students using magnifying glasses, dental picks, and tweezers. The detail of the "fines" sort is quite amazing. Student sorters pick out small pieces of newspapers, computer printouts, phone books, bits of glass and metal, grape stems, seeds, and even small pieces of eggshells. If you wanted to know what percentage of a landfill was eggshells, we could tell you. No one has ever asked, but we could tell you.

The first interesting pattern that emerged is that the older the landfill, the more rocks and dirt. In the 1980s, people began worrying about disposal costs and landfill space and it showed in a general decrease of about one-third in the quantity of daily cover spread. Of course, there are exceptions. Fresh Kills, New York's landfill on Staten Island, has operated 24 hours a day for decades. Under this regimen, there is little cover soil until the final cap.

A much-newer landfill in Packington, England, run by BFI, has added its own innovation to a no-daily-cover system. They build the soil that will become the final cover into a berm 10 or so feet high around the working face, which itself is kept flat. Garbage trucks enter through a tunnel created by a double berm of cover soil. The effect is to protect the newly dumped refuse from wind and to virtually eliminate the litter that can often surround landfills that have their working faces exposed on top of a hill.

Where cover soil is used, that six inches of dirt distributed over a landfill's working face really adds up! Think about it. Once a bulldozer spreads a day's refuse out, it is only a few feet thick—and much of that thickness is air. A layer of dense soil cover has got to be significant as the icing on that cake.

It is. The variability in the Garbage Project's 15 urban landfills is large, but somewhat lower than that in rural New York State. Overall, soil and rocks ranged from 30 percent to more than 60 percent by weight (or 1:2 to 2:1) and 10 to 56 percent by volume (or 1:9 to about 1:1) in landfills. The highest weight and volumes were from a landfill operated only during the 1950s.

In terms of deciding on the value of ADCs versus dirt, it is important to consider that "fines" include the largest percentage of daily cover material—about two-thirds by weight and volume. And these two-thirds are largely soil, not decomposed or decomposing refuse. ADCs of all types—foams, films, even cullet—have the potential to decrease the costs of cover soil, but also to extend landfill life substantially and defer the political and emotional headaches of siting new landfills and paying their high fiscal costs.

Disaster Garbage

In August I flew to North Carolina to be part of a solid waste seminar for middle school teachers. On the plane I suddenly realized that the eye of Hurricane Bonnie and I were scheduled to set down at about the same time and place. For some reason that upcoming event focused my thoughts on "DD"—disaster debris!

Archaeologists love to find DD. The deeper the debris, the more they love it. Finding the remains of a megadisaster is one of the surest ways for an archaeologist to attain renown. In Pompeii and Herculaneum—two Roman towns buried under tons of volcanic ash and lava from the eruption of Mt. Vesuvius in 79 C.E.—in Kourion—a farming community on the island of Cyprus decimated by an earthquake on July 21, 365 C.E.—and on the HMS *Titanic*—sunk in the North Atlantic on April 15, 1912—the intimate details of daily life are nearly perfectly preserved without the desecration that abandonment to the elements of nature or that scavenging and wanton destruction by humans who happen to pass by reek upon the remains of our past. Long after the human suffering had ceased, such devastating events are the inexhaustible fodder for spellbinding tourist attractions, spectacular museum exhibits, blockbuster movies. For some reason, we are all drawn to disasters . . . and the mountains of their garbage!

David Soren, the renowned (obviously) archaeologist who has been painstakingly excavating Kourion for almost three decades, identified the "telltale fingerprints" of an earthquake as: (1) debris, (2) collapsed structural materials, and (3) bodies left where they lay in the rubble. He is, of course, correct. I would like to expand upon Soren's defini-

tion by making a few additional observations that characterize the "wastes" from earthquakes as well as all other DD.

To my thinking, the key characteristic of DD is that it is studded with very large numbers of valuables and still usable utilitarian items. In the old days, the debris from megadisasters, like Pompeii, Kourion, and the *Titanic*, was left where it lay. While digging into Kourion, for example, Soren and his colleagues uncovered unusual quantities of jewelry, intact glass and metal containers, bronze proportional dividers used by an architect or marine navigator, a number of coins, and a fascinating bronze lamp in the shape of a duck, whose wicks rested in an opening in the tail, "so that," as Soren described it, "when (the wicks) were lit, the bird appeared to be turning around to examine why its tail was afire" (read the rest of Soren's account and see the duck in the July 1988 *National Geographic*).

Today, we spare virtually no expense to immediately rescue victims and recover bodies; and, while we spend extraordinary monies on documenting the cause of the disaster—for example, the "fingerprint" of terrorism—little thought or effort is given to retrieving valuables or useful commodities. Indeed, once the rescue and investigation phases are completed, we cannot wait to rush the remaining DD to landfills without the methodical scavenging that accompanies the demolition and removal of virtually all other wrecked structures and vehicles. This is one of the reasons why those who have recently handled the detritus of disasters, like Barry Shearin, the utilities superintendent of Winston-Salem/Forsyth County Utilities Commission (North Carolina), often comment on the large number of still-usable and easily repairable items he sees passing into disposal facilities for burial.

The same types of solid waste officials also note that another key characteristic of DD is a high proportion of green waste—bushes, huge tree branches, whole trees, and such. In fact, in his writings, Soren notes the same thing himself.

A third characteristic that I would add to a description of DD is its amazing scale. Garbage has surprised me many times, but the biggest surprise to date occurred when I visited the largest landfill in San Juan, Puerto Rico. The landfill is composed of three large mounds, and my landfill guide explained, "That hill is garbage from the seventies and eighties, up to 1989. The one we're standing on is 1989 up to the trash you see being dumped right next to us. The third one, over there, is all debris from Hurricane Hugo" (which hit Puerto Rico and the U.S. mainland in 1989 and cost $7 billion in damages).

One colossal natural disaster equaled one gigantic garbage mound! I was stunned. Over the two decades I have spent with garbage, I have come to realize the immense quantities of solid waste created by construction and demolition (C/D) activities—at least 20 to 30 percent of the volume in the municipal landfills the Garbage Project has excavated. But I had never thought of the stupendous amounts of DD left to clean up in the wake of a megadisaster. Obviously, I should have.

Now I can recall that local students working with us on our landfill digs in Florida were able to guess the date of garbage below what looked like a thick layer of disaster debris. "Oh," they'd say, "from the newspaper dates just above it, I'd bet that debris is from the 'No Name' tropical storm that hit us in 1982, so the garbage under it must date to before the middle of that year." And they were always right. No wonder. In August 1993 the *Warmer Bulletin* reported that in Collier County, Florida, "cleaning up after Hurricane Andrew in 1992 filled four years of landfill capacity." Disasters are like an instantaneous megademolition, usually followed today by lots of rebuilding. In fact, the two largest garbage generators in North Carolina are DD and C/D!

Debris from a particularly destructive disaster is what an archaeologist would call a "horizon marker"—a huge swatch of recognizable materials disposed of over a short time span. The day I arrived, a fire created such a marker in Winston-Salem by consuming "256," which for decades had been the plant where RJR had made tobacco products. The fate of this huge historic complex was especially tragic for Winston-Salem because the fire was started by the torch of a workman who was remodeling the structure into condos and office space for a new Piedmont Triad Research Park, a renovation job that would have prevented hundreds of truckloads of C/D from crowding into Winston-Salem's landfills.

Many landfills entomb such sad horizon markers that are the material legacy of hurricanes, earthquakes, tornadoes, floods, mudslides, and tidal waves.

The last characteristic of DD is intangible, but, I believe, just as real as the rest. There is no garbage in the world more thoroughly drenched in sorrow and tragedy. I don't hold with curses or spells, but I would not want to be the archaeologist who excavates the grim horizon markers created by the human-made DD from the bombing of the Murrah Federal Building in Oklahoma City, the bombings of the U.S. embassies in Dar es Salaam and Nairobi, or, no matter how justified they were, the U.S. missile strikes against Sudan and Afghanistan.

As unlikely as all of the above events seemed before they occurred, the impact of each was devastating, both to people's lives and to the solid waste management system. No matter how much reputation is at stake, no archaeologist wants any further disasters to occur. Nonetheless, as much as we want to avoid such thoughts, the findings of archaeology and history tell us that disasters—natural and human-made—will continue to disrupt our lives and must be a part of all kinds of solid waste management planning.

Is Santa Claus Coming to Sandtown?

I have been quoted as saying that "Next to Santa Claus, the most popular *myth* in America is that garbage biodegrades in our landfills!"

Honestly, I am not sure I ever said *that*, but I will admit to saying something like that. I said it because the staff and students of my Garbage Project (in BARA—the Bureau of Applied Research in Anthropology—at the University of Arizona) have excavated bucket auger wells and backhoe trenches in 15 landfills over the last 12 years. That, in itself, is not unusual. What is unusual is that these "garbologists" systematically sorted through samples of the exhumed materials, divided them into 30 or more categories, and recorded each category by exact weight and volume. In this process, they logged in a large portion of our buried discards that "should" have biodegraded, but didn't.

The most obvious candidates for biodegradation that we constantly find preserved are datable, readable newspapers buried 10, 20, or 30 years before excavation. My favorite headline is "Future of Europe Depends upon Conferences between Churchill and President"—January 7, 1952, excavated from Rio Salado landfill in Tempe, Arizona, in 1989. It is important to note that we did not just find one or two newspapers. The Garbage Project has documented 2,425 datable, readable newspapers that represent 15 to 20 percent or more of the volume of the refuse samples from every landfill the project has excavated. For the record, these landfills are not only in dry Arizona—two are in Arizona (about 11 inches annual rainfall), two in the Bay Area of northern California (about 22 inches annual rainfall), two in Chicago, four in Toronto, one in New Jersey, and New York City's Fresh Kills Landfill on Staten Island (about 36 plus inches annual rain- and snowfall), and three in Florida (about 80 inches annual rainfall).

As a result, I am, at best, skeptical about biodegradation in landfills. Now I may have to eat my words.

The reason is N. C. Vasuki, the chief garbageperson (CEO) of the Delaware Solid Waste Authority. I first met N. C. when we both gave talks in 1988 at a meeting in Washington, D.C. At the time, N. C. was enthusiastic about designing "bioreactor landfills" that would significantly enhance the breakdown process of buried refuse.

N. C.'s dream of landfills that biodegrade their contents is shared by most Americans. In fact, the public already believes that landfills were designed to biodegrade their contents. Nothing, in fact, could be further from the truth. When the first "sanitary landfill" was designed in 1911 at the University of Illinois and when sanitary landfills suddenly became nationwide fixtures in the aftermath of World War II, the original intent of "land fills" was to "fill" swamps, washed-out riverbanks, gravel quarries, and other land that at the time was perceived as "useless." There were even thoughts of building homes and businesses on top of the garbage after the landfills were closed. If you are going to build something on a garbage disposal site, the last thing you would want is for it to begin to settle and sink as garbage biodegrades!

But if the original landfill designers didn't want biodegradation, just about everyone I know today does. Whenever I give a talk about how many of

our society's discards are preserved in landfills, the first question is invariably, "Well, if landfills don't biodegrade our garbage, how can we fix them so they will?"

Solid waste businessmen and government officials couldn't agree more. In the past 30 years, both groups have come to see the methane produced by microorganisms as a by-product of the biodegradation process as a valuable source of both energy and revenue. To the best of my knowledge, in 1971, Palos Verdes in the L.A. Metroplex was the first landfill to begin to collect and clean its methane—one of the first uses for the energy was to light a Christmas tree—rather than just burn it off. Now, most landfills are following the Palos Verdes model.

To help predict the amount of methane that will be produced by landfilled refuse, numerous solid waste and microbiological laboratories have conducted controlled experiments; some involved filling huge lysimeters with wastes to simulate landfill conditions and others involved processing solid waste components in a variety of different ways, including grinding (sometimes to 2 millimeters in size) and adding different quantities of fluids. However, as premier landfill experts, like Professors Morton Barlaz and Robert Ham and Dr. Jean Bognar, have determined, the expected yields of methane have usually been well less than half what was projected. Something wasn't "working." At the same time, Dr. Fred Pohland was finding that the recirculation of leachate increased gas production.

What the Garbage Project determined in its 15 landfill digs is that within the first 15 to 20 years of burial about half of all raw organics—food and yard wastes—biodegrade. That is what generates the methane gas. After that initial spurt, however, biodegradation seems to slow to a crawl. That is why most early methane wells, drilled in areas where new garbage hasn't been added for more than two decades, are now closed. That is also why the Garbage Project has dug up whole T-bone steaks (lean, fat, and bone) and heads of lettuce and Kaiser rolls after they have been buried more than 20 years. As far as paper goes, the Garbage Project has seen little evidence of any significant biodegradation, except within the most fragile components, such as facial tissue.

To the public, the major reason landfills don't "work" is because they shut out light and oxygen. The solution for many cities, such as Los Angeles, has been humongous above-ground composting facilities where aerobic microorganisms make short work of the organics in garbage. But such facilities are rarely popular with their immediate neighbors and some versions of "contained" composting (which cuts odors and potentially harmful wind-blown fungus, such as *aspergillus*) can be costly to build and operate.

Unknown to most Americans, anaerobic (non-oxygen) microorganisms are on the job in landfills—they just aren't as fast as similar aerobic microorganisms. Laboratory studies have determined that they need lots of fluids. In addition, both laboratory and landfill digs suggest that the fluids must move. I personally believe that the "movement" of fluids is the most critical component of the biodegradation mystery. If fluids don't move, biodegradation usually doesn't occur. In fact, any archaeologist would give a significant body part to dig up a water-logged site. Consider the "bog men" of Denmark. They were preserved, down to their nose-hairs and stomach contents after 2,000 years, because they were thrown into stagnant swamps.

On that day in Washington years ago, I found that N. C. Vasuki had a very dry sense of humor, but he planned to collect "wet" leachate at the bottom of his "bioreactor" landfill and pump it back into the landfill from the top—adding both fluids and movement. He based his plan on Dr. Pohland's laboratory experiments at Georgia Tech in the early 1970s. I was impressed, but still not convinced that a "bioreactor" landfill would "work."

In the middle of last year, N. C. called the Garbage Project to help him evaluate the success of his "bioreactor landfill," which was by then an eight-year-old physical reality in Delaware.

My original thought was, "But how much can N. C. expect in eight years?" I should have known him better.

On the assigned date, the Garbage Project collected seven samples from two test cells, one "bioreactor" (wet) and one traditional (dry). The wet and dry samples were excavated by backhoe from a depth of about 12 to 15 feet. They weighed

between 37 and 67 pounds each when taken from the ground.

Next, student sorters determined moisture content by filling a five-gallon bucket with part of the sample refuse, weighing it, drying it from October 13 to December 1 (48 days), and then weighing it again when its weight stabilized. During this same time, the rest of the materials in each Sandtown landfill sample were sorted into 37 categories (food debris ("once-edible" food separated from "nonedible preparation debris"), newsprint, paper packaging, matrix (small bits and pieces that at the beginning of the sort fell through a half-inch screen), glass, steel, aluminum, and on and on).

When the figures were all compiled, the staff, students, and I were surprised.

The first surprise was moisture content. The samples from the "dry" cell were somewhat wetter (an average of 20.2 percent moisture content) than the samples from the "wet" cell (an average of 15.7 percent moisture content)! Since leachate collected at the bottom of the wet cell was pumped into the top, I was shocked. At first it didn't make any sense; now it does—I'll revisit these moisture content figures later.

The rest of the graphs were what N. C. was expecting and I was not.

Food items, which by Garbage Project and all other study results are the most rapidly biodegraded materials, were almost nonexistent in the wet cell (an average of 0.29 percent by weight) and much more prominent in the dry cell (an average of 2.58 percent by weight). In fact, the lowest dry cell weight for food items (0.45 percent) was only slightly lower than the highest wet cell weight (0.49 percent). It could be that significantly less food was thrown out with the garbage that went into the wet cell, but the difference was so consistent and divergent . . . .

Newspaper, which is a significant quantity of the paper in MSW, seems to be highly resistant to biodegradation—as Professor Robert Ham noted in his studies of "salted" samples that he buried and later dug up in landfills in Wisconsin and Florida. The Garbage Project analysis showed that the wet cells (an average of 22.41 percent by weight) held slightly more than the dry (an average of 20.99 percent). But one of the dry cells (sample 2-1) had no newspaper contents whatsoever. If that particular area of the dry cell actually held no newspaper to begin with, then the dry cell held more newspaper overall (an average, without sample 2-1, of 27.99 percent).

The third biodegradation-sensitive category, matrix (the fine materials that goes through half-inch screens—note that no cover soil was added to the Sandtown dry and wet cells) documented another striking difference between the wet and the dry cells. My assumption has always been that the more matrix, the more biodegradation that may have occurred, especially if the cells were filled at the same time with the same amount of cover. The dry cells held an average of 18.53 percent matrix; in contrast, the wet cells included an average of 28.53 percent matrix—a lot more!

Placing the three categories together—food items, newspaper, and matrix—I have to admit that there seems to be a pattern, but . . .

I wanted to be thorough—perhaps especially because I wasn't expecting these results. So I decided to compare the wet and dry results to the one landfill the Garbage Project had dug that showed clear evidence of biodegradation—Fresh Kills.

In the late 1940s New York City was looking for a place to deposit its garbage. The city focused its attention on a swamp on Staten Island called Fresh Kills, which was created by a series of small streams (the Dutch word *kill* means stream) that eventually emptied into the ocean. The area was ideal in that era for the concept of a land "fill." As a result, in 1948 the city began dumping trash into Fresh Kills. Because it was a tidal swamp, water from the surrounding ocean travels through Arthur Kill (the waterway between Staten Island and New Jersey) in and out of Fresh Kills every day. When the tide came in, the water "wicked up" into the landfill (as garbage soaked it up), and when the tide went out, the water level fell. The result, in pre-liner days, was a landfill with plenty of fluids that *moved*.

When we dug the Fresh Kills Landfill in 1989, the Garbage Project discovered, for the first and only time in the fifteen landfills it excavated, the results of significant biodegradation—the bottom of the landfill contained large quantities of what we called "gray slime" and glass bottles, pieces of metal, large chunks of disintegrating lumber, and little else.

If Fresh Kills is a biodegradation ideal—"ideal" except that the leachate flows directly into Arthur Kill and then the ocean—then it was important to

compare Fresh Kills contents over time to those of the wet and dry cells in the Sandtown landfill in Delaware.

The comparisons were, to me, unequivocal, especially when "trend lines" were calculated that summarized the Fresh Kills data heading toward biodegradation.

Food Items: All three wet Sandtown landfill points that measured food materials were *below* the Fresh Kills trend line. Three of the four dry sample points from Sandtown landfill were above the trend line.

Newspapers: All three of the wet Sandtown landfill points that measured newspaper were above the Fresh Kills trend line, but the wet Sandtown landfill points were far more in line with the Fresh Kills trend than the dry Sandtown landfill points.

Matrix: All three of the Sandtown landfill wet points that measured matrix were below the Fresh Kills trend line, and so were all four Sandtown dry points. But the wet points were much more in line with the Fresh Kills trend line, showing an increase in matrix through time, than the dry points.

The Fresh Kills samples that showed significant signs of biodegradation and that led to the final Fresh Kills trend lines had been buried under ideal conditions for biodegradation for more than 30 years. The Sandtown sample materials had only been buried for 10 years.

Now, back to the moisture data from the Sandtown samples. The divergent high and low levels of moisture in the dry samples is typical of most of the landfills the Garbage Project has excavated. Water is trapped in lenses of garbage that were wet when deposited, and little water moves into refuse that was dry when dumped. In contrast, the three moisture levels for the wet cell samples are very similar. I believe that these results may indicate that fluids are moving *through* the waste materials in the wet cell. N. C. has also pointed out that for one brief experiment, the top over the dry cell was breached and significant rainfall might have entered.

Overall, there seems to be patterning in the seven small samples of landfilled materials the Garbage Project analyzed from the contents of the wet and dry cells at Sandtown. It is just as obvious that after only eight years of burial, any full demonstration of significant biodegradation must await the test of a lot more time.

Nonetheless, every so often now, in the quiet of early morning in the desert, I can distinctly hear the faint sound of sleigh bells . . . .

The Hazards of Being a Can Tosser

Tom Price was a can tosser's can tosser and one of my true heroes. Tom was in charge of Tucson's Sanitation Division when I met him in 1973 to explain my idea about a Garbage Project and ask for his help. He gave unsparingly of himself and Tucson's refuse from that day until 10 years ago when he died of leukemia. Every year at about this time, I try to do something to remember Tom. This year, I decided to take a look at can tosser safety, an issue that Tom always made number one.

Over the last 25 years, I have seen a number of references made to explosions, fires, caustic splashes, and other extremely nasty accidents involving refuse workers and household hazardous wastes (HHW). As a result, I thought that trying to identify the risks to can tossers posed by HHW would be a good place to start. Obtaining information on the nature and frequency of HHW injuries was not easy. As one example, I just read a 1997 article in an environmental health journal on household hazardous waste. It presented a figure for HHW injuries to waste collectors. The figure used had come from an article published in 1993 in a Canadian civil engineering journal, which in turn cited a 1988 article, which referred to a study published in 1986, which was largely anecdotal. Such referencing over a decade is, of course, the way academia works; but day-to-day refuse workers would obviously benefit from more current and more broadly representative information.

The U.S. Bureau of Labor Statistics (BLS) annually compiles reports of national "nonfatal occupational injury and illness" statistics per 100 full-time workers. There is no category for HHW injuries, so I looked for likely injury types. According to the BLS's reports for 1992, 1993, and 1994, there were no injuries to "garbage collectors" (code #875) from "heat burns" or "chemical burns." In addition, over the same three-year span of 1992 to 1994, between 0.55 percent and 1.06 percent of injuries to garbage collectors had their source in "chemicals and chemical products," which include both residential

and commercial sources. Finally, the BLS reported no "events or exposures" to garbage collectors due to "fires or explosions."

In contrast to the low number of potentially HHW-related incidents, the majority of problems reported by the BLS were "sprains and strains," which between 1992 and 1994 accounted for between 45 and 51 percent of all injuries to waste collectors. This would seem to confirm the characterization of injury types reported in the *Encyclopedia of Occupational Health and Safety* (1989), which identifies back strains as the leading single injury type among refuse collectors. Compared to sprains and strains, the BLS record suggests that injuries involving HHW in the sense of chemical product wastes are infrequent. There are other HHW items that do pose a much greater risk to garbage workers.

A 1994 article in *Safety + Health* magazine concluded that the garbage collectors at greatest health risk are those exposed to "sharps" (hypodermic needles and cutting tools) from hospitals and other sources that could be infected with human immunodeficiency virus and acquired immune deficiency syndrome (HIV/AIDS), hepatitis B (HBV), and other infectious diseases. Sharps are relatively common in residential refuse because of diabetics, other people in need of in-home injections, and intravenous drug users. The risk to sanitation workers from sharps of all kinds was also highlighted in a 1992 report to Congress by the Agency for Toxic Substances and Disease Registry. The reason for the concern is obvious in the BLS records. "Cuts and punctures" accounted for between 7.7 and 13 percent of all nonfatal injuries reported by can tossers.

National data are valuable for placing rates and frequencies in perspective, but there is no substitute for getting local specifics. For that, the Garbage Project staff examined injury data collected by Tucson's Sanitation Division over a 14 year period. In all, more than 3,000 man-years were represented. During the 14 years, the division recorded 1,201 injuries—less than one event for every two man-years. The vast majority were, as expected, sprains and strains. There were also a small number of injuries—15—attributable to "hazardous waste." Of these, 11 were due to chemical exposures and four were due to needle sticks. There were also 92 "punctures" from other sharp materials in the refuse.

The Tucson record shows a lower rate of injury than the overall BLS national statistics, but the general types of injuries in Tucson seem similar to national records. They suggest to me that one of the most important steps that could be taken for can tosser safety would be to focus more attention and information on needles and other sharp materials in commercial and residential refuse.

One encouraging step in that direction is that retractable needles are now on the market for hospitals, for give-away programs to intravenous drug users, and for home use. Nevertheless, retractable syringes are more expensive than normal needles and refuse is studded with all kinds of other sharp materials that account for the vast majority of punctures suffered by sanitation workers. And any of those materials could carry infectious diseases. Given the prevalence of puncture injuries, alerting the public to the dangers refuse collectors face from sharp materials would be a valuable contribution to worker safety.

What is the overall direction in can tosser safety over the last 20 years? Because of the differing reporting protocols used by different agencies that record worker injuries, I was only able to tabulate overall injury rates; but those were encouraging. National Safety Council records report injury and illness incidence rates per 100 full-time employees as 8.43 in 1975, 6.81 in 1980, 4.23 in 1985, and 6.97 in 1990. When combined with BLS data from 1992 to 1994, the trend continues to be encouraging: 4.48 in 1992, 6.17 in 1993, and 4.38 in 1994—heading down with some bumps. While no trend is steady year to year, there seems to be a general trend toward lower frequencies of injuries from 8.43 in 1975 to almost half that rate—4.38—in 1994.

These data appear to indicate some good news for garbage collectors—that their injury rate is declining. Perhaps one reason is major steps taken at refuse collection agencies and companies nationwide. Since the vast majority of injuries occur when workers are directly exposed to wastes or during the actions of lifting or moving wastes, worker safety is one of the reasons many communities have adopted "mechanized" collection technologies—by which a driver-

collector manipulates a mechanical lifting device and avoids most direct contact with refuse. Although I don't have hard data yet, I have heard estimates that at present more than 30 percent of refuse collection systems across the United States are mechanized. Just to substantiate the injury-prevention effectiveness of such systems, it would be valuable to compare the injury records in several communities before and after implementation of mechanization. Maybe I'll do that at this time next year.

See, Tom, things are getting better for your can tossers. If we keep thinking about "sharps," they can get even better still.

The Perfume of Garbage*

** The title is courtesy of Michael Shanks*

I find myself on planes fairly often and end up talking to strangers. For a decade and a half, when someone would ask me what I did for a living, I would change the subject. As I found every time I didn't, most people couldn't understand why any sane person would systematically sort through garbage and write it all down item by item. All I'd get would be stares and then an embarrassed silence.

Blacks and other minorities have long complained about the inhuman consequences of racism. Over the last two decades, women have increasingly focused on the degrading aspects of "sexism." Even though our discrimination is of a lower order, I believe that those of us who deal with garbage every workday should cry "foul" because of "garbage-ism"—the intensity with which virtually everyone ignores garbage people and the jobs we do.

In one of my columns I claimed that for the vast majority of Americans, garbage is "in sight, outta mind." This column is the second installment on the same topic. Garbage persons are totally in sight, outta mind.

My hat is off to Merle Ukeles, who has long been the "Artist in Residence" at the New York Sanitation Department and well over a decade ago, decided to shake the hand of every New York City Sanitation Department worker. Many who got the handshake looked mystified—Merle was usually driving a van with huge mirrors on both sides—but she was definitely doing a good thing.

I respect Tom Price for the same reason. Decades earlier, when Tom became the director of the Sanitation Division of Tucson, Arizona, he turned a dispirited workforce into the pride of the city by showing them films on the ways flies spawn and spread disease. Then he'd say, "Everyone respects policemen and firemen because their job is so vital, but that job is only critical to individual members of the community once in a long while. On the other hand, you provide a service that is critical to people's well-being every single day." The people who suffered through Chicago's recent garbage strike can reaffirm how right Mr. Price was!

To try to keep this diatribe focused, I will center on two areas: (1) science fiction films—the vision of our future that Hollywood's intelligentia believe will sell—and (2) the way archaeologists—most of whom spend their lives digging up old garbage, recording it in excruciating detail, then publishing it and putting the actual garbage on display—view the future of archaeology.

Garbage is not prominent in sci-fi films. The central city in *Blade Runner* was dark and dirty and an exception—there was some garbage visible. The other sorta honest-to-goodness garbage I recall in a sci-fi film nestled in the amazing sequence in the original *Star Wars* film where Luke Skywalker fell down a chute into a garbage bin and was almost overcome by a humongous garbage-thriving organism.

There are, of course, more such examples, but the most common characteristic of "cities of the future" is their sterility and utmost cleanliness that looks a lot like suburban streets in TV sitcoms or even most TV dramas and detective shows. Set designers don't seem to know how to use garbage to make neighborhoods look "lived-in"; or directors/producers don't want to show that "garbage look" to audiences.

Okay. Who wants to repulse viewers. Fake blood and guts, yes! Real garbage, no! But what about archaeologists who deal mostly with garbage—period!

I recently read two articles published in 2002 by archaeologists about "exo-archaeology"—the archaeology of outer space. I was interested in what they had to say because I wrote a column on "exo-archaeology" in the September/October 1999 issue of *MSW Management* magazine in which I mentioned that we earthlings have populated our surrounding space with our own garbage. We have launched

about 10,000 "resident space objects," such as 1,500 upper-stage rockets and a myriad of explosive bolts and clamp bands, along, of course, with urine and "other" bags. I concluded that this light-speed space junk—which is a major hazard to any future flights—is the natural study area of archaeologists.

I was shocked to find out that in an article titled "The Case for Exo-Archaeology," Vicky A. Walsh wrote that the mission of exo-archaeology was to "evaluate distant worlds for signs of intelligent life"—sounds like the mission of *Starship Enterprise* to me. The author never mentioned the issue of how to identify alien garbage or, for that matter, our garbage, which is the most prolific sign of our "intelligent" life in space . . . and on Earth!

Even more disappointing was the paper by Greg Fewer, called "Towards an LSMR and MSMR (Lunar and Martian Sites & Monuments Records): Recording the Planetary Spacecraft, Landing Sites as Archaeological Monuments of the Future."

Yes, let's record landing sites for posterity. But what about the myriad threats to our future spacecraft from the voluminous hurtling junk discarded from our past ventures? And it is not just us and the Russians anymore. At the end of September 2003, Europeans launched their first unmanned spacecraft to the moon. In October China became the third nation capable of launching manned spacecraft, and more space cowboys—and space tourists, like U.S. businessman Dennis Tito, who reportedly paid the Russians $20 million for a ride to the international space station and back in 2001—are sure to follow.

To complicate matters further, ask yourself: what kinds of garbage have other space travelers in other parts of our galaxy and beyond discarded that are now hazards to our space travelers? If we are dedicated to continuing the exploration of space, can we continue to ignore such questions? The report from the committee that investigated the tragic *Discovery* burnup called for a complete revamping of the safety culture at the National Aeronautics and Space Administration (NASA). Perhaps it is also time to look at NASA's "garbage culture," or lack of it.

This space garbage myopia is a reflection of our whole society's lack of an "in mind" approach to our discards. Yes, most people are now recycling, and that reduces garbage. But they are also buying, using, and discarding more nonrecyclables, and that increases garbage. The majority of our clients are now squarely facing recyclables because those items are "good"; but they won't directly address the use of nonrecyclables because they are not visible on their radar screens. Yes, garbage is still considered "yucky" and is clearly out of mind . . . and so are we!

I'm not usually much of a preacher, but it is up to garbage professionals like us to change both our image and the public's perception of garbage so that people can see both us and the garbage we manage for them. That will make all of us more content because it will translate into both a more secure self-image and less garbage for us to handle in our newfound security.

Let Landfills Be Landfills

This commentary is totally biased. It is biased against the commonly held belief that municipal "garbage is yucky and disgusting gunk"—most of it, after all, is stuff we brought into our homes—and that reducing it, recycling it, and safely disposing of what's left over should not be discussed in polite society. Just the opposite, this commentary is biased toward publicly honoring the people who devote their lives to retrieving vast quantities of useful resources from garbage and safely managing the rest . . . and even honoring the messages about where our society is headed that are in the garbage we throw away.

Shocking biases? No. In our day and age my attitudes are totally politically correct (PC). It is only shocking that they don't seem to be shared by many of those on the outside of solid waste management who make the final decisions about garbage and its disposition as well as those who communicate such decisions to the public. I will give you two examples.

I was grandly pleased on August 27, 2001, when Secretary of the Interior Gale Norton, following a lengthy review (that began under the Clinton administration) conducted by the National Park Service, named Fresno Sanitary Landfill a National Historic Landmark. I beamed with pride for garbage persons everywhere! It was about time, since this prototype of sanitary landfill operations nation- and worldwide was initiated in 1937!

You may read that the first sanitary landfill opened in England. Wrong! As the nomination papers document, the first "working" sanitary landfill was

opened in the real world of Fresno, California, by Jean Vincenz, a man with vision—a vision tempered and sustained by his travels throughout the United States to learn from what others had tried that worked and what they had tried that didn't. It wasn't rocket science, but it was extremely creative for its day—with carefully structured drag lines to position refuse, techniques to compact the refuse, and, at the end of the day, the same drag lines to spread soil as daily cover that had been dug out to make room for the next day's refuse. This was Vincenz's "sanitary landfill" system, created at the same time that virtually all of the rest of the country and the world were feeding the fires and rats in open dumps or unleashing a black rain of cinders, soot, and ash from the chimneys of refuse-burning facilities appropriately called "destructors."

I was then unspeakably horrified when Secretary Norton "temporarily" rescinded her designation of the Fresno landfill the next day. At least Secretary Norton, on the advice of the deputy director of the Park Service, used rational (though inappropriate—see below) grounds by stating that the landfill was on the dreaded list of Superfund sites. The media, on the other hand, weighed in with unusual (even for them) refuse bigotry by intimating or outright saying that a "garbage dump" was a "joke" as a National Historic Landmark.

That is one of the most bizarre statements I have ever seen in the press. Who cries out the loudest in self-righteous indignation when landfills aren't sanitary? Where is U.S. society supposed to find bright, hard-working applicants for garbage disposal jobs that get no respect?

But what about the Superfund designation? At least from the 1950s through the 1960s, petroleum products and solvents, battery acid, and, with the approval of the county Health Department, wastes from convalescent homes and the Fresno Dialysis Center, were regularly deposited at Fresno Sanitary Landfill. These contaminants are strictly prohibited from today's landfills; but let the mid-century landfill that didn't regularly accept such now-illicit discards cast the first can of used motor oil.

Certainly Fresno Sanitary Landfill wasn't perfect. But do our historic monuments have to be flawless? The designation as National Historic Landmarks of "poorhouses" (where debtors were incarcerated), Alcatraz and other prisons, and World War II internment camps for Japanese Americans would suggest not. Each of these monuments, however, does provide a unique, close-up perspective on our nation's key coping strategies as we forged history.

In our past, just as today, garbage disposal was an all-pervasive activity that affected not many communities, not most communities, but absolutely every community! Our garbage heritage is one to remember. Our forefathers' and foremothers' garbage habits evolved from burying their wastes in pits in the yard and/or throwing them willy-nilly into the streets to today's systematic weekly refuse pickups, usually partnered with curbside collection of recyclables and various means to separately manage household hazardous wastes. Fresno Sanitary Landfill was a critical catalyst in this almost-180 degree transformation. According to a recent Environmental Protection Agency (EPA) report, in 1937, Fresno Sanitary Landfill "was a substantial improvement over the accepted methods of sanitary waste disposal at the time and a model for other landfills around the country."

(Note: In 1940 there were not even a handful of such landfills. Then in World War II, the U.S. military adopted the sanitary landfill format, and by the end of 1945, 100 cities had adopted it as well.)

But let's not forget the place on the Superfund list that Fresno Sanitary Landfill earned in 1989 through Fresno officials' own self-confessions. Fresno officials recently noted that the Superfund remediation process is virtually complete. The landmark will soon play host to a 115-acre sports and recreation complex that includes soccer fields, a baseball diamond, and plenty of green space. How many other Superfund sites have been reintegrated into acceptable society? In my opinion, for the completion of the successful remediation process alone, Fresno Sanitary Landfill deserves National Historic Landmark recognition.

The second example of landfill despisement is at the other end of the country. Fresh Kills Landfill, on Staten Island accepted New York City's discards from 1948 until it was closed in March 2001. To plan the future of this 2,000-plus-acre refuse behemoth, the city of New York held a competition open to design teams around the world. Currently, in the last phases of the selection process, three teams are

still standing. The team ranked number one at this stage proposes to turn the landfill into a nature preserve. The team ranked second plans three enclosed ecospheres—temperate, subtropical, and arctic. The team ranked third will morph the landfill into Re-Park (as in Re-duce, Re-use, and Re-cycle).

I am a part of the Re-Park team, and I want to tell you why.

Fresh Kills is the largest landfill in the world. To the rest of the globe, Fresh Kills' nearly 2.6 billion cubic feet of refuse is also the most obvious symbol of America's wasteful habits.

I don't believe that we should try to sweep Fresh Kills under a "natural" rug. With the vast majority of landfill under from 30 to 80 or more feet of refuse, it can never be returned to Mother Nature's bosom. What is the "natural" ecology of a closed landfill? Who are the "natural" denizens of a monster plateau built of trash?

Ecospheres? What message would they be sending—that when the garbage gets too deep we can live in isolated bubbles? Besides, isn't planning the endgame afterlife of the Mother of All Landfills enough of an experiment in itself.

I would much prefer Re-Park. That would turn the world's largest symbol of New York's and America's wastefulness into the world's largest symbol of New York's and America's new environmental ethic of reducing, reusing, and recycling waste. At the same time, it would honor the thousands of refuse workers who labored mightily to dispose of the Big Apple's rejectamenta.

At Re-Park, facilities would be constructed from recycled materials (such as picnic tables made from soda bottles and walkways made from glassphalt). To make people aware of what materials were under their feet, there would be a "refuse" walking tour that would visit the 14 wells the Garbage Project dug into the landfill and describe what currently available reuse and recycling schemes could do to reduce the same materials if they were discarded today. There would be a special area for garbage rodeos (featuring colorful competitions in the artful use of dozers, compactors, scrapers, and other wondrous tools of the garbage trade) and one for a variety of extreme sports. The side of the landfill that currently abuts local businesses would sprout entrepreneurial enterprises of its own—restaurants, souvenir shops, and retail outlets for the growing cornucopia of products made from recycled refuse. There would be a garbage museum where, besides viewing the history of Fresh Kills and New York City's garbage, adults and children alike could play garbage-oriented video games and interact hands-on with the latest information on reuse and recycling and ways to measure environmental contamination. Elsewhere there would be permanent displays as well as a series of shows and competitions featuring garbage art, a form of expression whose bizarre materials and sense of humor have clearly established a following today among the *haute couture* as well as among those whose *haute* is not so *couture*. What survived of the Fresh Kills tidal marsh would be returned with human help to something close to its "natural" state.

Power for Re-Park would be produced by alternative energy schemes, including windmills, solar panels, the landfill's methane, and even wild grasses on the tops of the garbage mounds that would be mowed and converted in combination with the landfill gas. Best of all, with the proper design and appropriate business sponsorships, Re-Park might even become self-supporting! . . . And the remains of the World Trade Center would be covered over and planted with one specially selected tree for each of the victims to establish a sacred and serene area of remembrance.

But Fresh Kills may never be Re-Park and Fresno Sanitary Landfill languishes in landmark limbo. What have these refuse disposal sites done to make themselves outcasts that are hidden from sight instead of being honored as crucial players in America's solid waste management heritage?

In the brouhaha over the Fresno Sanitary Landfill, Martin Melosi, the official historian of the American Public Works Association and author of the nomination of the site as a landmark, observed that the controversy exposed the inability of many people to view the waste issue "as an integral part of the process of living, and thus to view it as culturally and historically important." Professor Melosi certainly has correctly characterized our collective attitude as a nation. That attitude, I believe, results in an incredible irony.

Shortly after the torrent of media ridicule erupted, National Park Service spokesperson David

Barna noted that "the Romans would laugh if they knew that their aqueducts, which just carried water, were a part of their civilization that is most prized today." He's right, of course, but why didn't he mention the Romans' sophisticated indoor plumbing? It is not totally unreasonable to believe that he didn't because Mr. Barna might have been embarrassed to mention a system that carried away human wastes.

The irony for Americans is that we are so effective at disposing of our solid wastes for the same reason we don't want to recognize that we even have solid wastes—they embarrass us. That's the same reason that we never congratulate ourselves for creating the best indoor plumbing systems in the world. If we patted ourselves on the back for our landfills and our toilets, we would have to publicly own up to our wastes. The problem is that, if nothing else, Americans are idealists, and our wastes aren't part of our pristine American Dream houses, shiny SUVs, manicured yards, and highest-tech entertainment centers. That's why we're so good at hiding our wastes and their facilities from sight!

Now, however uncomfortable it may make us, it is time to publicly recognize our discards, because until we do that we will have neither the motivation nor the inclination to decrease those embarrassing wastes.

As a first step, let's honor landfills as landfills!

Litter

Two Million Years of Littering Must Tell Us Something

I was recently asked by a reporter (Hilda Muños from the *Los Angeles Times),* "Why do people litter?" She didn't ask it, but there was a second question implied: "Don't people know any better?"

The answers to both questions are often counterintuitive and something that most Americans today, especially those who belong to Keep America Beautiful (KAB . . . and I totally believe in their goals) don't want to hear. But here I go anyway. After all, it's about garbage, and whenever you deal with garbage, the truth will eventually come out . . . and the overall message reinforces the validity of the KAB approach!

As an archaeologist—someone who digs up the remains of long-past days, mainly refuse—I have learned that when it comes to something that is not wanted, a human being's first inclination is—and has been for more than two million years—to dump it when and where it becomes useless. From prehistory through the present, dumping then and there has been the means of disposal favored everywhere, including within most cities worldwide until at least the 1700s.

The first response of hunter-gatherers—our most ancient ancestors who moved every few days or weeks to hunt and gather fresh food resources—was to drop or throw whatever they didn't want wherever they were at the time and to simply move away from their campsites when the garbage around it got too deep and/or too smelly.

That seems reasonable to me if you have to move soon anyway and if you have no regularly scheduled garbage pickup. That means that dropping garbage wherever you happened to be was totally acceptable behavior.

I am not suggesting that hunter-gatherers were being environmentally irresponsible; they had no garbage containers to put their garbage in. Consider that KAB defines "litter" as "garbage out of place." In our society, that means garbage that is not in a "garbage container" or a recycling center, landfill, or incinerator. But, how can garbage be out of place if there is no generally accepted place to put it in?

In fact, while it is easy to believe that our earliest preliterate ancestors divided items in their minds between "useful to me" versus "not useful to me," anthropologists don't know whether they even had a concept of "clean" versus "dirty." In this light, the concept of "natural landscape" versus "littered landscape" seems unlikely to have occurred to most of our prehistoric relatives. Such concepts would mean little to people who moved frequently over vast expanses of territory.

The Australian government learned this lesson the hard way in the 1970s when it began an effort to settle Aborigines in permanent residences and discourage them from following their traditional lifestyle of yearlong cyclical treks around their humongous

hunting-gathering territories. The bureaucrats built the Aborigines permanent settlements that would, to the bureaucrats way of thinking, keep the Abs (Ab or Abs is the PC shortening of Aborigine/s—a_o is a dirty word!) in one place where they could be looked after. Shortly after the first settlements opened, however, government officials were shocked to find that the Aborigines had trashed their brand new 20th-century tract homes by throwing garbage inside, outside, and every-which-away.

What was wrong with these people!

What was wrong was that the Australian government officials didn't understand how garbage is related intimately to virtually every aspect of life—to death within a family, to conflicting obligations to family and friends, to domestic quarrels, and to the buildup of refuse and more. So, to change hunter-gatherer garbage patterns, you have to change the whole hunter-gatherer lifestyle, and not just give them "permanent" housing that they don't understand.

Just one of the things that the bureaucrats didn't understand was that hunter-gatherers traditionally solved social problems, just like garbage problems, by walking away from them. If you are having difficulties in your relationship with your wife or your parents or your in-laws, when you run into another hunter-gatherer band—which happened fairly frequently during the yearly "round"—you just hook up with the other band for a few months. When you run into your relatives a few weeks or months later, things would have cooled down and you could rejoin them on good terms.

That strategy doesn't work as smoothly in a settled village. Archaeologist Jim O'Connell lived in a "permanent" Australian government Aborigine community and determined that over an 11 month period, the members of 19 households relocated into 85 new locations. Under Australian rules that required that you stay in one place, such moves usually involved building impromptu housing out of sheet metal and car body parts near your original house. The trashing-houses problem was not a garbage dilemma—it involved all of the mindsets as well as the social and other behaviors associated with a mobile hunter-gatherer lifestyle!

As Gordon Willey, my major archaeology professor, once said to me, "complex societies—'civilization'—began when people settled down and the garbage got so deep that they had to figure out a way to clean it up." As noted above, the answer to the refuse problem in a permanent settlement was simple: instead of the people moving away from the garbage, discarders have to reorganize and rethink a way to move the garbage away from themselves. That is being done with a little time and patience in Australia.

Our challenge today is equally obvious. Money has to be spent on litter prevention education, not only on cleaning up litter. We cannot depend upon some inborn natural bent toward cleanliness. Like Rousseau's "Natural Man," it doesn't exist. The key thing about humans is not our innate beliefs. Instead, it is that we can learn appropriate time-and-place-specific behaviors and beliefs. Consider one example:

The German *Der Spiegel* magazine sent one of its staff to Australia to photograph "Natural Man" in his natural habitat. The photographer flew to Sydney and then to Alice Springs in the middle of the Great Western Desert of Australia. He then drove into the heart of the wilderness, where he began searching for his elusive prey.

A key part of his preparations included carefully adjusting his camera so that the lens (under sophisticated camouflage) actually took a picture out of the side of the camera instead of out of what looked like the end of the lens. The photog did this because he thought that the "primitive" Aborigines would probably be afraid that their spirits would be captured in the "picture box."

Eventually, as he sat on the bank of a gully, he spotted a small band of nearly naked Aborigines loping along the opposite bank. He was ecstatic and clicked away with glee until he heard the clearly identifiable clicks of the cocking of a .45 automatic and felt a cold muzzle pressed into his left ear. A calm voice asked him in Australian-accented English what he was doing. He responded that he was taking pictures of the tree in front of him. "Then why," said the voice, "is your lens pointed toward the people over there?"

The German photographer had run into a group of so-called "weekend Abs." On weekdays, the Ab with the .45 had been a quick learner and worked at a U.S. satellite tracking station in the Great Western Desert.

What took millions of years for humankind—replacing stone tools with satellite dishes—can be accomplished by individuals through education in a few months. Along with cleanups, we have to depend upon education and peer pressure to prevent litter. I am especially supportive of the Park Service giving out "litter" bags to people in their parks. Cut litter cleanups now to save money if there is no alternative; but don't stop education campaigns, especially for kids. I believe what KAB believes—preventive education is the most efficient means to diminish litter. There is no other way to fight 2 million years of tradition.

"In Sight, Out of Mind"

Talking trash is riddled with boring truisms. That's acceptable. What bothers me is that the truism I hear most often—"outta sight, outta mind"—isn't even true! In fact, I believe that giving it any credence obstructs the path to efficient and effective solid waste management.

What brought this burr-under-my-saddle to my attention recently is a stunning picture book titled *Litter Only: A Book About Dustbins* by Alexandra Martini. The book is a treasure trove of photographs of garbage receptacles (mostly in public places) worldwide—261-plus containers in 249 locales in 130 countries. Ms. Martini's globe-trotting garbage can panorama extends from Hardangervidda, Norway, to Ujung Pandang, Indonesia, and beyond.

As the introduction asserts, "content is not everything—look at the container, look how universal the role of the trash can is . . ." And that is exactly why I bristle when someone says about garbage, "outta sight, outta mind," because garbage and garbage containers are almost always IN sight.

Think about the garbage realities of contemporary life. I'll bet good money that there's a garbage container in most rooms of your house. There are garbage containers in most public spaces and rooms. How far are you at any time from a garbage receptacle in a mall? How often are you more than 30 feet from a garbage receptacle? On an interstate—sure, but garbage containers are more frequent and available than gas for your car or food for you!—and National Parks—the natural beauty is studded with trash containers.

As an archaeologist, I am very aware of "living" reconstructions of the past, where tourists walk through "accurate" replicas of life in previous times.

Yeah, right!

Take Colonial Williamsburg in Virginia, just outside of Washington, D.C., a "living museum" frequented by presidents with potentates and the public alike. Note that the "authentically reconstructed" Early American site is honeycombed with trash containers. And, as part of this scenario, the living museum is constantly crisscrossed by vehicles that collect the day's trash for disposal.

The site's original inhabitants would be totally mystified by such behavior. They were accustomed to throwing garbage in the street—in fact, the role of men walking on the street side of women was not started to protect women from being splashed by passing vehicles; instead, the man walked on the outside to take the brunt of the garbage thrown toward the street from second-floor windows.

Quite honestly, if Williamsburg were an accurate reconstruction of colonial times, it would be closed down within a day for health and safety violations!

Put all this together and you reach the inescapable conclusion about garbage that we should not be saying, "Out of sight, out of mind," but instead, "In sight, out of mind!"

Okay, what does this mean? It means that people ignore garbage because it is so commonplace—it is IN sight everywhere!

In effect, the biggest problem in "garbage education" is that even though garbage is everywhere, most people don't see it. That is, of course, quite different from "outta sight, outta mind." In fact, what it means is that there is no way to easily put garbage on people's radar screens.

A good example is what people think is in landfills. Ask most folks—educators, students (all ages), environmentalists, businessmen, government officials . . . anyone . . . what takes up the most landfill space, and the most common responses will be styrofoam, fast food packaging, and disposable diapers. The Garbage Project's 21 landfill digs demonstrate that if you add all three of those landfill villains together, they fill up less than 3 percent of MSW landfill space.

Why are the estimates so wrong? Simple. Those who don't deal with refuse for their livelihood

don't carefully notice and mentally record the garbage they or other people discard. What forms their mental image of garbage is not what is normally thrown away. Instead, what sticks in their minds about garbage is the garbage that *shocks* them, and that is garbage out of place—litter. And litter, of course, is often styrofoam, fast food packaging, and disposable diapers (it is my experience that you can usually find a garbage can at an interstate rest stop by looking for the pile of disposable diapers covering it).

The way people perceive garbage is also the reason that newspapers get recycled, but household food waste hasn't diminished in 30 years. Newspapers are often kept in stacks, so it is easy to see how quickly they build up. Food waste is not saved in a corner of the kitchen, so the food preparer and the food consumers are not constantly confronted with the quantities they waste.

The incredible degree to which people can overlook food waste is best illustrated by a study the Garbage Project conducted for the U.S. Department of Agriculture (USDA). We divided sample houses into four groups—all households were asked for permission before we collected and sorted their garbage. In the middle of a five-week garbage collection/recording period, householders in three groups were asked to report their edible food discards verbally. Not surprisingly, very few respondents owned up to any food waste; nonetheless, their refuse contained, on average, one-eighth pound of wasted food (not including rinds, peels, skins, bones, etc.) per person per day. The fourth group of households was given plastic bags and asked to save all the edible food they would have thrown away. They gave us one-quarter pound of wasted food per person per day!

When there was a knock on the door, I can hear John saying to Martha, "Yikes! It's those crazy university students who want food waste, throw some food into that bag!"

The kicker, of course, was that we still found one-eighth pound of wasted food per person per day in their garbage. They made up food waste for us to collect at the front door and still didn't see or decrease the food they threw out the back.

But lest I forget the lesson that people don't see the garbage they discard, I have one constant reminder. About once a month or more, some agent of the media takes me to a landfill to record me in photographs or video. I could get really tired of this except for one wonderful event that almost always happens.

There I am with the photograher(s) surrounded by garbage at least 20 feet deep. At some point they have to change their film roll or video cartridge. They rip open the film pack, hold the foil or box for a minute, and then stare up at me with a quizzical look and say, "Is there anywhere around here I can throw this?"

At that point, I quietly say, "Just drop it. It'll be okay."

In sight, outta mind.

Reading Red•ing

Remember the "Reading Railroad" property from the game of Monopoly? It was always my favorite acquisition in my unrelenting struggle to drive opponents into bankruptcy.

Last Earth Day I visited Reading, Pennsylvania, the town that gave the railroad its name. Imagine my chagrin when I learned that all these years my Midwest friends and I had been mispronouncing its name. It may be spelled like something you are doing right now—"reading"—but it is pronounced "red·ing," as in the color red.

That is irony with just a twist from what you would expect. In Reading, Pennsylvania, ironies with a twist are what I soon came to anticipate. As we prepare to carry our refuse dilemmas across the threshold into the next millennium, Reading's ironic and slightly twisted mix of garbage lessons may be worth *read*ing.

How many garbage haulers would you think it takes to pick up the discards from Reading's 29,326 residential units?

To be precise—30! In fact, in this day of acquisitions and centralization in the trash trade, Reading might be considered for a Guiness record for the highest ratio of garbage-hauling companies to garbage generators in the United States! Reading's ratio is about 1:1,000; in Tucson, Arizona, and its environs, the ratio is 1:26,000—26 times higher!

This means that the trucks of several different small, and not so small, trash haulers are forever traipsing up and down the same Reading streets. This may be a model of independence that exempli-

fies the entrepreneurial Yankee spirit, but it is not a model of efficiency.

Another consuming Yankee passion—that of trying to save a few bucks—complicates matters further as some people squeeze themselves through the cracks of Reading's rather unsystematic lattice of garbage collection. Since Reading itself is not responsible for household trash pickup, individual citizens are. With the welter of haulers coming and going virtually every day, it is relatively easy for, say, a nonresident owner of a small number of rental units to take garbage into his or her own hands or even for very small haulers to improve their competitive edge by tipping where there are no fees.

Voilà! Another Reading garbage irony—so many garbage haulers to carry refuse away and so much refuse left behind as litter or illegal dumps!

Sadly, the tracks of Conrail (what's left of the old Reading Railroad and more) have become a "trash magnet." That's dangerous because large unwanted items can damage breaks and block signals. Recently, railroad workers filled six railcars with 450 tons of debris in just 10 months. Conrail has done what it can to deter inappropriate dumping with chain-link fencing, but as an editorial in the *Reading Eagle/Reading Times* reported, "People cut through the fences. That's determination."

The habit of wanton dumping also clutters the town's center of business. In response, Reading's Downtown Improvement District (DID) first hired a private company to clean up litter. When expenses seemed prohibitive, the DID arranged for nine unpaid inmates of Berks County Prison to do their dirty work. The largest problem to date is that the sheriff wants the inmates identified as prisoners, but the DID board doesn't want them to look like a chain gang.

But the property blighted is not just corporate or public. In fact, if nothing else, Reading's litterbugs are thorough, and the homes and lots of all-too-many private citizens continually fall prey to "drive-by dumpings." Those victims inclined to a little hands-on *garbology* have often found a pay stub, a piece of junk mail, or even receipts *(OOPS!)* tucked among the soiled diapers and gunky pizza boxes. While valuable in tracking the trash to its dumper, it hasn't provided the dumpee with much "closure." All that the perpetrator household has to do is claim that a private hauler had been hired. Even if that hauler is not directly named, charges have usually been dismissed.

The local government of Reading is responding to this undesirable state of affairs as best it can. Currently, the person whose trash is illegally dumped is held responsible unless he or she names a specific hauler who was hired to pick it up for disposal.

In another move, the Reading City Council devised a plan to divide the city into four districts and put refuse collection in each one up for competitive bids. Reading's voters, however, probably in sympathy with the smaller "underdog" haulers—another Yankee trait—defeated this plan for systematic citywide refuse collection by voting down a referendum in May 1998.

The city council responded by retrenching and emerging with a new ordinance that required non resident owners of four or fewer rental units (the profile that fits an inordinate number of those caught illegally depositing trash) to participate in a city-managed collection system. In addition, any property owner convicted of three or more trash violations in one year would also be compelled to join the city system for two years. Other Reading residents could voluntarily participate, which, at least by city calculations, would be cheaper than hiring a "private" hauler. The city plan would place 500 litter baskets throughout the community and pay its refuse collection contractor to expunge debris from properties that owners didn't clean up themselves after being cited for a trash violation.

Employing a more recent Yankee tradition, the trash haulers are suing to stop the implementation of the ordinance.

In this age of merger mania and efficiency at any cost, Reading, Pennsylvania, sticks out like a sore piece of litter, one where unsystematic refuse collection leads to lots of unsightly refuse leaks.

But—yes, ironically—the seeming chaos in discards leads to something else as well. Reading's citywide curbside recycling program is the most productive in the entire state. Each month J. P. Mascaro & Sons, the city's curbside contractor, collects 360-plus tons of recyclables.

Why is a city with a significant litter problem a model recycler? Not surprisingly, the answer seems to be *time* and *money*: the more a Readingite

recycles, the less he or she has to dispose of by some other means, either legitimate or nefarious.

Does this mean that messier is better?

Ask any resident with the least bit of community pride, and they'll tell you, "No, we want to be free of litter." Nonetheless, the Reading situation does add support to the "pay-as-you-throw" concept—people recycle more if they have to pay to get rid of their garbage but they don't have to pay for the collection of recyclables curbside.

And what of those who are more than tempted to litter and illegally dump—ah, well, to every Reading solution, there's a twist!

Exo-Garbology

On June 17 this year, Air Force trackers of "space junk" alerted the U.S. National Aeronautics and Space Administration (NASA) that a spent Russian booster rocket was headed straight for the International Space Station (ISS). By sheer luck alone, the huge relic missed blowing the ISS to smithereens by only five miles.

My first thoughts were, "how in tune with recent human history it is that our garbage should come back to haunt us." Then, I couldn't help but dream of an *exo-garbology*—meaning the study of space junk created by "intelligent life" (and I use "intelligent" with some misgivings)—to help humans learn from past garbage mistakes.

But are earthlings conducting the first "exo-garbology"? Perhaps not. As recently as August 1996, a NASA team examined a potato-sized chunk of Mars. They tentatively concluded that it might contain signs of life. While the evidence was only a few specks that resembled fossilized microbes, the announcement led bookmakers in London to raise the odds of "intelligent life" somewhere in our universe.

If there are currently exo-garbologists on other planets, I wonder what they make of our first venturings into their realm. As any earthling knows, what most defines our humanness is our indefatigable urge to create garbage—the bounty from which archaeologists learn about human lifeways. Consider what an Indiana Jones from another planet would know about us.

Appropriately, the Earth is surrounded by orbital flotsam. But unlike the hordes of miniature moons neatly aligned into rings around Jupiter and Saturn, according to Nicholas Johnson (*Scientific American,* 1998), Earth's hangers-on "resemble angry bees around a beehive, seeming to move randomly in all directions." When you look at their numbers, you can almost hear them buzz.

First, there are about 10,000 "resident space objects"—only 5 percent of which were functioning spacecraft in 1997. Spent artifacts include some 1,500 empty upper-stage rockets, a myriad of explosive bolts, left over after separation from their payload, and lens caps jettisoned from sensitive instruments. Then there is real garbage garbage. During its first decade in orbit, for example, more than 200 objects drifted away from the Mir Space Station, most appropriately hooded in garbage bags.

But the greatest source of significant-sized space stuff is approximately 150 satellites that have blown up or fallen apart, either deliberately or accidentally, leaving a trail of 7,000 fragments large enough (over 10 centimeters) to be trackable from Earth.

To make matters even messier, NASA estimates that there are another 400,000 space artifacts too small for us to detect, as well as about one million small flakes of paint and other tiny spots of debris—some of it surprising. In 1990, the surface of a recovered satellite that had been in orbit for six years was found to be speckled with urine and fecal material—another discard from Russian and American space missions.

To some of us on Earth, this gaggle of space junk may sound like a laughing matter—that is, unless you were in the Outback of Australia when the remains of the 100-ton Skylab, our first space station, survived reentry into the atmosphere and crashed there in 1979. Or unless you'd imagine what would have happened if the rocket shell had hit or even just grazed the space station! Then you'd know why understanding the causes and trajectories of space junk is important to humanity's future in space. That is the reason the Air Force and NASA have their own brand of exo-garbologists tracking and modeling the future of our space orphans.

By now, extraterrestrial exo-garbologists must have some theories about why we continually shoot ourselves in the foot with our castoffs. Perhaps they

have reasoned that this kind of *faux pas* occurs because of one of the most consistent human–artifact relationships: *whenever we humans try something new, we throw everything material we can at it to make our attempt successful. The result is a tremendous accumulation of leftover junk*.

In fact, frontiers—whether physical or theoretical—are junk magnets of immense proportions. That's because we tend only to worry about the success of our immediate goal—settling an "untamed" land, "conquering" Mt. Everest or Mt. McKinley, "harnessing" nuclear power as an energy source—and not about cleaning up the mess we leave behind.

American pioneers abandoned so much of what they originally loaded onto their wagons that professional scavengers regularly followed the trails west to glean the leavings. Organizations friendly to the environments of both Mt. Everest and Mt. McKinley have recently become concerned about oxygen bottles, climbing equipment, camping gear—left behind in massive fields of eyesores. And who can forget our nuclear waste dilemma—tons of radioactive material without any disposal plan in place. As a result, today, many of the storage containers of older wastes are too degraded to move safely even if there were a place to put them.

Space exploration has obviously been no different. So now earthlings are stuck with two kinds of nonfunctioning space artifacts—those in the heavens and those used on or brought back to Earth.

Those on the Earth are not such a problem. The main reason is that most, if not all, humans seem to have an uncontrollable desire to collect, and for decades people have been acquiring space memorabilia. The intensity of private collectors is documented by two massive Sotheby's auctions, held in 1993 and 1996, of Russian space artifacts, much of it "looted" from the old Soviet Union. But even the monetary value of space artifacts pales beside the educational and emotional potential of items that have been out in space and come back.

In the United States, besides the government's Smithsonian and various NASA museums, there other public contenders for these treasures, such as the Cosmosphere in the city of Hutchinson, Kansas. Such organizations save never-used, but deteriorating, backup spacecraft from neglect and landfills.

Most distressing about the junk still in space is how it affects our space future. Sadly, because of orbit speeds of 20,000 feet per second, both mammoth *and minuscule* space junk is currently the most serious threat to the safety of the International Space Station and its future occupants, even with the potential of new "bumpers" that use several layers to shatter and slow any projectile.

If we look at all the Earth-generated debris in space as a great metaphor for the profligate discard practices of humanity, there seem to be a few lessons:

We—Americans, Russians, and all other space entrepreneurs—created all our gizmos with little thought about disposal. What else is new?

Lesson 1**:** Whether designing a new clamshell for burgers or the next flight to Mars, it is only responsible to plan for disposal during invention.

Our collection mania for space objects is still far from satiated. Lesson 2**:** There will be gold out there for whoever figures out how to recapture, renovate, reuse, and recycle the garbage we have already wrought.

The first and so far only man-made object to leave our solar system to sail among the stars is a little Pioneer 11 robot spacecraft that was launched in December 1974 and spectacularly fulfilled its task of exploring Jupiter and Saturn. On its side is a plaque designed by the late Carl Sagan that shows a woman and a man, plus the location of the sun in relation to several prominent stars, and Earth's status as the third planet out. In the vacuum of space, the little messenger will last essentially forever, though its electronics have long since died. The idea is that someday some space-faring civilization might stumble across Pioneer 11 and know that life exists on this small, blue planet.

How fitting that our first emissary to the stars is our trash.

Postscript: And the reason to clean up our space may be more than astronaut safety and money. One vision of the form that intelligent life on other planets might take was the summer 1997 movie *Independence Day.* Light-years from the cute and lovable E.T., *Independence Day* aliens were mad as hell at the human race. The question the movie really didn't explain was the source of the grudge against earthlings? After reviewing how much garbage we've left in space, I think I know the answer.

Deadly Litter

The 1902 French satire *A Trip to the Moon* ends with one world's best-known cinematic images. The 14-minute short doesn't show humanity directly shooting itself in the foot; instead, it shows astronomers building a humongous cannon and shooting a rocket ship at the smiling "woman in the moon." The film ends with the disturbing image of the now-useless rocket lodged in the moon's left eye as the face around it writhes in shock and pain.

What was outlandish fantasy at the turn of the century became fact in less than 60 years. In the late 1950s, both the former Soviet Union and the United States successfully launched a series of "impact" missions that crashed "probes" into the lunar surface and created some of the first space litter.

Despite our hard-won acumen in satellite and "manned" space flight technologies, we have continued to smash probes into the moon. As recently as July 31, 1999, the 354-pound Lunar Prospector hit the moon's surface going 3,800 mph to see how large a plume of dust and vapor it would kick up (it was hoped that the height and content of the plume would provide evidence of water on the moon, but no plume was sighted).

Not to be outdone, space novice China recently announced that within five years, it will launch its own "moon probe" satellite. That may seem to be adding less debris to the lunar surface, but after a few months or years in orbit, China's probe will become useless space litter and eventually follow the familiar impact trajectory. The European Space Agency sent a similar probe to the moon in September 2003, while dropping off two communication satellites along the way.

But litter on and around the moon is only a tiny fraction of the problem of human-made litter in space. As any archaeologist can tell you, every creature marks new territory in its own special way—humans do their marking with litter, items that no longer serve a purpose for those who put them there.

"Marking" litter is currently an especially acute problem in space. When we earthlings began our space exploration, we followed an age-old tradition. Pioneers and explorers have always done whatever it takes to "get there" the first time and have given little or no thought to what they leave behind or no thought at all to cleaning up after themselves. Note that the Mars record to date is that two out of every three "lander" missions have produced nothing but space junk!

All of us have been indoctrinated to believe that litter of any kind should be avoided, prevented, or cleaned up. In our hearts, we all know that's true. Appropriately, while l was writing this piece, I was attending an awards banquet of the New Jersey Clean Communities Council, where litter is taken very seriously and litter cleanups abound.

And so it should be. Litter is a sign of a lack of concern that goes far beyond environmental indifference, and its presence continually instigates and reinforces such attitudes. In fact, Professor Malcolm Sparrow, at Harvard's Kennedy School of Management, has argued that "grime" is linked to "crime"—grime being a kind of usual suspect that tells anyone in the vicinity that other types of crime are tolerated.

When, however, standard roadside litter is compared to the discard of "official" EPA hazardous wastes—lead-acid car batteries or industrial canisters full of used solvents or nuclear wastes—many of us also believe that the litter we're used to seeing takes a secondary place.

But what happens to this view when items common in refuse and litter—such as french fries or plastic bags—get frozen solid and hit you or anything else at a speed of 20,000 feet per second! If you are traveling in the same direction at the same speed, the litter will just float along side; but if you are going at some other angle, and especially if you are moving in the opposite direction, it could shoot right through you! *Ouch!*

Forty years ago, in 1964, just seven years after basketball-sized Sputnik became the first human-made object to be shot into Earth's orbit, James White wrote "Deadly Litter." White used this science fiction short story to illustrate how, in his view, within 150 years human-made space junk would become exactly that—deadly litter!—and littering in space would become the "dirtiest crime in the books."

This author's prescience is so far best exemplified by a chunk of an exploded Ariane rocket that hit a French satellite in 1996 and reduced the orbiter to space junk smithereens. White was clearly writing in the far-sighted mode of *A Trip to the Moon,* but

as prescient as he was, he may have underestimated the incredible threat that supersonic speed-space litter will pose in just the next few decades.

There are already about 10,000 "resident space objects" (satellites, rocket parts, and more), only 5 percent of which were functioning in 1997. Spent artifacts include some 1,500 empty, but rather large, upper-stage rockets—one such Russian booster barely missed the International Space Station on June 17, 1999—along with a myriad explosive bolts, lens caps jettisoned from sensitive instruments, and a glove lost by U.S. astronaut Edward White during a 1965 spacewalk.

Of course, although it is not often mentioned, there is real "garbage." During its first decade in orbit, for example, more than 200 Mir Space Station "objects" "drifted away"—at speeds equal to or exceeding the speed of Mir itself—most appropriately hooded in garbage bags.

But the greatest source of significant-sized space litter is approximately 150 satellites that have blown up or fallen apart, leaving a trail of 7,000 fragments large enough (more than 10 centimeters in any one dimension) to be tracked from Earth. To make matters even worse, NASA estimates that there are another 400,000 space artifacts too small for us to detect, as well as 1 million small flakes of paint and other tiny specks of fast-flying debris. No wonder that space shuttle windows have been replaced with growing frequency during the past decade.

At this point, the United States and Russia may have become successful enough to be concerned about not creating more space junk, but what about the new kids on the block trying to prove themselves? The lunar and other space programs of the European Space Agency and China are the major new entrants at present, but there are still more in the wings.

As if this isn't enough, space, especially around Earth, as endless as it seems, is being rapidly populated by entrepreneurs: Celestis launches satellites carrying "cremains" (cremated remains of earthlings, the first sent into orbit from the Canary Islands on April 21, 1997); French scientist Jean-Marc Philippe created the nonprofit satellite KEO to orbit a United Nations Educational, Scientific and Cutural Organization (UNESCO)-approved 220-pound "time capsule" satellite around Earth for 50,000 years; and, of course, the competition (encouraged by the multimillion dollar price tags that the megarich have been willing to pay to become space tourists) offers $10 million to the first private company to launch a passenger vehicle into low orbit. Who with a spirit of adventure could resist such a challenge?

No wonder Sergei Kulik, head of the international division of the Russian Aviation and Space Agency, said in 2001, "In the middle of the century the contamination may be so big that a kind of a cascade effect could appear, a collision between the space debris particles creating more and more [collisions]." That could eventually mean, he told Reuters, "there will be no possibility of flying in space at all."

What space junk and all its hazards point to is the importance of breaking the intimate and age-old relationship between exploration and litter. Teaching ourselves and our children to think about litter *when we make plans* and *before* we do anything is one of the most important lessons for all of us to learn. If we had followed that simple strategy in just the recent past, we might not have generated all of the difficult-to-recycle packaging we have and, even more importantly, all of the nuclear waste we don't want but can't find any acceptable place to bury—and even worry about moving because of corroding containers even if we could find an acceptable burial locale.

Just a few months ago, I was sure that the space junk situation couldn't get any worse. Silly me.

Orbital Development of Carson City, Nevada, initiated a "MoonCrash Project." The company provided a lunar spacecraft that can be packed with 22 pounds of whatever any client paying $6 million desires. A Russian aerospace contractor's commercial launch vehicle will "lob" the craft and cargo to the moon, where it will crash, hopefully, somewhere near where the client wants.

As Gregory Nemitz, president of Orbital Development, said, "The MoonCrash Project would probably be attractive to some bored rich guy, who is tired of playing with his radio-controlled model airplanes." Then he added that no one should worry about litter because, after all, the moon is only a large expanse of vacant rock anyway. Until I read this news release, I didn't realize how engrained our "right" and "need" to litter are.

Whoa! Surely, the Woman in the Moon must be writhing once again!

Believe it or not, I believe that Mr. Nemitz and MoonCrash should be brought to the attention of as many people as possible.

There is nothing better than an attitude like Mr. Nemitz's and a project like MoonCrash to dramatize the critical need to fund both litter abatement and full-fledged environmental education programs in our schools!

A Loaf of Bread, a Jug of Wine, and . . . Garbage

Take a "Bite Out of Garbage"

In-between grapefruit rinds and coffee grounds, and under an empty Cheerios box, in the first bag of household refuse I ever sorted, I uncovered a whole T-bone steak, fully cooked and neatly wrapped in a paper towel. That steak, to me, was like a mini–Tut's Tomb, and like so many ancient archaeological finds, it seemed shrouded in mystery. Ever since that "find" in Spring 1973, I have been fascinated with trying to understand the enigma of the gross quantities of edible food thrown out at home. For more than two decades, now, Garbage Project sorters have delved deeply into sticky, darkened heads of lettuce, droopy celery stalks, rock-hard jelly doughnuts, and limp clumps of macaroni with a crust of cheese. In the process, we have identified a few patterns that transform home food waste from a puzzling fact of life into an opportunity *ripe* for source reduction.

As a means of decreasing residential refuse, the waste of once-edible food at home has not attracted the kind of attention focused on recycling newspapers. The reason is simple. We often place newspapers out in plain sight after reading them and can easily see how quickly they literally "stack up." On the other hand, no people I know pile their food waste up in a corner of their kitchen. As a result, we have no sense of overall food waste quantities, even though they are sizable.

According to refuse sort records, about 20 percent of household refuse is food related. Half of this goop is honest debris—all those peels, rinds, tops, skins, and so forth that are discarded in preparation. The other half is a real *waste*—once-edible food. One-third of this waste is plate scrapings or what the sorters call *slops*, the little bits and pieces of food that are too small or mixed or mushed to save for another meal. The other two-thirds is *straight waste*—blue and slimey heads of lettuce, wilted celery stalks, hardened jelly doughnuts, and limp clumps of macaroni. In Tucson (a city with a metropolitan area holding more than half-a-million), around 23,500 tons of abandoned but once-edible foods are dutifully carted to local landfills each year—that represents 70 pounds of food waste per person. If this pattern holds true nationwide—and Garbage Project studies in Milwaukee, Marin County (California), New Orleans, Phoenix, New York City, and elsewhere suggest that it does—then the United States throws away enough food every year to feed all of Canada, including the lumberjacks.

The Garbage Project's waste figures include just the once-edible food that the student sorters have held, weighed, and recorded; it does not include food debris (such as bones, peels, rinds, and so on) and is not corrected for whatever food was ground down garbage disposals.

Such a flagrant waste of food is a weighty waste of money. In addition, once-edible food alone represents 10 percent of the household refuse destined for disposal. In landfills, food waste occupies a fair-sized portion of available space, as can be documented by 10-year-old heads of lettuce and the 20-year-old guacamole that have been exhumed by Garbage Project excavations.

The reality of food waste has been disheartening to me for more than two decades. Today, however, given the increasing interest in source reduction, I view the discard of once-edible items in an entirely optimistic light. Food waste is a source reducer's motherlode—the most tangible target of opportunity for conspicuously decreasing what households discard. Those who are willing to keep a few simple truths in mind can literally take a gaping bite out of what would otherwise become garbage! What follows are a few of those truths gleaned from two decades of garbology.

There are several specific behavior patterns that are associated with high rates of food waste. Most

are obvious. It should come as no surprise, for example, that fresh produce is wasted at ten times or more the rate of processed fruits and vegetables. Others are not so obvious.

That T-bone steak I found in my first sort was especially puzzling to me because in Spring 1973 the nation was in the throes of a widely publicized beef shortage. In and out of the media, everyone was complaining about the scarcity and high cost of beef as they described their own personal beef-saving tactics. Despite these public declarations, that T-bone steak was just one of several that garbage sorters recorded that spring among item after item of wasted beef.

Data analysis would show that the high volume of beef waste (three times the nonshortage rate) was due to the disruption of familiar buying habits. Some people bought cheaper, unfamiliar cuts of beef and, not knowing how to prepare them to their taste, discarded the results. As a hedge against future price increases, other people resorted to panic buying and stockpiled quantities of meat without thinking about how to preserve them properly.

The Garbage Project found that this odd type of behavior wasn't limited to beef. A similar pattern emerged in the media, and in refuse, during the sugar shortage of 1975. Consumers changed their normal behaviors, buying dessert mixes made with sugar substitutes and stocking up on pastries and candy. The result was double the discard of wasted sweets.

At the Garbage Project, these discoveries led us to what we called the First Principle of Food Waste: *The more frequently a food is used in a household, the lower the rate of waste of that food.* It makes sense—just think of the potential difference in waste between trying a new recipe and preparing a favorite dish. The First Principle of Food Waste explains why garbage sorters find less once-edible food thrown in the garbage of Mexican Americans. Mexican American border cuisine offers an immense variety of dishes—tamales, enchiladas, tacos, burritos, tostadas, chimichangas—but each is made from the same dozen or so ingredients. These ingredients are continually used and replenished; they don't sit on a shelf and spoil. Moreover, leftovers can be readily incorporated into the next meal.

The Garbage Project discovered, too, that most Tucson households buy standard 16-ounce and 24-ounce loaves of bread (about one loaf per week). Specialty breads (buns, muffins, biscuits, rolls, raisin bread, and so on) are bought less often—about one package every four to six weeks—and used sporadically. As the First Principle would predict, 40 to 50 percent (by weight) of specialty bread finds its way into Tucson's landfills, versus only about 10 percent of standard loaves. Sandwich bread is used every day, but hot dog buns or biscuits still in their package get shoved to the back of the refrigerator where they harden behind the pickles.

The First Principle very simply suggests that food discards can be reduced by buying common items in standard sizes and using them in as many different ways as possible. Variety, it seems, is not only the spice of life, it's also an invitation to waste.

Given the First Principle, it is not surprising that those of us who find our lives spiced up with so many things to do and so little time to do them often fall prey to another food waste pattern.

The Fast Lane Syndrome is the trend clearly visible in Garbage Project records that *households that purchase the highest proportion of processed foods waste the highest percentage of fresh foods.* (Note: This does not mean they waste the most fresh food, but only that they waste the highest percentage of the fresh food they purchase.)

This odd-sounding pattern has a simple explanation. When those of us afflicted with it go shopping, we buy fresh produce, convinced that we will find the time to make nutritious, home-cooked meals from scratch. Knowing our hectic lifestyle, however, we also buy prepared foods as backups. At the end of a week or two, the packaging from the prepared foods is in our garbage . . . alongside a whole head of gooey lettuce and a host of other forlorn and discarded fruits and vegetables!

The best antidote to the Fast Lane Syndrome is to be more honest with ourselves about how much home cooking we'll actually do. But it is not easy to focus the attention on food waste that it deserves.

The outrageous quantities of food waste documented by the Garbage Project have been largely ignored by both home management and environmental advocates for more than two decades. As a means of decreasing residential refuse, the waste of food at home has not attracted the kind of attention paid to recycling newspapers. The reason is simple.

We often place newspapers out in plain sight after reading them and can easily see how quickly they literally "stack up." On the other hand, no people I know pile their food waste up in a corner of the kitchen; instead, each fiasco quickly disappears into a covered garbage container. As a result, we have no tangible sense of overall food waste quantities, even though they are sizable.

Today, however, given increasing interest in source reduction, I have come to see food discard in an entirely optimistic light. The 10 percent of household refuse that is food waste is a source reducer's motherlode—the most conspicuous target of opportunity for rapidly decreasing what households discard. Those of us who are willing to keep a few simple food waste truths in mind can literally take a gaping bite out of what would otherwise become our garbage!

Sound familiar? If it does, then you and I are a lot alike. If we can be a little more honest with ourselves, we will be able to take a "bite out of our garbage."

Dietary Fiber, Cancer, and Garbage

"Whew!" they exclaimed with obvious relief. "No more bran muffins! No more high-fiber cereal!"

This was the response of several of my friends to an article in the January 21, 1999, issue of the *New England Journal of Medicine* (*NEJM*). And, no, they don't read the *NEJM* any more than you do. But the article was hard to miss. The instant it appeared, it was trumpeted nationwide at hyperbolic speed by the electronic media. In fact, Dan (CBS), Peter (ABC), and Tom (NBC) reported the article's conclusion on the evening news in living rooms across America with the same awed reverence they bestow on moon landings and each new cease-fire agreement signed in the Middle East.

The article's facts are these: over the past 16 years, a clutch of eight medical doctors and researchers regularly recorded the diet of some 88,000 nurses. They also registered occurrences of colon cancer among the same people. When the researchers compared notes, they were surprised to find that nurses who reported eating high quantities of fiber were just as likely to develop the fearsome cancer as those who did not. This conclusion flew in the face of 20 years of medical research, prevailing medical advice, and numerous ads for high-fiber foods. Nonetheless, the study followed all the rules of scientific medical investigation. Besides, the subjects were all nurses, and this was the largest and longest-term diet-disease study attempted thus far.

The result was that the medical community, while disappointed, largely kept mum and left the public—you and me—to draw the dietary moral of the study for ourselves. So did the media. In fact, an article on "foods that fight cancer" in the April 26 issue of *Time* magazine discussed the positive effects of tomatoes, soybeans, and broccoli, but not high-fiber sources, such as certain types of breads, breakfast cereals, and vegetables. Hence the "fiber-free at last!" response of my friends.

But you and I, because of our intimate acquaintance with garbage, are not without recourse to other relevant sources of information on this topic. As we all know, virtually every human activity produces garbage, and, therefore, the study of garbage can tell us something about almost everything we do, including the relation between how much fiber we eat and our risk of a diagnosis of colon cancer.

Since I have been freer than most solid waste aficionados to examine refuse for arcane—some might say bizarre—interests, I will share a few Garbage Project research results with you that are vitally relevant to interpreting the *NEJM* fiber and cancer article. I don't want any garbage person to make a diet decision without all the refuse facts!

My garbage "facts" are based on a comparison between garbage analysis and diet reports—both from the same households—in Green Valley, Arizona, which is a very health-conscious retirement community. The study was partially funded by the National Cancer Institute (NCI). The anonymity of participants was protected, and household residents knew that their garbage was being collected for analysis.

Refuse sorting measured "food use" (medical research jargon for what people eat) within households by recording original package contents (ounces of edible food brought in), food waste (ounces of once edible or still edible food thrown out), and fresh fruit and vegetable purchases (measured by weighing fruit peels and counting vegetable stems, large seeds, rinds, tops, and more—one by one).

Residents of study households reported their diet by completing a standard National Cancer Institute

"food frequency questionnaire"—the same kind of survey used in the *NEJM* study. For a list of 80 or so foods, it asks, for example, how many times per day, week, or month do you eat green beans? Then it asks whether, overall, you eat a serving size that is "small," "medium," or "large"?

As you already know, garbage measures have plenty of problems. While purchases of package goods—Fiber One breakfast cereal, Aunt Hattie's whole wheat bread, Campbell's navy bean soup—are easily quantified, the same is not true for apples or asparagus. In such cases, the presence of such items is measured by discarded cores and the butt ends of stalks. The "average" size of, say, Granny Smith apples or asparagus stalks is then estimated using average sizes calculated regularly by the U.S. Department of Agriculture (USDA). In all this, of course, remember that items the Garbage Project believed were eaten could, as likely, have been fed to visitors or pets, ground down garbage disposals, or composted.

Householders' responses to diet questionnaires have problems as well. Can you accurately estimate how often you eat green beans? Or cantaloupe? Moreover, how similar is your estimate of serving size to mine? (Consider that when my mom was 75, she and I both filled out an NCI Food Frequency Questionnaire. She weighed 105 pounds and I weighed more than double that. According to her responses, all of her serving sizes were "large"; according to mine, all of my servings were "medium" or "small"!) In addition, how willing are people to admit to eating a less-than-appropriate diet?

I do not know the precise answers to these questions, but I will tell you the results of our comparison between what people reported they ate and the packaging and food debris they discarded.

On average, the residents of the households questioned underreported their beer consumption by at least 40 percent and over-reported their asparagus ingestion by 200 percent. Similarly, virtually all high-fat items, such as sausages, salad dressings, and butter, were drastically underreported, while all soups were dramatically overreported—of course, vegetable soups were overreported substantially more than meat soups.

The major contributors of fiber to the diet were also misrepresented. High-fiber cereals (like Fiber One and All Bran) were overreported by 55 percent. Highly "fortified" cereals were overreported by 21 percent. And cold cereals, like, say, Rice Krispies and Cap'n Crunch were underreported by 57 percent. Would it now surprise you to learn that "dark" bread purchases were overreported by 48 percent, while the use of white bread was underreported by 21 percent?

Through these Garbage Project comparisons, it became clear that people overreport what they think is "good" for them and underreport what they think is not. The problem is that while we have a general clue as to which way people will distort their consumption, we have no way to gauge *how much* individuals will exaggerate in either direction.

This all means that the reports of fiber intake by 88,000 nurses are likely to be all over the map relative to their actual fiber intake. Right now, without a garbage study to check their accuracy, what the nurses have reported over the last 16 years can only be considered "noise"—random information relative to how much fiber each of the individual nurses really eats!

This is what "garbage" says about the latest research concerned with eating fiber and the occurrence of disease. In other words, don't quite your day job and don't stop eating bran muffins and high-fiber cereals—unless you know something that garbologists don't.

A Pop(-Top) Legend

I bet that you know what a "pop-top" or a "pull-tab" is, but I'll bet that your younger kids don't. In the 1970s and 1980s, the pull-tab pop-top stood out as one of our nation's most widely recognized icons—one small but potent scrap of aluminum that symbolized America's unbridled devotion to creativity and convenience. But even as I write this commentary, this key part of our "garbage" past is being buried deeper in the anonymity of our society's refuse remains.

To record this lost part of the 20th century for posterity, as well as its role in helping the Garbage Project unveil and quantitatively document our mid-century American lifestyles, I will here recount the story of Ermil Fraze and his garbage creation—the pop-top—which has now acquired "legend" status among Garbage Project sorters.

The legend was born on a hot Ohio day in the summer of 1959. Ermal Fraze and his family were about to enjoy a luscious picnic when their idyllic outing fell on its face. The beverage cans were chilled, but Ermal had forgotten to bring the one indispensable tool of the day—a "church-key" can opener. Faced with a solid steel top, Ermal found only gut-wrenching despair! In fact, Mr. Fraze was eventually reduced to prying the cans' lids off on his car's bumpers.

In a similar situation, the protagonist of the 1990s movie *Falling Down* went on a violent rampage. Ermal, however, followed the spirit of his times and set about correcting this huge gaffe in his otherwise convenient lifestyle. By 1963 he had patented the pull-tab pop-top that made him a fortune on its way to becoming a short-lived hallmark of American life.

The story picks up again in 1977, when I assigned my sophomore archaeology class to study the detritus left behind at a drive-in theater by movie-goers. While drive-in cleanup crews removed cans, bottles, cups, wrappers, and other visible debris each morning, they invariably left behind much smaller bottle caps and pull-tabs. When we began our study, these neglected throwaways carpeted the whole drive-in. The class decided to use the nicely labeled bottle caps to determine quantities of soda and beer by brand. We'd collect the pull-tabs to determine the ratio of bottles to cans that people brought with them to drive-ins and assume that the brand distribution among cans was about the same as among bottles.

Each student was assigned a speaker post and tethered to it by a length of rope. Then, on hands and knees, they each picked up and bagged all the bottle caps and pull-tabs they could reach. Every student, that is, except one young woman, whom I noticed sitting against her post staring at her hands. I walked quickly over to encourage her to take a more active role.

"How's the surface collection going?" I asked.

"Have you ever looked at these things?" she responded as she held out two pull-tabs in my direction.

"Yeah, fascinating!" I exclaimed as I got down on all fours. "Let's pick up a few more to look at."

"Why are there so many different kinds?" she asked.

I stopped collecting, sat down, and stared at the pull-tabs in my hands. I held eight, and all were slightly different. The most distinctive pull-tab had two small holes in the base of its pull-ring above the flange that had sealed the can. The second pull-tab was light gold colored on its top side, but silver on its bottom. It had no grooves in the pull-ring, as many others did, and no holes.

I was shocked! I hadn't known that there were different shapes and colors of pull-tabs, much less why. Within a few minutes, everyone in the class was sitting and staring down at the tiny artifacts in their hands.

On my way home that day, I stopped at a convenience store to rummage through their beverage coolers. I found that the pull-tabs with two small holes were attached to Coors beer cans and that the ones with light gold fronts and silver backs came on Michelob cans. Eureka! The different pull-tabs correlated to different brands of beer and soft drinks. Within days, the Garbage Project had constructed a "pull-tab typology" for Tucson, Arizona. (You can see it for yourself in the May 1991 *National Geographic,* on page 131).

The brand-specific pull-tabs combined with labeled bottle caps told an interesting story about what people brought with them to drink at drive-ins. Half the tabs/caps were soda and half were beer—no surprise. One result, however, was quite unexpected: the largest number of beer pull-tabs by far were from Michelob cans, one of the more expensive brands. Splurging on a "drive-in night out"?

But what was the typology good for outside of identifying some of the beverage consumption habits at drive-ins? It didn't take long to determine that just as the final resting place of pull-tabs was widely separated from cans in drive-ins, the same was often the case at home. A few people dropped pull-tabs into their cans, but the vast majority threw them into their garbage separately. This was a classic example of the McKellar Principle in archaeology: Items that are used together are often treated differently as refuse if they are dissimilar in size. The implications were stunning: even when responsible citizens took their aluminum beverage cans to recycling centers, Garbage Project sorters could still find tell-tale tabs to indicate which beverages had been purchased. Thus, we could track the rise and fall of beer brands and consumption levels as well as the cola wars within household

refuse. (One student has even suggested, based on a study of the co-occurrence of beverage containers and relatively liberal or more, conservative newspapers, that Pepsi drinkers tend to be more politically conservative than Coke drinkers—but the jury is still way out on this one!)

But every silver lining has a cloud. The very same separability from cans that made pull-tabs a boon to garbage sorters also made pull-tabs a public enemy. Parents worried that children might swallow them. And just as at drive-ins, pull-tabs began to pile up along the sides of streets and roads, over parking lots, around schools, across parks—in fact, archaeologist Stan South once used the density of pull-tabs to determine the relative popularity of different campsites and trails in parks. So, to protect throats and the environment, during the early and mid-1980s, pull-tabs were replaced by push-pull-tops. Sadly for Garbage Project sorters, the push-pull tabs generally remain attached to their cans (except for those drunk by nervous people who play with them until they break and people with moustaches, who often pull off the tabs intentionally).

For sorters of fresh garbage, the glory days of easy brand identification are gone. But for garbage archaeologists, those silent telltale pull-tabs will continue to inform the future about the drinking habits in the latter half of the 20th century, forever retrievable from the insides of landfills.

I believe a toast to Ermal is in order!

Drinking in Garbage

There's always one poignant bag of garbage I keep in the back of my mind. It was recorded in the fall of 1974 and, like the other 20,000-plus samples of household discards Garbage Project sorters have recorded, came from the trash one household had put out on a biweekly collection day. Unlike other samples, inside this brown-paper grocery bag, all of the packages were still nearly full:

- 1 10-pack of Cudahy beef wieners—unopened
- 1 24-oz. loaf of Rainbo white bread—4/5 unused
- 1 14-oz. bottle of Kerns tomato catsup—3/4 full
- 1 6-oz. jar of French's mustard—4/5 full
- 1 16-oz. jar of Best Foods mayonnaise—5/6 full
- 1 16-oz. box of Blue Bonnet margarine—5/6 unused
- 1 2-oz. pack of Lipton soup mix—unopened

These artifacts suggested an outing that was never to be: "John" and "Martha" were going on a picnic. But first John put their garbage out in a brown-paper bag. Then Martha took their picnic out in a brown-paper bag. When John and Martha arrived at the picnic ground, they found that they had brought their garbage for lunch.

How could such a mix-up happen? One item in the bag indicated significant consumption . . . and a possible answer to the question:

- 1 pint-bottle of Southern Comfort ("The Grand Old Drink of the South")—nearly empty

All too many of us can now understand how the mix-up might have occurred.

When I think of this case, I am reminded of a basic human truth, constantly reaffirmed when sorting garbage: what people *say* they do and what people *actually* do are often two different things.

When asked during the 1970s to report on their beer consumption for a health survey, 70 to 80 percent of the respondents in a typical Tucson neighborhood reported no consumption by any household member (at home or away) during an average week; 20 percent or so reported total household consumption at seven or fewer 12-ounce beers; and only a handful of respondents reported emptying more than seven 12-ounce cans or bottles.

The record of garbage sorts from the same neighborhoods at the same time is distinctly different: 25 percent of household refuse samples contained no beer bottles or cans (and no beer caps or pull-tabs from recyclables); 25 percent held one to seven empties; and 50 percent revealed more than seven beer containers, including a few households that were consuming at the rate of a case every three-and-one-half days. (Party remains were excluded from these statistics. Parties are identified by substantial quantities of snack-food packaging, tubs of half-wasted dip, soggy paper plates and cups, and/or by the "smoking gun" of parties: cigarette butts floating in stale beer, the smell of which will stay with me to the grave.)

The use of alcoholic beverages is one of the most misdocumented aspects of human behavior. Part of the reason, of course, is that few people who drink large quantities of alcohol openly admit this to interviewers. Furthermore, many who drink, but not obsessively, still prefer to remain oblivious to just how much alcohol they consume, thereby deceiving themselves as well as interviewers. The result is that both medical and market researchers find a consistent gap of from 40 to 60 percent between the amounts of alcohol brewed, fermented, and distilled for consumption (including imports) and the amounts people own up to imbibing.

The Garbage Project's archaeological perspective, which has no self-report bias (archaeologists have other problems), has identified some interesting patterns. One pattern could assist those who want to record alcohol use through interviews. The "surrogate syndrome" states that if a respondent reports personal drinking, then all reports of alcohol use from that source are likely to be underreports; on the other hand, if the respondent reports no personal use of alcoholic beverages, then he or she is likely to tattle on housemates with chilling accuracy.

Other Garbage Project studies of alcohol consumption have run from the esoteric to the highly pragmatic. Undergraduate Fred Haskell combed through 12 years of data to determine whether at-home consumption of beer fluctuated in sync with the phases of the moon. It did not. But it did fluctuate in response to paydays.

I have long maintained that garbage is the great equalizer, being the material reality of the American Dream. At first glance, alcoholic beverages would seem to contradict that assertion: lower-income neighborhoods are characterized by beer (bought mainly in bottles) and some hard liquor; every type of alcohol is consumed in middle-income neighborhoods—beer (most of it in cans), wine, and hard liquor; upper-income neighborhoods discard better wine and large hard-liquor bottles (often not as prestigious and expensive as those from middle-income households) along with a few rotgut beers. Yet, amazingly, 18 years of research indicates that just below the surface lies equality. Boil all the data—the beer, the wine, the hard-liquor containers—down to the actual alcohol delivered by each, and the average household consumption across the neighborhoods studied does not vary one whit. Picnics are likely misplaced at all levels of society.

The Moving Hand of Plastics

When I founded the Garbage Project in 1973, the main goal was to track changes in our society over the long haul: where better to look for these changes than in garbage, that common denominator of life in America? And, what could be more commonplace in American life than soda and beer?

When I counted the soda and beer containers that student sorters recorded in the garbage from households in Tucson, Arizona, the results were to be expected: aluminum cans had largely replaced steel cans, glass bottles had risen somewhat for beer and fallen, especially in larger sizes, for soda; and two-liter polyethylene terephthalate (PET) plastic bottles have become the major workhorse to heft soft drinks. Further evaluation, however, suggests that there are some surprises in the way a few mundane basics of life have changed in the past three decades.

Surprise Number 1: From 1979 to 1989, aluminum *soda* cans generally *increased* in refuse as the number of soft-drink brands using aluminum increased. During the same period, aluminum *beer* cans *decreased* in refuse, even though sales of beer in aluminum cans remained strong. What's more, in precurbside recycling days, while aluminum cans in general were dropping rapidly out of refuse and into recycling centers, the drop was twice as steep for beer cans as for soda cans. (The recycling of aluminum cans was identified by finding pull-tabs and no cans in refuse; whether the recycled cans had contained soda or beer was determined by the color and shape of each pull-tab—see above on "A Pop(-Top) Legend.") This pattern suggests that people who drink beer at home may be more ardent recyclers than those who imbibe mainly soda there. Perhaps because beer is more expensive than soda, beer cans pile up fast enough, especially among heavy consumers, to become an important supplement to pay for their brews.

Surprise Number 2: When the total ounces of beer and soda delivered by all the various containers was tracked over time, the result was startling. Household beer-container disposal has fallen from an amount representing 40 ounces of average beer use per bi-weekly refuse pickup in the mid-1970s

to about 20 ounces per pickup in the early 1990s. (Note that the real drop in home beer consumption is not anywhere near as precipitous, due to the beer cans taken to recycling centers.)

In the same period, household disposal of soda containers has skyrocketed, from containers representing just over 20 ounces of average soda use per refuse pickup in the late 1970s to more than 50 ounces per twice-a-week refuse pickup by the late 1980s. (Indeed, *Beverage Industry* magazine reports that soda consumption went from 30.3 gallons per capita in 1972 to 48 gallons per capita in 1992.) And, of course, that trend has continued as some of us—probably a lot of us—are guzzling a good deal more soda than we used to.

How to explain this seismic soda shift in guzzling at home? Megabucks spent on advertising by Coke and Pepsi? Beer companies are hardly advertising slouches. Lessening alcohol consumption due to rising health consciousness? Soda isn't exactly health food. For me, there is only one convincing explanation: the two-liter PET bottle.

Lightweight plastic PET makes it much easier to bring large quantities of soda home from the store. The two-liter PET bottle delivers a whopping 67.6 ounces of soda—more than double the cargo of its nearest glass or metal competitor; and the PET container by itself today weighs less than two ounces. To bring home the same load of soda in glass, along with the soda, you would be lugging around 14 ounces of glass.

For the shopper who transported soda home over the last two-plus decades, the choice between glass and PET was made quickly.

From the date of its first introduction in the late 1970s, the quantity of soda that Tucson shoppers carried home in PET rose exponentially, blowing past soda in glass and aluminum in just three years. Over the past decade, the soda brought home in PET has leveled off at more than 40-plus ounces per refuse pickup—double the total held by all beer containers found in garbage.

If PET has been such a boon to soda, why isn't beer bottled in PET? It wouldn't taste as good? That's what was said when beer was first put in cans. And, in fact, beer is now bottled in plastic in Europe and Australia, where people are very particular about their beer.

But there is a legitimate reason for an incompatibility between PET and beer sold in America. A soda container's most important job (apart from carrying the liquid) is keeping the CO_2 carbonation inside. A beer container's job is keeping beer-souring oxygen out. PET holds in soda fizz well enough. But, in America, due to the mega-logistics of national distribution from a few large breweries, there is an average of five to eight weeks between bottling and consumption of beer. PET doesn't keep oxygen out well enough for that long. Packaged in PET, beer bottlers sadly note, the flavor of the brew deteriorates. (Beer is bottled in plastic in Europe and Australia by breweries that distribute their brews rapidly to nearby consumers.)

Of course, it is no wonder Coke and Pepsi have been supporters of PET recycling. The Food and Drug Administration (FDA) has issued a "letter of no objection" to Coke and Pepsi, tacitly approving their processes for recycling old PET bottles into new ones. Due also in large part to container deposit laws, more than 40 percent of all plastic soda bottles were recycled during the 1990s.

In addition to soda, PET bottles hold shampoos, cooking oils, and peanut butter. But beware, recyclers: not all clear plastic containers of these items are PET. Generic brands, and the special-offer items ("Get 1/3 More Free!"), are often packaged in polyvinyl chloride (PVC) because limited runs of PVC containers are cheaper than limited runs of PET. If consumers do not check the recycling logo on each and every bottle or jar for a "1" (PET) versus a "3" (PVC), some PVC bottles will surely slip into PET bins. Just one PVC rogue in 100,000 PET bottles can ruin a whole batch of recycled PET products.

When I think like an archaeologist, 20 years is nothing—hardly the blink of an eye. But that's all it took for the introduction of PET to dramatically affect our consumption. Now, why do you think all those people are carrying bottled water in highly light-weighted plastics. For health reasons, sure; but it is more than health reasons alone. Would the likes of Gwynth Paltrow be lugging heavy and cumbersome glass water bottles? Too bad I didn't write this column 10 years ago, so I could have foreseen the coming wave of water in light-weighted plastic bottles and invested in it!

Best Laid Plans . . .

The Best Laid Plans . . .

Do you remember where you were when you first heard of the "garbage barge," which was pushed and pulled into history by the tugboat *Break of Dawn* in 1987? I was in the Garbage Project office at the University of Arizona when an excited student ran in with the first newspaper clipping. It seemed like such a hoot! Clipping followed clipping as the world's media followed the *Mobro*'s progress—or lack of it—for months.

The next thing you know, there's a "Garbage Crisis." In newspapers and magazines and on radio and television, issues of garbage disposal superseded crime, drugs, and taxes. Local outcries exploded into a national chorus of "Garbage Glut!" "No Place to Put Our Refuse," and "We'll Be Buried in Our Garbage!"

City, county, and state governments all responded. Bans of products the public and politicians thought were responsible for an overabundance of garbage were immediately proposed—most never became law. Recycling quickly burgeoned into a national obsession. Recycling is doing a lot of good, but mainly it is just preventing population growth and other causes of garbage increases from making our disposal problems any worse. Overall, many people who deal with garbage every day believe that 10 years later we haven't gained all that much ground in our war against waste.

What is a concerned discarder to do?

Well . . . move to New Jersey where people are saying that "there's not enough garbage!"

In New Jersey the battle over "waste flow controls" has turned the "Garbage Crisis" on its head. Several counties are, in fact, saying that they honestly don't have enough garbage to get by. How can that be? How can we have gone from far too much garbage to not nearly enough in 10 short years? Despite the best planning efforts of New Jersey's waste managers, the answer to this question involves major components of politics, the law, and economics, and therefore is nonsensical and convoluted, but this is how I understand it:

Once the "Garbage Crisis" embedded itself in the public mentality of New Jersey, it instantly created several offspring. State government mandated recycling. In addition, each county was given to understand that it was to be self-sufficient in the solid waste arena and, therefore, responsible for developing long-term plans to dispose of the garbage its municipalities created. For their part, the counties took the responsibility for their garbage seriously.

Today, the state's largest resource recovery facility—operated by American Refuel—has a capacity of 2,700 tons per day, or nearly a million tons a year, for the solid waste of New Jersey's largest county, Essex. Warren County operates both a resource recovery facility, with a capacity of about 450 tons per day, as well as a landfill. Both were designed to handle Warren's own refuse plus the solid wastes from Somerset and Hunterton counties. Morris County has built two state-of-the-art transfer stations to collect its municipalities' solid waste and send it to Tullytown Landfill in Pennsylvania.

The only problem that arose in this process was that new facilities, whether landfills or resource recovery plants or transfer stations, cost lots of money. But that was planned for as well by giving each county "waste flow control," which mandated that the refuse generated by the county's municipalities—the waste that the county was held responsible to dispose of—would go to the county's new facilities. Each county was therefore able to figure how much garbage would be coming its way for disposal and then calculate a tipping fee that would pay for its amortized debt. Most county tipping fees also included components to support proper landfill closure, resource recovery facilities, market development for recyclables, future planning, and public education. These tipping fees were expensive, but they were also farsighted in their attempt to create a truly "integrated" system of solid waste management.

This utopian idyll was disrupted by a strong dose of reality when tipping fees outside New Jersey dropped markedly and the counties' captive audiences—waste generators and their haulers—decided to shop around for the lowest rates. In subsequent disputes, counties and private haulers battled their way to the Third Circuit Court. The judge decided,

as elsewhere in the country, that the issue was one of keeping interstate commerce of waste or whatever unimpeded. The specific ruling (which the Supreme Court refused to reconsider) held that waste flow control was valid as long as the bidding process did not discriminate against out-of-state vendors. Morris County, which was sending its refuse to Pennsylvania, reinstated waste flow control after it documented that an appropriately nondiscriminatory protocol had been followed. Hudson County, another county without a resource recovery facility, has been able to rebid all its solid waste disposal and reestablish waste flow control. Many other counties have not been so lucky.

Essex County has had to cut its tipping fee to $50 per ton to be competitive with out-of-state disposal options—and that fee cannot satisfy the county's share of the debt encumbered with Refuel's $300-million facility. Warren County is retrenching on several fronts, including restructuring its debt, seeking voluntary contracts, and lowering its tipping fee to $48 per ton, with further discounts for high volumes. Even after these Herculean efforts, because the market value of refuse disposal is so low, Warren County would be happy for any help forthcoming from the higher reaches of government.

The economic plight of New Jersey's counties has not fallen on deaf ears in Trenton. The State Department of Environmental Protection has set up emergency rules that allow counties to levy a "garbage tax"—if they can collect it. The governor wants to replace this temporary measure with environmental investment charges, which counties could levy to pay for "stranded" debt. And the legislature is considering a statewide "garbage tax" to help keep counties from the shame of defaulting on the cost of their facilities. You can imagine the turmoil all this political action has caused if you just consider how pleased New Jersey residents must be with the thought of paying a new tax to get rid of something they don't want anyway.

As unpleasant as this situation is for New Jersey, it does have a few side benefits for interested out-of-state onlookers.

First, this whole "not enough garbage" dilemma should not be misconstrued. There is as much garbage as ever—too much. There is just a lot more disposal capacity out there than before. The problem for New Jersey's "self-sufficient" counties is that solid waste haulers are now free to seek out the cheapest alternatives.

Second, the trends in garbage disposal are cyclical. Low levels of long-term capacity at small landfills, which typified the disposal market surrounding the cruise of the garbage barge, have been replaced by high levels of long-term capacity represented by monster megalandfills. But even these behemoths will eventually begin to reach capacity, and the media's concerns about disposal will again burst upon the public. Note that Tullytown Landfill is now occasionally reaching its daily limit of waste before the garbage trucks from Morris County at its doors have been emptied.

And third, as one county solid waste coordinator told me, "It's all economics and law and the ability to compete" . . . and, as he is rapidly learning, the capacity to adapt quickly to a changing environment! You can do what is right for the environment, but still, the best laid plans . . .

Rolled Steel—Another Clash of Good Intentions

"Rolled steel"—the very words appeal to the ear, suggesting strength and solidity but also grace and elegance. Rolled steel—steel that has been hot rolled and then cold worked—is so thin and pliable that it can be punched into cans that are almost as light, just as easily crushed, and nearly as cheap to transport as their aluminum counterparts. But iron ore for making rolled steel is cheap to mine and process, whereas extracting aluminum from bauxite is expensive. The problem is not that aluminum is scarce. In fact, it is the most abundant element on Earth. But separating aluminum from the ore in which it occurs is accomplished by means of an extremely energy-intensive electrolytic process. As a result, the production and distribution of an aluminum can consumes a quarter to a third more energy than the production and distribution of a rolled-steel can.

In the late 1960s, when rolled steel was developed, it seemed to be a stunning technological achievement—the imminent successor to aluminum, and the NutraSweet of the canning industry. Today, a little more than 30 years later, cans made of rolled steel are a footnote in the annals of the beverage industry.

Was the technology flawed? No, the performance of rolled steel proved to be as good as its promise. Did the captains of industry see too little gain? No, again. The profit motive started rolled steel rolling, and initial experiments with the new technology bore out all of their happiest predictions. It is tempting to look for villains when something as obviously advantageous as rolled steel meets an unexpected demise. But around its deathbed one finds instead only good guys doing right and proper things.

The fate of rolled steel is another one of those cautionary tales that abound in the waste management industry (see the previous essay) and plague much of the rest of 20th century America. No matter how good your intentions, too many issues to consider—like too many cooks—spoil the broth.

This particular story begins during the late 1960s, when beverage companies began replacing their traditional solder-seamed, tinned-steel cans with cans made of aluminum. The lighter cans meant that distributors could move more cans farther for substantially less money. The future of aluminum cans seemed, like the cans themselves, bright and everlasting.

Unfortunately, the durability of aluminum drew attention to a problem. It used to be that cans thrown from car windows or left at an open dump—cans made of tinned steel—would rust and degrade inconspicuously. But aluminum was different: its ability to survive the elements, and thus to be conspicuous in the landscape for years, alarmed environmentalists. That concern dovetailed with another: that the processing of bauxite into aluminum—a material vital to industry for car parts, plane parts, and a variety of electronic components—was contributing inordinately to the depletion of the world's energy resources. In the early 1970s some environmental visionaries speculated that future generations might have to strip-mine the landfills of their ancestors in order to salvage a material that had once been ubiquitous.

But all was not gloom, since a solution—recycling—was at hand. Aluminum manufacturers and beverage companies, together with environmental groups and dealers in used metals, set up recycling centers across the country. Success was not instantaneous, but industrialists and activists alike worked hard to raise the public consciousness and also to make enlightened environmental behavior financially worthwhile. Recyclers began to offer premiums of as much as a penny a can. By the late 1970s it was not uncommon to see people with litter sticks walking along the highways spearing cans. In cities, garbage dumpsters behind apartment complexes were systematically looted. Recycling achieved a broad, even unintended, mixture of social objectives. Trash was collected, resources were conserved, and many of society's less fortunate members received a supplementary income.

Enter American Can Company, with its invention of rolled-steel beverage cans. The relative advantages of rolled steel were immediately apparent to the beverage industry. It was cheap, it was lightweight, and it was degradable. The only aluminum that a rolled-steel can would require would be for the top. All that American Can needed was a company daring enough to be the first to experiment with the new material. Coke was it. By 1976, in most parts of the country, Coca-Cola bottlers were canning all of the company's beverages, from Coke to Tab to Sprite to Mr Pibb, in containers fashioned from rolled steel. Rolled steel entirely lived up to the company's expectations. Financial success and kudos for good citizenship seemed assured. Nevertheless, by 1980 most of the Coke's bottlers had switched back to aluminum.

Why? At least one reason for the about-face seemed to have to do with "image"—rolled steel was hurting Coke's public relations profile. How? Aluminum cans were worth 27 cents a pound, but rolled-steel cans were worth barely one or two cents a pound: recycling rolled steel—in other words, recycling cans that had contained Coca-Cola products—was not cost-effective for consumers. Was the Coca-Cola Company, environmentalists asked, turning its back on the whole concept of recyclable resources?

In response, Coke might have explained to the public that recycling has never been total. It might have pointed out that, notwithstanding optimistic claims by some proponents, in thousands of landfills across the country "truckload quantities" of aluminum cans are discarded every day. In this way, the company might have argued, that as long as beverage cans are made of aluminum, a great deal of aluminum will be wasted no matter how aggressive the attempts at recycling. Coke might have concurred

with some environmentalists of the time who cautioned that recycling is itself energy intensive. What, Coke might have asked, is to be gained by using gas-guzzling cars to shuttle a few pounds of aluminum several miles to a recycling center? Coke might have noted that even though it is not profitable to recycle rolled steel, steel is manufactured cheaply from materials whose availability is far from scarce. Coke might have observed, in sum, that a beverage industry using unrecycled rolled-steel cans would save more resources than a beverage industry using aluminum cans in conjunction with a recycling effort of even the most optimistic proportions.

But Coke argued none of these things. The company decided instead to turn away from rolled steel, thereby supporting the recycling industry and succoring the environmentalists. It reverted to aluminum cans. As a result, despite the best intentions of everyone concerned, the United States is still producing far more aluminum—and thus using up far more energy—than it needs to.

As I mentioned at the outset, there are no real villains in this story, and that is the point. Recycling is by and large a good thing. The profit motive is by and large a good thing. A social conscience in the corporate boardroom is by and large a good thing. But sometimes good things bump into one another in unexpectedly bad ways. This is a feature of life in America that continually takes us by surprise. We tend to be vigilant when it comes to archfiends and evil motives. We are accustomed to catastrophes that come in SpectraVision and with Dolby sound. But we are not very watchful of the ordinary—of the small conflicts among desirable goals in which most larger-than-life calamities have their sources.

Recycling's Percentage Paradox

This last Christmas I decided to print my own cards. Rather than the standard format of normal-weight paper printed on one side and folded in four, I decided to use heavier paper and print on both sides. To be conservative, I culled the list to a moderate number and started in good spirits. Soon after, I was not in a holiday mood and my waste-paper basket was overflowing with misprints, most with an acceptable print on one side and a smudge, stain, or misalignment on the other. I culled my list even more and retreated from my losing battle with my computer. I salved my wounded ego over the mess that I had made by the thought that at least all the waste paper I had created could be recycled. At least that was the way I thought the waste world was working. After looking a little closer at recycling figures, I'm not so sure, and I'm planning that if I send anything out at Christmas, it will be short, handwritten notes. Why the change of attitude? Because of "recycling's percentage paradox."

According to EPA statistics, in 1995 we recycled or composted 26.9 percent of MSW collected during the year. For added emphasis, the most memorable reports compare our 1995 recycling record to some earlier date, say 1970, when we recycled or composted a mere 6.6 percent. To make the contrast even more stunning, these percentages are usually also presented in millions of tons, a recycled quantity that exploded from 8 million tons in 1970 to 1995's gargantuan 56.2 million tons. Given this dramatic contrast in both percentage and tons of MSW recycled, most of those who are aware of these figures—ironically, whether they consistently recycle much of their own refuse or not—are busy patting themselves on the back.

These accolades are, of course, richly deserved. Recycling consistently takes commitment, planning, dedicated space at home, and storage bins and other equipment. Its not easy. Nonetheless, householders have responded to recycling calls both more rapidly and more enthusiastically than most experts predicted. Through their participation, many people have also become more concerned about garbage, waste, litter, and other environmental issues. One result is that many consumers believe that, if the victory over our wastes is not won, at least we have invaded enemy territory and are bearing down on their strongholds.

As positive as this attitude is, I believe that there is some unwanted baggage attached to it. First, it is easy for Americans to lose interest in issues that are not threatening imminent harm to them or their immediate environment. If it is common knowledge that we're gaining in our efforts to reduce wastes, the willingness to put additional energy into the fight could begin to lag. In addition, there is a less obvious, but potentially far more destructive, by-product: the attitude that "if I am doing my part in recycling and recycling is working to reduce waste,

then I don't have to worry as much as I did about what I buy." Think, for example, of the people considering the purchase of a printer for a home computer—I can identify with their attitudes. They might decide that, at least in terms of paper use, there's no reason not to get a printer, since the paper that is misprinted or no longer useful can be recycled. I now see this as the biggest danger associated with believing that we are reducing our wastes: we will feel freer to increase our consumption.

I worry about this issue because since recycling achievements are usually reported in terms of percentages (or actual quantities recycled without reference to the actual quantities discarded), people can easily misinterpret the state of our wastes. That's "recycling's percentage paradox." I can best explain with an example. Most anything will do, but since my Christmas card fiasco and since paper represents more than 40 percent by volume of all the landfills the Garbage Project has excavated, it seem a good illustration. In 1994 we recycled 35 percent of MSW paper in the United States, that is more than double the 1970 paper recycling rate of 15 percent. In more concrete terms, 28 million tons of waste paper were recycled in 1994 compared to 6 million tons of waste paper recycled in 1970. Whew! That increase took tremendous effort and dedication by consumers, waste haulers, recycling centers, recycling middlemen, and the paper industry. There's just one small "but . . ."

But despite the fact that 1994's paper recycling rate was substantially higher than 1970's rate, 14.7 million *more* tons of paper were landfilled during 1995 than in all of 1970. That's the *paradox*—a high recycling rate but more wastes thrown anyway. Does that add up to reducing wastes?

The reason for the paradox is simply the much larger quantity of paper wastes generated in 1994 than 1970. In the 24 years that intervened, the quantity of paper and paperboard included in EPA's calculations of MSW burgeoned from 44 million to 81 million tons. The problem is that the absolute increase in the paper wastes recycled (22 million tons of paper) was not as great as the absolute increase in the paper wastes *not recycled* (37 million tons)! Thus, while the paper wastes that went into the environment through landfilling or incineration were significantly lower than they could have been, they still represented a hefty increase over the paper wastes that went into the environment in 1970. (And, for sure, some of that paper came from home printers.)

So, which of the two years was less demanding on the environment in terms of the disposal of paper wastes? I would say 1970, because, even though it had a far lower recycling rate than 1994, far fewer paper wastes actually ended up in the environment in 1970.

Don't get me wrong. I'm not advocating returning to the 1970s. I strongly applaud both the high level of public participation and the increase in the percent and quantity of recycling in the 1990s. In addition, I don't want another "Garbage Crisis" dripping with doomsday rhetoric.

On the other hand, I believe that the public should be presented the facts about recycling more clearly and more often in terms of the absolute quantities of wastes *not* recycled. We are old enough to know that we are winning the war on waste in terms of increases in recycling quantities and in terms of our heightened involvement, but we are not reducing wastes—not yet, at least, especially not in the light of my Christmas card disaster!

A Preverse Law of Garbage

Only two refuse realities can reduce stalwart Garbage Project sorters to fear and loathing: one is raw, rancid chicken (as bad as any smell stinks); the other is Parkinson's Law of Garbage (as unintentionally perverse as any human behavior becomes). Anyone in the vicinity immediately recognizes rancid chicken; Parkinson's Law of Garbage was exposed only after thousands of Garbage Project sorts of household refuse pickups.

The original Parkinson's Law was formulated in 1957 by C. Northcote Parkinson, a British bureaucrat who concluded: "Work expands so as to fill the time available for its completion." Parkinson's Law of Garbage similarly states: *Garbage expands so as to fill the receptacles available for its containment.* While the evidence for this refuse law is not yet totally conclusive, its implications go to the heart of every city's solid waste management strategy.

During the past decade, many municipalities have switched from a system whereby homeowners provided their own garbage cans and sanitation work-

ers emptied them by hand to a system whereby the city provides special containers that trucks empty mechanically. The object is to save labor costs and reduce worker injuries. Mechanized trucks can handle only a limited number of sizes of bins. Because large households must be accommodated, most city residents receive a very large 90-gallon wheeled container, in contrast to the old standby unwheeled 40-gallon galvanized can.

In 1980 the city of Phoenix adopted such an automated system, with 90-gallon containers, and a subsequent Garbage Project study (in 1988) revealed that the per capita generation of garbage seemed to be abnormally high, at least compared to Tucson, a mere 100 miles away.

Nothing more was made of this finding until researchers began analyzing data from areas of Tucson that had recently converted to mechanized collection (in 1990). We realized then that the garbage-generation rates of sample households had shot up about a third, comparable to the apparent increase in Phoenix.

Other cities that have mechanized are also registering significant increase. In Sacramento, for example, the annual per capita haul has risen from about 1.4 tons before mechanization to more than 1.8 tons afterward, even as tipping fees have more than doubled. A Dodge City, Kansas, sanitation official expressed surprise at the results of a pilot program in which households were given 120-gallon garbage bins: "People filled the suckers up!" In Beverly Hills, neighborhoods have been given 300-gallon containers, and one can only wonder what effect such encouragement will have on a community whose discard patterns are already excessive. (Beverly Hills is the kind of place, according to sanitation workers there, where some homeowners regularly pick up the sod and throw out their entire lawns twice a year, switching grass type to keep it green year-round.)

Parkinson's Law, with respect to garbage, is really quite simple. When people have small garbage cans, larger discards—old cans of paint, broken furniture perpetually awaiting repair, bags of old clothing—do not typically get thrown away. Rather, these items sit in basements and in garages, often until a residence changes hands.

But when homeowners are provided with plastic mini-dumpsters, they are presented with a new option. Before long, what was once an instinctive "I'll just stick this in the cellar" becomes an equally instinctive "I'll bet this will fit in the dumpster."

The Garbage Project has compared the contents of Tucson garbage collected before and after mechanization. Solid waste discards went from an average of less than 14 pounds per biweekly pickup to an average of more than 23 pounds. The largest increase was in the yard waste category, followed by "other" (broken odds and ends), food waste, newspapers, and textiles. The first pickup of the week was substantially heavier than the second, reflecting the accomplishment of weekend chores, and the discards in that pickup contained consistently larger amounts of hazardous waste than we had come to expect in a typical load. These findings suggest that the introduction of 90-gallon containers should be of concern for three reasons.

First, the increase in discarded newspaper suggests that one counterproductive result of larger containers may be a lower participation rate in any form of recycling. For those who find separating out recyclables a bother, the 90-gallon bin is a no-penalty means to circumvent the issue. Likewise, the increase in "other" and textiles could mean an alternative to the "donation avenue," which leads unwanted resources to the Salvation Army and other charities.

Second, the substantial increase in hazardous wastes indicates that the large bins are a convenient alternative to storing toxic items until used up at home or until the next household hazardous waste collection day.

Third, at the same time massive, all-out recycling programs are being implemented to *decrease* the flow of garbage, collection techniques are being installed that unwittingly may be *increasing* the overall flow of garbage to an even higher rate.

Why should *you* care? The answer is simple: a major problem in the increase of garbage has nothing to do with fast food or diapers or even packaging. The increase in today's garbage has more to do with the general attitude of the consuming public. In interviews, we are all more than happy to talk about cutting down on waste; but when we are home alone, we may, in fact, behave quite differently. As hard as it is to blame people who consider themselves to be innocent bystanders, *the buck stops with the consumer.*

McDonald's Cross to Bear

Recently, on the same day, both BanTransFat.com, Inc. and a San Francisco radio show host filed lawsuits in California against McDonald's. They charged the company's delay in its September 2002 promise to reduce trans-fatty acids in its fried foods' cooking oil constituted false advertising. So the fast food giant is back in a very public war zone.

Anyone who works in the solid waste arena is no stranger to the battles between what consumer advocate groups want for consumers, what consumers as individuals are willing to pay for with their dollars, and what is good for society and the environment in the long run. Perhaps there are some lessons for us all in McDonald's classic struggle with the public's perceptions of their burger wrappers.

During the early 1970s, McDonald's came under attack from those concerned about the number of trees cut down to make the paper that went into the wrappers that satisfied America's burger lust.

Citing what has become a corporate mantra—"We sell burgers, not packages"—McDonald's responded by hiring a state-of-the-art environmental consulting firm to consider available packaging options. The costly report concluded: to be environmentally sound, McDonald's should switch from paper to foam packages (expanded polystyrene foam (EPF) or polyfoam—what most folks call Styrofoam, but isn't—more on that in another column). Virtually all players ignored the fact that burger-wrapping paper was not made of pulp from old-growth forests, but instead from fast-growing southern pines grown on tree farms. No one noted that when tree farms cannot find markets for quick-growth trees, they shift crops to high-fertilizer and low-oxygen producers like cotton—the end result being something like clear-cutting forests in the Amazon, eh!

In 1976 McDonald's shifted from paper to foam containers for its larger hamburgers and some other foods.

Much to its surprise, McDonald's found it had traded one convenient target for an even more potent bull's-eye. And the opponents of foam were even more vocal than the friends of trees—protesting the use of chlorofluorocarbons (CFCs) in the creation of polyfoam as well as the sheer waste they argued discarded foam represented in landfills.

Based on widespread public misperceptions of its actual volume in landfills (only a small fraction of the one half of one percent of all fast food wastes) and the belief that paper biodegrades rapidly in landfills (which it doesn't)—the polyfoam issue received sustained attention. Communities across the country—Berkeley, then Portland, Oregon, and Suffolk County on Long Island—took steps to ban polystyrene foam. In 1987 McDonald's sought to dampen the controversy by announcing that its suppliers would stop using traditional CFCs in their polyfoam and switch to a variant form of blowing agent that depleted 95 percent less ozone.

Note that McDonald's did not mention that blowing agents of EPF accounted for less than two percent of the CFCs released into the atmosphere—the vast majority of CFCs, in fact, came from refrigerators (both commercial and home) and car, office, and home air conditioners. (Hey, but which activists and legislators had the backbone to call for bans of CFCs from those sources?)

Protests continued. Schoolchildren (perhaps helped by adults?) formed an organization called Kids Against Pollution, and their cute protests against fast food packaging became the subject of feature stories in local news everywhere. (The average elementary school student is probably unaware, incidentally, that every month he or she throws away at school the equivalent by weight in edible food of 300 Big Mac foam clamshells).

McDonald's and its polyfoam suppliers set up a recycling program for polystyrene to be announced in the fall of 1990. In recycling, the biggest challenge after finding a market is being able to collect homogeneous quantities of a given commodity in great volume—something that McDonald's, with 9,000 outlets nationwide at the time, was uniquely suited to do.

But this recycling dream never materialized. For reasons that remain unclear, McDonald's abruptly decided in November 1990 to abandon polyfoam completely in favor of "quilt wrap" (a plastic-coated paper) for hamburgers (less bulky than foam, but recyclable only with great difficulty).

The McDonald's decision was hailed almost universally as a victory for the environment. But if an environmental victory, it was an equivocal one.

A few months after McDonald's made its announcement, Martin B. Hocking, a chemist at the University of Victoria in British Columbia, published an article, titled "Paper Versus Polystyrene: A Complex Choice," in the journal *Science,* the most respected scientific peer-reviewed journal in the world.

Hocking's aim was to compare the environmental merit of paper and polyfoam packaging by focusing on the manufacture of single-use, hot-drink cups.

His conclusions contained surprises. First, he wrote, the production of paper for a paper hot-drink cup consumes as much in the form of hydrocarbons (oil and gas) as does the manufacture of a polyfoam cup (which is largely *made* of hydrocarbons). Moreover, the production process for the paper cup requires a great many more chemicals than does that for a polystyrene cup: for paper, 160 to 200 kilograms of chemicals per metric ton of wood pulp versus about 33 kilograms per metric ton of polyfoam.

On a per cup basis, Hocking found the air emissions from the production of polyfoam to be about 60 percent lower than those from the making of the paper hot-drink cup. Of course, Hocking observed, even if the polystyrene is blown up with pentane rather than with CFCs, there will be a negative effect on the ozone, but he added, polystyrene's "contributions to ozone and as a 'greenhouse gas' are almost certainly less than those of the methane losses generated from post-use disposal of paper cups in landfill sites." (Well, to be fair, one must add this proviso: "if the paper cups biodegrade.")

A paper-industry spokesperson and several scientists engaged Hocking vigorously. Hocking conceded a few points but fundamentally stood his ground.

Perhaps the matter is a wash. The lesson to remember about this particular foray into substituting market-driven packaging with consumer advocate–approved packaging is that after an enormous amount of activism by thousands of very concerned people over the course of more than a decade, and after the expenditure of enormous sums of money by McDonald's to make the switch, and after all the considerable dislocations among McDonald's suppliers—after all this, there would seem to be very little to show in terms of any real amelioration of the environment–garbage situation. The famous phrase of the poet Horace about "laboring to bring forth a mouse" may very well apply to these circumstances—except that in Horace's case, at least you ended up with one live and healthy mouse!

Just a couple of relevant notes.

Polyfoam totaled only some 4 percent by weight of all the garbage produced by McDonald's overall. Most of the garbage produced by the franchises—45 percent—was always plain old cardboard (for the packages that buns, patties, napkins, bags, and so on came in) and paper bags, straw covers, and more. So, since 1990 there has just been that much more paper.

Many at McDonald's were very unhappy with the abrupt polyfoam/quilt wrap switch, especially, I was told, because the food inside degraded in taste and texture so rapidly. At McDonald's University—the corporate training camp—students are exquisitely sensitized to the most minute transformations in food, so I took these concerns as merely insider gripes.

Then, one day, I was on the phone with a "fact checker" from *House and Garden* magazine. At one point she off-handedly asked, "What happened at McDonald's? I'm sure they had their reasons to switch from Styrofoam to paper, but the burgers just don't taste the same anymore—even if you eat them right there!"

So what is the lesson? As I've documented a few times before in these columns, public perception is nine-tenths of the law—even if the public in the end won't buy what they said they wanted! McDonald's made an abrupt executive decision before it had well-rounded scientific evidence. In such a rush to judgment, *everyone* (except self-serving special-interest groups) pays the price.

Just How Is Obsolesence Built In?

Just the other day, I was talking to a colleague at a county solid waste authority whose job is to minimize and prevent waste. She was ardently complaining about all the waste generated because people no longer fix broken appliances and furniture; instead, they go off to a "super" store of one type or another—that, of course, has no repair department—and buy a brand-new bulky durable. "So much waste," she said, "because when something breaks it's so much cheaper and easier to buy a new one than to fix the old."

I instinctively agreed—when was the last time you saw a repair shop in a mall? But then I remembered some studies by anthropologists that made me question that reaction. Why people buy new durables and what they do with the old ones is worth considering in any attempt to battle waste.

Michael Schiffer, an archaeologist at the University of Arizona, has for decades been a frequent visitor to thrift shops, yard sales, and swap meets in a quest to understand the extent to which we reuse our possessions. In another aspect of the same investigation, he and a handful of students, under the aegis of what they called the Reuse Project, conducted interviews with members of randomly selected households in a broad transect that cut across all of Tucson, Arizona. They asked householders whether they had recently disposed of any one of 13 major appliances or pieces of furniture—washer, dryer, refrigerator, stove, stereo, television, couch, armchair, kitchen or dining-room table, chairs to that table, dresser, bookcase, bed.

In the 184 households surveyed, the interviewers learned, 743 of the specified items had recently been replaced. But practically none of these were replaced because they had broken. The vast majority of the new items were gifts from friends or relatives or were purchased by the householder and most featured new gizmos and functions that the householder coveted. Think about it yourself—if you have a DVD player for videos, is it because your VHS tape player broke? If you have a new HDTV, is it because your old TV stopped working? Most of us buy new bulky goods to acquire innovations in options and styles that we don't have. And what was the fate of those replaced appliances and pieces of furniture? A landfill burial? No. A little more than 30 percent of the no-longer-used durables were still kept around the house somewhere; 34 percent had been sold or given to strangers, stores, or charities; and 29 percent had been sold, given, or loaned to relatives and friends. Only 46 of the 743 items (or 6.2 percent) had been thrown away.

And many of these "discarded" durables didn't end up in disposal sites as intended by their first owners. This was documented during early-morning Garbage Project stakeouts in advance of special "amnesty" days on which sanitation crews collect from households the bulky durable goods that they ordinarily shun. Before the garbage collectors arrived, scavengers in pickup trucks swept rapidly through the alleyways of Tucson. They methodically swiped nearly every major household appliance and piece of furniture in sight and ferried them off to larger trucks stationed nearby, which in turn carried the booty off to scrap dealers and resale shops, a number of which were located in Mexico. When Tucson garbage crews arrived, the durable appliances that were still forlornly waiting for them were taken to a specially set aside area at the landfill to store goods for city-contracted scrap metal dealers to feed into the recycling system. No wonder scrap metal is one of America's top exports.

But what of those hardy souls who take their appliances and furniture to the landfill themselves and deposit them on the tipping face used by small haulers? Two Garbage Project researchers, Paul Freidel and Bruce Douglas, were detailed to Tucson's Los Reales landfill for one week and asked to keep a record of all the major appliances and big pieces of furniture that were hauled onto the site. As it turned out, few of the targeted items ever appeared. And, tellingly, even though scavenging is forbidden at the landfill, private haulers' trucks that came in full rarely left empty, resulting in most of the appliances and furniture that did arrive being whisked rapidly back to some new role in the working world.

How many bulky durables were refurbished and resold, how many were scavenged for parts, and how many were recycled as scrap into new durables we don't know. Nevertheless, it is interesting to peruse what Schiffer's researchers found when they conducted inventories of their respondents' 184 houses, making note of all the items of interest that were said to have been acquired secondhand. "Where had these items come from?" they asked. The acquisition mechanisms broke down like this:

Some New, Some Used
- Gift from a relative, 19.9 percent
- Purchased at a new-used specialty store, 11.9 percent
- Gift from a friend, 5.8 percent

Used
- Rented with dwelling, 19.5 percent
- Inheritance, 9.5 percent

- Purchased with dwelling, 3.3 percent
- Purchased from a friend, 3.3 percent
- All others sources, 18 percent

The astonishing thing is that the total number of used durable items reflected in the data above was 2,412, for an average of more than 12.5 per household; used appliances and pieces of furniture represented fully one-third of all the major appliances and pieces of furniture in the 184 households surveyed.

For all the talk of the United States as a "wastemaker" society, the informal and commercial trade in large used goods—most of which escapes the notice of the government's record keepers, tax collectors, and other official statisticians, and goes largely unrecognized by the public as well—is apparently huge. In addition, judging from Michael Schiffer's study, at any given time, only a fraction of the appliances and pieces of furniture that households no longer need or want is being "thrown away" in any conventional sense of the term. The rest of these durable goods continue to live healthy and productive lives, *laterally cycled* (Schiffer's term meaning that they performed their same tasks in different places) for years, until they are eventually cannibalized for parts or sold as scrap. Many end up south of the border. One Garbage Project associate, Ramon Gomez, encountered operational Westinghouse washing machines from the 1940s, with attached roller-wringers, in households in Nogales, Mexico.

"Thus," Schiffer wrote in a summary of his findings, "it appears that few pieces of furniture and appliances reach the Tucson archaeological record (that means being buried at the local landfill) intact." That explains why in Garbage Project digs at 21 landfills, the only identifiable durables recovered have been hot-water heaters (they do break and are nearly impossible to repair or scavenge for significant parts) and mattresses (which usually appear as a mass of tangled springs). Based on his evidence, Schiffer went on to observe of this propensity to recycle and reuse: "It would seem that our industrial society has some characteristics usually considered to typify 'primitive' economies."

That is the good news; now for the bad. While in Schiffer's study breakdowns of durables were not the reason for getting new ones, and while most durables can live a second life, these second lives in Mexico today suggest an ominous trend: among used appliances that are between 5 and 25 years old, the prices for many older durables tend to be higher than for many newer ones, since the older appliances tend to be more "durable" and replacement parts for them are easier to obtain and install! Maybe my worried friend was giving me a glimpse of the future.

That is up to the durables industry. If consumers don't buy thinking about ease of disassembly to promote both repair and ease of recycling, given that long lives and recycling save money and resources, then industry should.

Restore: The Fourth "R"

Year in and out, millions of tourists trek to the imposing ruins of the ancient city of Teotihuacan (100 B.C.E. to 650 C.E.), just outside of present-day Mexico City, and to Colonial Williamsburg, just outside Washington, D.C., and to similar shrines that preserve remnants from our past. As an archaeologist, I believe that the preservation of ancient and historic sites immeasurably enriches humanity. As a garbage archaeologist, I am, therefore, rather proud that there is evidence that the preservation of such anachronisms can help to minimize today's solid wastes. The contribution to waste reduction is so significant, in fact, that I believe that waste management's 3 R's may soon become 4: Reduce, Reuse, Recycle, and *Restore* (or, in other words, preserve and utilize older buildings and other old things). My interest in number 4 is built on my experience with landfills.

I am often asked, "What's the biggest surprise you've found in your landfill digs?" Some assume that I will answer "styrofoam," because its volume is so small compared to most people's perceptions, less than 1 percent, compared to expectations 30 times larger. Others are sure I will say "paper," because it occupies more than 40 percent of the volume of most landfills. These expectations are wrong. The biggest surprise was a landfill content that eluded the attention of Garbage Project researchers even after our results from digging up and analyzing the contents of landfills began to accumulate. The biggest surprise from our landfill digs was the vast quantity of construction/demolition debris, or C/D, that we unearthed.

At first, the Garbage Project avoided or ignored C/D. There were several reasons for this aversion: (1) C/D is extraordinarily dull (big pieces of lumber, concrete, wallboard, and the like); (2) C/D is bulky, heavy, and unmanageable. Just one ruptured block of concrete can be the size of a standard sample of landfill refuse, and; (3) C/D can disable the toughest and most costly landfill excavation equipment. As a result of our sampling bias against C/D, we recorded very little of it in the first six landfills we dug (never mind that we had to drive around huge mounds of it on the surface, and that every so often we would be forced to abandon an excavation when our bucket auger hit an impenetrable layer of concrete).

We are not the only ones whom C/D debris in landfills has eluded. The EPA has labeled C/D an independent category of waste, distinct from ordinary MSW. The result is that because C/D is not officially MSW, by EPA definition, C/D supposedly takes up no room whatsoever in municipal landfills.

In reality, of course (if unofficially), landfills are chock-full of C/D. When the Garbage Project purged itself of its bias and took refuse samples every few feet no matter what, our picture of the insides of landfills altered dramatically. Excavations at our last four U.S. landfills documented that C/D alone was equal to nearly one-third of the weight *and* the volume of all general mixed refuse; in other words, C/D filled a minimum of 20 to 30 percent of the space in our sample MSW landfills. Rather incredibly, our subsequent digs at four Toronto-area landfills produced identical results.

There is nothing new about construction/demolition debris—whole civilizations have been built on it. Among the earliest civilizations in the Near East, for example, when a house was to be rebuilt, the old roof and walls were knocked in to use as a foundation for the new structure. In this manner, many ancient cities rose atop mounds, or *tells,* comprised of their C/D wastes. While Biblical-date tells, such as Nineveh and Kish in present-day Iraq, are striking examples that tower hundreds of feet over the flat plains that surround them, the process of "rising above C/D" is familiar to all cities. Much of London, for example, is fully 20 feet higher than its earliest Roman ancestor.

Urban centers are still rising on their wastes. Construction/demolition fill underlies LaGuardia airport, much of Foster City, California, and Toronto's upscale harborfront district. No one knows for sure how much C/D debris has been incorporated into New York City's substrata, but "street level" on the island of Manhattan today is typically 6–15 feet higher than it was when Peter Minuit lived there in the 17th century.

To me there is no question that C/D is currently one of the most significant contributors to the rapid filling of our landfills, and that the "preservation" of old and even relatively recent buildings is one of the most effective source reduction solutions.

I am, of course, aware that a full-scale restoration of a dilapidated structure can generate dozens of 50-yard roll-offs of C/D. No matter what measures are used, however, less demolition debris will be carted away for disposal if the structure in question is not totally torn down, and less construction debris will be discarded if a new building is not built on the site from scratch. The financial savings in transport and landfilling are substantial. Perhaps even more valuable to society is the savings in available landfill space *not* used and in *not* having to create new landfill space to take its place.

How about a "concrete" example? The city of Chicago has recently provided one. The 19-floor, 280,000-square-foot U.S. Gypsum Building at 101 South Wacker Drive was opened in 1966. The unique angle at which it faced the street and an equally dramatic white marble and gray slate facade were among the features that won the building awards and made it a Chicago landmark—that is, until it was torn down between August 1994 and January 1995. Based on standard rule-of-thumb calculations used by demolition contractors, the demise of the U.S. Gypsum Building may have filled more than 600 50-yard roll-offs, or sent enough C/D to landfills to pack Islip's infamous garbage barge one-and-a-half times over.

As archaeologists, I believe the past, even the relatively recent past, deserves the respect of preservation. At the very least, I believe that those who do the preserving should be recognized for their massive contribution to source reduction; at best, I believe those in the business of restoring old buildings deserve tax credits based on avoided C/D disposal costs.

Remember the Los Angeles earthquake of 1994? Those in the waste disposal business moved moun-

tains of rubble from collapsed freeways, businesses, apartments, and homes and deposited them in landfills. I just learned recently at a restoration convention that because of quake damage, the Los Angeles Colliseum, a landmark that hosted the 1990 Olympic Games and a Super Bowl or two, came close to being demolished and carted away to a landfill, where it would have added a few peaks to the 1994 mountain ranges of C/D. The decision to restore rather than raze was based solely on the expense of a new football stadium. Adding a fourth R to the waste management litany would be useful if it encouraged people to think of preserving the past as a way to preserve a more environmentally friendly future.

Biodegradable Education

How long does it take for a newspaper to biodegrade in an landfill? What about plastic containers? Since the Garbage Project began digging landfills in 1987 and exhumed 40-year-old newspapers that were both intact and readable, hardly a week goes by without one or more local government, environmental group, company, teacher or student, or other interested individual asking the project's staff these kinds of questions. The reason for the questions, of course, is that quite a lot of people know the answer. And no wonder . . .

There have been any number of media reports on the topic, and, from my point of view, they are usually contradictory, misleading, or downright wrong! Consider just one example, a "USA SNAPSHOT" (the chart at the bottom left corner of *USA Today's* front page) on "Breaking Down: How Long It Takes for Some Products to Decompose," that appeared on November 13, 1989. The information given to readers: traffic ticket, 2–4 weeks; cotton rag, 1–5 months; aluminum can, 200–500 years; plastic six-pack ring, 450 years.

How accurate is this information that was provided to educate the public? How many landfills did the "Washington Citizens" dig up to make these determinations? Who observed aluminum cans or plastic six-pack rings in landfills for a period of 200 to 500 years? I will venture out on a limb and state that I don't believe that the "Washington Citizens" conducted systematic digs and waste sorts at any landfills, and, since aluminum cans and six-pack rings (technically, "high-cone carriers") have only been manufactured for a few decades, I don't believe that anyone has observed either aluminum cans or six-pack rings or their disappearance during two or more centuries in landfills. In addition, the Garbage Project's digs of 18 "dry" landfills in Arizona, California, Florida, and elsewhere in North America have exhumed more than a few 20- or 30-year-old cotton rags and paper documents, including some traffic tickets.

I am extremely interested in decomposition issues because I was trained as an archaeologist. For more than 100 years, my colleagues have been methodically excavating and recording millions of buried discards that are hundreds, and even thousands, of years old. In fact, archaeologists are so interested in what happens to buried artifacts that they have a name for that particular area of study—Natural Formation Processes, or NFPs for short. An understanding of NFPs is crucial for archaeologists. When they begin a dig, excavators need to know whether they will unearth perishables that will require special equipment for continued preservation. And further, when they are interpreting the remains they have exhumed, archaeologists need to know whether not finding wood or textiles means that none were buried or that if any were deposited, they would most likely have completely degraded or biodegraded. Altogether, the study of NFPs is a very important issue in archaeological research.

But no one interested in the breakdown of modern garbage seems to have queried my colleagues who are specialists in long-term biodegradation. If they had, they probably would have been a little surprised and come to one important conclusion.

Surprises: How long do you think a buried ostrich plume would last? One lay preserved under the outer stone lid over Tutankhamen's sarcophagi in the Valley of the Kings in Egypt for more than 3,000 years. Of course, Egypt is very dry.

How long would intricately carved wooden objects last if they were covered by a very wet mudslide? Such objects were recovered by archaeologists at the site of Ozette in Washington State after almost 400 years of burial.

How long would a human body last in a marshland? Throughout Europe, some 20 "bog people"—several intact down to nose hairs and stomach

contents—have been unearthed after 2,000 years of burial in one-time stagnant swamps.

Confusing? Yes. The result of "pyramid power" or some archaic magic? No.

For archaeologists, materials scientists, and microbiologists, one key decomposition concept is the distinction between "degradation" and "biodegradation." Degradation is the breakdown of materials due to chemical interactions, such as metal that rusts when exposed to oxygen and plastic that becomes brittle with age and breaks into small pieces. Biodegradation is a breakdown of organic materials due to the action of microorganisms, such as food, leaves, or paper "rotting away."

For any kind of breakdown to occur, there must be a variety of prerequisites—time, aridity/moisture, movement of fluids, presence of specific microorganisms, and so forth. The archaeologists' important conclusion: *each individual burial spot presents a different set of conditions and, thus, a different potential for both degradation and biodegradation.* This is even true from day to day and load to load of refuse in the same landfill—clear versus rainy weather, different kinds and associations of paper or metal or plastic, stagnant versus moving fluids, etc. That is the reason there are no widely accepted rules of thumb for how long particular materials will take to decompose—because it all depends on the specifics of their burial context. In different contexts, the same carrot or piece of paper could last less than one year or more than 3,000 years.

There are some general guidelines archaeologists use to know what to expect to uncover when they begin digging.

First, contrary to a commonly held belief that fluid—and especially water—greatly speeds biodegradation, most archaeologists are elated to excavate a site that is waterlogged. In cases where perishable materials are thoroughly saturated with water and there are no significant currents—certain marshes, swamps, small lakes, fill behind retaining walls in harbors, and even outhouses—archaeologists have found papers, textiles, leather, and a variety of food remains intact after 100 to even 1,000 years of burial.

On the other hand, any archaeological site that goes through seasonal wet-dry cycles or that is submerged in moving water is not likely to produce many intact degradable or biodegradable remains. That is why the Garbage Project found clear evidence of significant biodegradation in the lowest lifts in New York City's unlined Fresh Kills Landfill, which was begun in 1948 on Staten Island in a swamp where tides wick water in and out of the bottom levels of refuse every day. This understanding of the role of moving fluids is behind the concept of "bioreactor landfills," which are carefully designed to circulate leachate in an effort to facilitate biodegradation.

Knowing what kinds of garbage are likely to remain recognizable garbage is not just an arcane interest of archaeologists and landfill managers. Every discarder should know how much of what they throw out will likely be preserved for decades to come. Some people might feel that if paper items do indeed decompose in a very short time, why go to the trouble of recycling them? But wouldn't they feel differently if they knew that most paper doesn't decompose rapidly in standard landfills, or that, even if it did biodegrade, microorganisms do not affect the lignin (the fiber element in paper) that composes 40 percent or so of paper's volume?

At this point, I am sorry to report that public education about decomposition in landfills is way behind the times.

Last semester I gave a questionnaire to 63 students in an introductory class on "natural science" at the University of Arizona (UA). Fully 30 percent of these college freshmen believed that landfilled newspapers biodegrade in a "matter of weeks." Another 57 percent responded that landfilled newspapers biodegrade within 10 years. Okay, maybe they are confusing newspapers buried in landfills with those they have seen decomposing as litter in the open.

But what about glass? Glass—vitrified sand of various forms—is an inorganic solid that is totally nonbiodegradable, and the only way it degrades is by being broken up or ground into smaller and smaller pieces. Yet 24 percent of the UA freshmen queried believed that glass biodegrades within 10 years of burial in a landfill.

Would the will to recycle increase if people knew more about what does and doesn't decompose rapidly in landfills?

Solid waste specialists—and archaeologists—have a lot of public educating and re-educating to do!

Perspectives From the Past

Just How Biodegradable Were the Ancients?

From the way people talk, "biodegradability" seems to be held up as a primary characteristic of the garbage of our ancestors—one that, owing to the advent of plastics and other such materials, seems to be increasingly less in evidence today. And that, from the way they talk, seems to be somehow unnatural and undesirable.

As an archaeologist, I know that, in fact, from the very beginning of human time, "nonbiodegradability" has been a strikingly consistent, even predominant, feature of garbage. In every kind of environment, both cutting and grinding stone tools—for hunting, food preparation, all kinds of manufacturing, and weapons—as well as mountains of debris from the manufacture of the stone tools themselves, have remained intact for more than two million years. Fired-clay pottery—employed every day for cooking, storage, serving, and ceremony—may break into pieces and even discolor a bit, but the pieces themselves are virtually indestructible. These "potsherds" can be ground down into finer and finer bits, but they will always be there. Glass is just as durable as pottery.

Even things that are theoretically biodegradable don't always biodegrade. For example, animal bones decompose in acidic soil; but not all soils are acidic, as is evident from the vast number of bones, human and otherwise, that archaeologists uncover in refuse middens and graves.

Much of the nonbiodegradable matter that turns up in middens, such as intact pottery and utensils, invites speculation as to why it's there in the first place. Those who condemn our own era for its conspicuous consumption and waste should at least bear in mind that throwing away perfectly good objects seems to be one of those inexplicable things, like ignoring history, that human beings have always done. David Pendergast, an archaeologist who is a curator at the Royal Ontario Museum in Toronto, spent seven years studying a Classic Maya site—Altun Ha, in Belize, which was occupied from around 800 B.C.E. to 1000 C.E.—and after examining the contents of various tombs, caches, and garbage dumps, he concluded: "These people would have traded in a Cadillac when the ashtray was full."

How much nonbiodegradable waste did our forbearers generate? What proportion of all garbage did it account for? There are, of course, no precise answers to these questions, but certain discoveries give one pause. For example, shell middens—the remnants of countless feasts on clams and oysters by prehistoric Native Americans—have been discovered by the thousands along the Atlantic coast of North America and the Gulf of Mexico, and the size of these ancient, unbiodegraded dumps is often startling. There is one, for example, on the Potomac River, at a place called Pope's Creek, Maryland, that covers 30 acres and is an average of 10 feet thick. It would take a modern American community of 50,000 people roughly 10 years to fill up an equivalent volume in a landfill. One estimate of the area covered by ancient shell middens in Virginia and Maryland alone is 100,000 acres.

Another example from antiquity comes from the results of excavations conducted in Colorado in 1958 and 1960 by the archaeologist Joe Ben Wheat. During late May or early June in 6500 B.C.E. or thereabouts, a band of paleo-Indian hunters and their families stampeded a herd of *Bison occidentalis* into an arroyo 140 miles southeast of what is now Denver, at a place known to archaeologists as the Olsen-Chubbuck Site. (The time of year in which the event took place could be determined because of the presence of the bones of young bison calves.) Two hundred bison were killed, and of these the hunters completely or partially butchered 150. By one estimate the hunters carried off enough meat to feed 150 people for some 23 days. Behind them they abandoned the leftovers that archaeologists uncovered 8,500 years later: 18,380 pounds of bone.

Compare those 18,380 pounds to the total amount of garbage that, according to the highest estimates put forth by the Environmental Protection Agency, 150 latter-day Americans throw away in 23 days: a relatively modest 14,145 pounds, which includes all household food debris and food packaging, all nonfood packaging, all yard waste and other household waste, and all the garbage that these 150

people are responsible for in schools, offices, stores, and restaurants. Left in the open, as the bison carcasses were, more than half of the 14,145 pounds of modern garbage would rapidly biodegrade.

The comparison here is extreme, of course. Most ordinary household waste consists of material that has somehow been processed, and waste is generated at every stage of production. That waste never shows up in the data on household waste because it gets dealt with somewhere else—at the factory, say, or at the slaughterhouse, or on the farm. Although many of these waste products themselves have further uses—and are not simply discarded—it remains true that Americans are responsible for many times more garbage than the amount they personally throw away. But the Olsen-Chubbuck story draws attention to the fact that garbage that doesn't biodegrade has long been a fact of life. Indeed, because dogs and pigs were available to eat the organic waste that people threw away, and because the eyes and hands of the poor would have been attentive to clothing and textiles of any kind (including rags) that could be manufactured into paper, items that were nonbiodegradable probably accounted for a very large portion of the garbage that made it to ancient trash heaps. It is only in relatively recent times, with the advent of civilization that is based on—and utterly dependent upon—vast quantities of paper of all kinds made from wood pulp rather than textiles, that potentially biodegradable materials have come to constitute a majority of everything that finds its way into a dumping ground.

In this context, it is worth remembering that the generation of large amounts of nonbiodegradable garbage in new and ever-mutating forms is not necessarily a sign of social woe. When William Stewart Halsted, the chief of surgery at Johns Hopkins University Hospital became, in 1893, the first surgeon to wear a pair of sterile gloves during an operation—unwittingly setting in motion a chain of events that would turn American hospitals into vast dispensaries of disposable rubber and plastic objects—the goal was not, of course, to create more garbage. It was to make surgery safer for patients. In the United States, a garbage problem is in some respects the price we pay for having learned to do some important things very well.

The World's Oldest Profession

What is the world's oldest profession? If you answered "prostitution," you're wrong.

In fact, the most likely titleholder is "making a living from reducing, reusing, and recycling"—in today's politically correct terms, "making a living by preventing garbage!"

Garbage and humankind have been intimately related for quite a while—in fact, from the very beginning. The earliest "hominids" are identified as such by the first stone tools and tool manufacturing debris they left behind. In other words, what makes the first humans "human" is making garbage!

It may sound simplistic—after all, the first humans millions of years ago were not rocket scientists—but "reuse" began as soon as a tool was employed to cut, chop, scrape, or whatever on a second occasion, either at a later time in the same place or at a different place where the tool had to be brought with the forethought of "reusing" it. Actually, for these hominids, such behavior was a breakthrough comparable to rocket science.

No one knows for sure when such reuse started, mainly because human-made tools and ornaments constructed of perishable materials, such as wood, disappeared long ago. Most of humanity's first two million years is called the Paleolithic, or "Old Stone Age." Appropriately enough, the vast majority of artifacts made during this period that archaeologists recover and analyze are stone tools. The specific composition of the stone artifact and the exact way it was knapped (or shaped by striking with a stone, bone, or antler hammer) reveal a great deal about how resources were exploited and conserved.

As a result, at Olduvai Gorge in Kenya (made famous by the Leakey family discoveries), and other regions containing early hominid sites, archaeologists have convincingly documented that by one million years ago many tools were found several miles or more from the source of the stone from which they were knapped.

Archaeologists have also determined that the concept of reuse of stone tools was refined by the invention of "retouch" techniques—rather sophisticated methods that employed bone and antler tools to skillfully apply pressure to resharpen the edge of tools that had become dulled in use.

Recycling, which by definition requires some kind of change to take place in an artifact—such as remanufacture—began as soon as a tool broke (unintentional remanufacture) and someone picked up a piece or fragment to use. For example, if a good-sized flake were chipped off a chopping tool during use, that piece might be retrieved to scrape the flesh and blood from hides to turn them into clothes or some other useful artifacts. Again, no one knows exactly when this form of behavior began, but archaeologists have identified signs of intentional remanufacture on stone tools dating as far back as one million years ago.

Source reduction began as soon as some early humans ventured any significant distance from a natural stone source and carried stone tools or "blanks" (chunks of stone to manufacture into tools in the future) with them. An excellent exemplar of extreme source reduction are the stone tools found on Middle Europe's windswept grasslands. Elsewhere, at hunting "kill" sites and at base camps with stone sources nearby, excavators often find significant numbers of large and still-functional implements. In contrast, most of what the earliest high plains drifters left for archaeologists were virtually unusable stone fragments that had been through the entire litany of reuse and recycling and had nothing left to give! The few still usable tools recovered were most often diminutive in size, made small to conserve the stone that people had to carry with them. Finding only one of these mini-artifacts gives rise to great thanksgiving at an archaeological dig camp.

Early humans were "hunters and gatherers" who moved from place to place to take advantage of the seasonal round of natural stands of ripening fruits and vegetables and the migration habits of the animals they hunted. Because they had to carry everything with them on their frequent relocations, our most ancient ancestors' possessions and discards were relatively few. Besides, our earliest ancestors always had a simple solution to their refuse problem: when the garbage became too deep or smelled too strong, they just moved away. Once people settled down in farming communities (beginning about 11,000 years ago) and "civilizations" with cities (beginning about 5,000 years ago), the problem became more vexing. Instead of people moving away from their garbage, the garbage had to be moved away from the people. Hence the first refuse collectors.

Historians of public works record 1543 C.E. as the year that "Roger the Raker" was recorded as a garbage collector in Bristol, England; but the collection and transport of discards has a far more venerable history. From almost as early as there are any records, cities are associated with scavengers. Discards were usually thrown into the streets where degradable garbage was eaten by dogs or pigs or left to rot. Relatively small nondegradable items became part of the thoroughfares and their borders. Scavengers removed larger discards to the outskirts of habitation in exchange for the privilege to keep any of the castoffs they coveted. This made a considerable contribution to lessening traffic problems in the first urban centers.

Whether officially employed or not, scavengers—rag pickers 100 years ago and "scrap" dealers today—have been a fixture of human society ever since.

As an archaeologist, it is sad, but true, for me to say that scavenging has been a curse! At any battle site, archaeologists are enthralled by the specter of finding spear points and pieces of chain mail at the positions predicted by history or legend. Perhaps the most disappointed were the British archaeologists who excavated the reputed site of the Battle of Hastings, where William the Conqueror's Normans decimated King Harold's Anglo-Saxons, on the battle's 900th anniversary in 1966. The historical treasure trove they recovered were a few human and horses' teeth that survived the scavengers and the forces of nature.

For a chilling explanation, watch Peter Watkins's 1964 BBC docudrama called *Battle of Culloden*. After the deciding clash between the Scottish clans and British troops on April 16, 1746, virtually all the dead were picked clean of weapons, armor, valuables, and clothing, down to the last memento, by the ubiquitous camp followers, both professional scavengers *and* ladies of the night. Then the bodies were neatly stacked in large piles and set ablaze.

Relative to conservation, don't forget that Geoffrey Chaucer, the esteemed author of the 12th-century classic *Canterbury Tales,* earned his daily bread by keeping track of England's scrap iron for his king.

I was reminded of the rich heritage of the garbage industry when I watched "Junkyards," one recent installment in the *Modern Marvels* series on the History channel. It provided clear evidence that the world's oldest profession is one of its most honorable.

Garbage people, rejoice!

Where Have All the Ragpickers Gone?

During my childhood in the early 1950s, I became aware of a group of people called "ragpickers." I wasn't sure what they actually did, but I knew they worked in back alleys and garbage dumps. By adolescence, however, I had never seen one. Eventually, I relegated ragpickers to the same netherworld as Santa's elves.

How could I have been so wrong! I am writing this confession of enlightenment to help document America's heritage of flesh-and-blood people who literally picked rags from garbage; and to open more eyes to the largest still-invisible component of today's refuse—used textiles. As an archaeologist, I am keenly aware that every society has scavengers who sort through refuse for reusable, recyclable, and other valuable items. Scavenging is now officially banned at most landfills in the United States due to safety and legal concerns, but it wasn't always that way. During the 19th and early 20th centuries, ragpickers swarmed over our country's open dumps.

Although rag picking was considered work for the lowest classes, it was also relatively lucrative. The pickers' chief quarry was a category of rags called "thirds-and-blues." ("Firsts" were new, "seconds" were used, "thirds" were rags; the usable ones were all blue or lighter in color, that is, no blacks or reds.) There were two thriving markets for thirds-and-blues: (1) the paper mills in the northeastern U.S., which were one of the world's primary sources of paper in those days, depended on cotton rags from nearby urban dumps to supply the required fiber, and; (2) mills in Yorkshire, England, and the in the northeastern United States manufactured clothes called "shoddy" from wool rags, which they cleaned, garnetted, respun, and rewove. Because of the strength and stability of both markets, turn-of-the-century ragpickers in the New York City area could sell a ton of picked rags for about $370 in 1990 dollars. Not bad!

Very quickly, however, a one-two punch knocked out both rags and ragpickers. First, new rail links to the U.S. Pacific northwest delivered clean, low-cost wood, fibers which new technologies turned into paper. Second, the virgin textile industry lobbied successfully for the Wool Products Labeling Act of 1939, requiring shoddy textiles to be labeled as "reprocessed" or "reused" wool. When the name "shoddy" was first applied to yarn made from used textiles in the 1830s, it was a nonjudgmental term. By 1862, however, a connotation of inferiority had been affixed to it, not because of poor quality or workmanship, but just because shoddy cloth wasn't "new." The devastating impact on clothes made from shoddy after 1939 having to bear on their labels the epithets "reprocessed" or "reused" is evident by the fact that today in the United States, the shoddy textile market is not even a memory; "shoddy" itself is now just an adjective meaning "inferior workmanship."

Where have all the ragpickers gone? No one really knows. It's probably more than just coincidence, however, that many of the kingpins in today's scrap-metal industry proudly trace their roots to ancestral ragpickers.

Where did all the rags go? Many are still recovered for in-house reprocessing and reuse by the textile trade. New cuttings, or plant scraps, usually become "molded rag shoddy" for acoustical padding, or "headliner" for roof padding in automobiles. In addition, according to the Council for Textile Recycling, a yearly total of 1.25 million tons of post-consumer textile wastes are recovered from resale shops, charities, and the like. Some of this haul is recycled into new rags and felts for industrial wiping and polishing and for home uses. (Bags of reprocessed rags, for example, are on sale at auto supply stores.) At least half a million of these tons are graded and, if found wearable, exported to markets in third world countries. Unwearable clothes are mixed with asphalt to become new roof shingles.

Households, however, don't have such comprehensive recycling programs. As a result, still more textile wastes end up in landfills. Once there, they don't degrade any faster than does paper (not very fast at all). This brings me to the second phase of my enlightenment.

Overall, rags comprise about 2 percent of household refuse by weight. The highest rate of discard I am aware of is in New York City, where textiles

represent more than 4 percent of residential refuse. Garbage Project sorts of residential refuse streams indicate that used textiles flow most heavily from low-income neighborhoods. This is because some upper-income (and even some middle-income) households consider clothing "old" or unwearable after just a few uses—sometimes after just one outing. Owners, of course, know that the dress or whatever is still functional, and often they will give away or sell their textiles. The recipients of these hand-me-downs become the major discarders of clothing (by the time of discard, most textiles have seen service as rags). Compared to middle- and upper-income households, low-income households in Tucson and Phoenix on average send three times more textile seconds and thirds to local landfills.

When the Garbage Project started digging into landfills, we didn't pay much attention to the textile category. When I finally decided to determine how many rags a ragpicker could pick, I was shocked by the answer: lots and lots! The Garbage Project has now excavated 15 landfills in the United States and Canada. Within these, textiles represent 5 to 6.5 percent of the volume of MSW landfilled over the last 20 years—far more than all expended polystyrene, fast-food packaging, and disposable diapers combined.

Of course, rags that evade recovery by the textile industry aren't worth much today. There was, a few years ago a glimmer of hope that Madison Avenue and the clothing industry might ride to the rescue. As part of its fall 1993 "Ecollection," one clothier marketed a completely environmentally friendly line that included a duffle coat made of 100 percent "postindustrial undyed wool" (translation: plant scaps) and, more important, a Donegal tweed gardener's jacket made from reprocessed post-consumer sweaters. Although consumers publicly lauded this innovative apparel, not enough were willing to pick up the slightly higher price tags associated with being "all natural." The e-collection concept and its innovations are hibernating in Europe, where shoddy is still made and sold openly in stores. But there are just too many textiles in garbage cans and landfills for it to slumber for long. I, for one, predict that shoddy will make a comeback.

When it does, imagine how all those ragpickers will smile.

Our Greatest Garbage Triumph?

The media, the EPA, and others have assured us time and time again that America's finest hour in the "war on waste" was the recycling effort on the home front during World War II. In an all-out effort to win the conflict overseas, vast quantities of tin, aluminum, rubber, and other commodities were saved from becoming household wastes thrown into dumps or incinerators. Paper was the most visibly saved and collected "waste." Following calls to "recycle" that were issued on posters, radio public service announcements, and other campaigns by the War Production Board, Americans began compulsively saving paper, from newspapers all the way down to "wastebasket scraps."

Other critical items, such as rubber footwear, coffee, sugar, and butter, were rationed. A few commodities were so valuable that they were rationed and registered to assure reuse and recycling. Of these, tires were the most precious. While all armies march on their stomachs, ours also moved on inflated rubber wheels. Barely one month after Pearl Harbor, in January 1942, the rationing of tires was formally initiated. Automobile owners were each allowed four tires and one spare. Any additional tires, under threat of fines or jail, had to be turned in for the war effort.

What were the results of these remarkable wartime initiatives to reduce waste and conserve resources? They would surely provide valuable lessons to us today.

At least in terms of recycling, they were not what most of us have been led to believe. Suellen Hoy and Michael C. Robinson, in a monograph written for the U.S. Public Works Historical Society, note that the dutiful public offerings of used wastepaper were so overwhelming that they clogged the paper-collection program almost to constipation. Charitable and public service organizations found themselves with accumulations of wastepaper that weren't valuable enough to even cover their collection costs. Individuals found themselves with stacks of wastepaper that they could not give away. More important, the secondary materials dealers, the people who were the bulwark of the physical movement of wastepaper from collection point to recycling facility, found their livelihoods considerably diminished by the paper glut. The result: in

order to save the economic viability of professional wastepaper dealers, and to keep public disenchantment with paper recycling from spreading to other recyclables, the War Production Board, in June 1942, asked the public to stop saving wastepaper.

And what of the other materials that were collected for use in the war effort? Records in the United States are hard to locate. In England, however, according to Jane Bickerstaffe, the technical director of Britain's Industry Council for Packaging and the Environment, much of the material was simply stockpiled—the infrastructure to move, clean, and reprocess it did not exist—and, unbeknownst to the public, it was quietly landfilled when the war was over.

I found this totally unbelievable until I received a letter from the son of a lady who participated in and outlived WWII's recycling efforts, Peter Cherson:

> The story begins on a bitter cold morning in February, 1942 with my father, then in his 60s, shivering and about frozen stiff, waiting to register the tires of his Model A Ford and turn in the spares that he had saved . . . My father, honest-to-a-fault, could not sleep the night of this public announcement, determined to "do his duty" before he did anything the following morning. He wasn't able to do anything after freezing at that little train depot in Linden, a section of the City of MaIden, Mass., waiting for the bureaucrats to process all the forms and details.
>
> The story continues with my mother traveling by train to Florida in the late 1940s intending to expose her aching bones to the Florida sun. She sat unobtrusively next to a coach window . . . Always observant, she became aware of an unending mesa, taller than her sight was able to make out—of tires! (The train went by) miles and miles of tires as (it) sped southward down the coast. And, suddenly, this quiet, unobtrusive, elderly lady began to laugh hysterically, to the astonishment and concern of everyone in the coach. Some minutes went by, with people trying to 'calm this poor woman.' Finally, she was able to blurt out, 'Look, out there (to the mountain range of tires), there are my husband's tires.' You see, she had tried to dissuade my father from going out that morning; she knew better about the government.

In the end, then, the whole World War II recycling/rationing endeavor, perhaps unwittingly, might have done the most good for citizen morale.

After hearing a few similar accounts but being unable to track down more specifics, I am—especially as an archaeologist of the past and the present—interested in finding whatever information readers have that relates to the specifics of the World War II recycling efforts on the home front. As many a sage has opined: those who don't know about the past are condemned to repeat it. What do you know about recycling during World War II?

The Attack of the Home Garbage Disposers

As a garbologist who systematically studies household discards, what most people consider conveniences are inconveniences to me. Chief among them is the kitchen garbage "disposer" (more commonly called "disposal" today), which grinds up a portion of the Garbage Project's data before we can even look at it. Disposers did not become a standard feature of new homes until the 1970s, by coincidence, the same era that the Garbage Project started in earnest. As a result, I have spent some time looking into these devilish gizmos and the potential they have had to change nearly everyone's garbage life.

Overall, it seems to me that there are two kinds of technological innovations. The type that really changes the basic spin of the world, like the car or the Internet, are usually called "_____'s Folly" (as in "Fulton's"). The other type are promoted as instruments that will revolutionize the world but usually don't do more than add a dose of convenience along with a gaggle of repair specialists and add-on devices.

Here I should note that I am not the only one threatened by the garbage disposer. One of its earliest promises was clearly to fire the garbage collector! Let's see if we should be looking for a new line of work.

The first garbage disposer designed for use in a household kitchen sink was a descendant of the large grinders and shredders that municipalities employed beginning in the 1920s to prepare some solid waste for disposal in municipal sewer systems. The household disposer came on the market in 1935; it was 20 inches in length, weighed 75 pounds, and bore General Electric's trademark. Although World War II delayed the device's refinement, in the post-

war years other companies joined General Electric in the garbage disposer business, and the machines themselves grew smaller and lighter—and more appropriate for widespread household installation.

Enthusiasts like Morris M. Cohn, a conscientious public servant in Schenectady, New York, and the editor for many years of the garbage-industry journal *Wastes Engineering,* claimed that garbage disposers would *eliminate* garbage cans the way flush toilets had eliminated outhouses. Cohn, whose books include *Sewers for a Growing America* and *By the Magic of Chemistry: Pipe Lines for Progress,* had begun tirelessly promoting the idea of a household garbage disposer in the early 1930s, and it was largely as a result of his encouragement that General Electric took the steps that led to the introduction of the first commercial model.

Cohn's remarks in an article in *Sewage Works Engineering* make plain that he heartily approved of the actions of the town of Jasper, Indiana, which became the first community in the United States to vote to place itself entirely in the hands of this new technology. As historian Suellen Hoy recounts in a 1985 article titled "The Garbage Disposer, the Public Health, and the Good Life," which was published in the journal *Technology and Culture* in August 1950, this town of 6,800, with a bothersome open dump and a recent history of hog cholera that had been traced to infected slops, set about installing General Electric garbage disposers in all of the town's household kitchen sinks; at the same time, Jasper discontinued all public collection of wet garbage and prohibited the discarding of wet garbage in garbage cans.

"Somebody had to stick his neck out and do things like this," said Jasper's mayor, Herb Thyen. "Otherwise progress ceases."

By October, the new technology was in place everywhere, and Jasper began its new life as a town without a garbage collector. The initial results were encouraging. There was no deleterious effect on the sewer system, as some had feared, and there were fewer flies in town (according to a before-and-after "flies per grill" count made on automobiles).

As a side benefit, Suellen Hoy reports, the installers of the garbage disposers found and corrected numerous instances of defective amateur wiring.

General Electric began distributing a brochure whose cover featured a young boy looking up at his father (book open on knee, pipe in mouth) and asking: "Dad—What was garbage?" Of course, the collection of non-wet garbage would still be necessary, but the universal availability of disposers to deal with organic household debris would keep the volume to a minimum.

Inspired by Jasper's example, a number of other communities in the midwest took up what became known as "the Jasper Plan." And, it must be said, the efficient disposal of garbage was not the sole impetus. Garbage disposers promised not only to get rid of garbage, more or less effortlessly, but also palpably to improve the quality of life.

The garbage disposer symbolized the American Ideal. "In essence," Suellen Hoy writes, "this 'hunk of better living' touched a responsive chord in a generation of Americans who, having survived years of Depression grayness and wartime scarcity, resumed their search for a healthier environment and a 'greater ease of living' through goods and amenities that offered more cleanliness, convenience, and comfort."

The disposer has certainly made life easier, but it turns out not to have made all that much difference as far as garbage-generation rates are concerned. I checked up on Jasper, Indiana, not so long ago, and spoke with Jasper's street commissioner, Robert Main.

How was the future going? Well, he said, Jasper still didn't have anyone picking up wet garbage, and it still gave out tickets to people whose trash cans were found to harbor such garbage. But the town had never been able to dispense with a pickup of non-wet garbage.

Now Jasper's landfill is nearly full, Main said, and the town has had to ask the state to allow it to pile refuse higher and higher. Insofar as garbage is concerned, Jasper is now scarcely distinguishable from anyplace else in the United States. And your job—as always—is as secure as can be.

The Garbage Project, as well, continues to survive the onslaught of disposers. Over the years we have found that all households, whether in neighborhoods where every household has a disposal or where only a small portion are so equipped, discard some sort of food waste and food preparation

debris. Through interview-surveys of householders and through detailed analyses of discards, we have discovered a variety of reasons for the omnipresence of food remains.

First, disposers usually advise operators not to grind down bones or meat fat. Second, at any given time a significant number of disposers are inoperable. Third, many people don't use their disposals as often as they might because they are afraid that they will break. And, fourth, most people use their disposers in a selective manner; for example, most people wisely discard unwanted hard candy rather than grind it up. The result is that households in neighborhoods where all households contain garbage disposers throw food remains out at only half the rate of households in neighborhoods where only a few households have such a luxury.

While an unknown amount of wet garbage is, in fact, ground down disposals, this does not invalidate the Garbage Project's findings based on hands-on sorting and weighing actual discards. The presence of legions of kitchen garbage disposers simply means that our estimates that households waste between 10 and 15 percent of the solid food they buy are highly conservative.

By and large Americans have never been content to do things the old-fashioned way, and where garbage has been concerned they have always been receptive to any new state-of-the-art means of disposal—to each new technological fix—especially if it promised a savings in money (fire the garbage collector!) or, better yet, a tidy profit.

In the mythology of the American Dream, the relationship between advancing technology and a state of personal well-being that ratchets ever upward was long assumed to be linear and direct. And, until recently, this assumption seems to have been stunningly unaffected by the repeated failure of technological fixes to perform precisely as advertised. Today, of course, technological backfires and misfires, real and alleged, have become so common that the old mythology is at best non-PC, at worst an object of hostility.

That the pendulum has swung in this direction is perhaps not a bad thing. One lesson of the Jasper story may be that ambivalence is the most sensible stance to take toward many technological innovations, including those that involve garbage. Such a stance may allow us to employ realistically the technological tools that we possess or may develop.

They Don't Make 'Em Like They Used to . . . and Never Did

Last week as I left a supermarket, one of the plastic bags I was carrying split open under the weight of its contents. As you might imagine, a few choice expletives fell out with the groceries. But given time to think about the lessons of archaeology, I smiled. Here are my thoughts:

In northern Mexico most appliance stores resell old washers, dryers, stoves, and the like, acquired from the United States . . . and the older U.S. models cost more than the newer ones! The reason is simple. The older appliances may look clunkier and have fewer glitzy features and less fashionable colors, but they are expected to last longer and be less costly to repair than the newer models. The lesson is an obvious one that we all know well—*they don't make 'em like they used to!*

This was one of the key insights that ignited the environmental movement in the 1970s and is exemplified by Vance Packard's best seller *The Status Seekers*. According to Packard, and others, "built-in obsolescence" was the engine driving exponentially increasing consumption. Their argument was that every year the latest model of a product would come out in a new "style" and with new convenience features that made the older models obsolete. At the same time, these newest models used cheaper, less durable materials and designs, which also quickly made the products obsolete or, at least, nonfunctional.

I believe that Packard had a point. But what I've learned from an archaeological perspective covering thousands of years is that this is nothing new—*no one has ever made 'em like they used to!*

What that means simply is that manufacturers throw resources and labor in abundance at products in their early stages of research and development in the marketplace. But once they find a mix that works, their efforts invariably shift to cost control—shaving away resources and labor in the hope that the product will still do its job and consumers won't notice the difference, while the manufacturers' profits increase—or, at least, don't decrease in the face of ever-escalating resource and labor costs.

Manufacturers also add frills, in typical public relations style, to make sales—a new icemaker on a refrigerator, a new setting on a VCR, or an "in" color on anything—and, amazingly, it works. A study in Tucson of why people get rid of old "durables" found that the reason was rarely, if ever, because the old machines or furniture broke or wore out; instead, it was to obtain the new gimmicks and styles.

How typical of the contemporary United States! But also, how typical of the past. Take jade carvings in Mesoamerica. Really exquisite pieces could take much of an artisan's lifetime, since fine jade was so hard that it could only be ground with jade dust. Virtually all the most time-consuming carved jades date to Olmec ("Mother Culture," ca. 1200–400 B.C.E.) or Classic Maya (ca. 300–820 C.E.) times. Later examples are mostly smaller and cruder baubles by comparison.

Or take pottery. Classic Maya figural polychromes, complete with glyphic inscriptions surrounding their accompanying tableaux, were followed by cruder Fine Orange mold-made pots at the beginning of the Postclassic and, finally, in the civilization's final Decadent Period, by aptly named Dribble Ware.

In fact, this pattern of change is so typical that systems theorists—those scholars who look for similar patterns in organisms as diverse as civilizations, fetuses, and sunflowers—have devised a few general principles to describe it.

My favorite is the "Principle of Non-Proportional Growth." It states that if one part of an entity increases significantly in size, other parts will increase as well, but often at a different rate. For example, if a cardboard box doubles its linear dimensions—length, width, and height—its outside area will increase four times, and its volume expands by a multiple of eight.

For potters this meant that producing lots more decorated pots could not be accomplished by simply hiring lots more potters. They'd just end up fighting each other for the best clays, slips, paints, brushes, drying space, or, at best, literally bump into each other all the time.

What's the solution? We don't know for sure in really ancient times, since few chroniclers paid much attention to pottery factories. But we do know about Josiah Wedgwood (1730–95 C.E.).

At the time Wedgwood began to make pots in England the 1750s, there were common everyday pottery makers—about whom we know precious little—and there were the potters who catered to the royalty and nobility—about whom we know quite a lot. These latter "master potters" were extremely compulsive and took a set of ceramics upon themselves from design through hand-dipping in glazes and finally firing. Wedgwood understood this system and felt that there was a much more efficient way.

He noticed, for example, that master potters' arms were stained black by the lead-based slips and glazes into which they dipped their pots, and that these talented men rarely survived past their mid-thirties. In response, Wedgwood hired women to dip pots in lead-based solutions (Wedgwood was really not a male chauvinist; just, sad to say, in his day women were worth less than men!). He also noticed that a master potter spent a great deal of time carving figures or flowers or whatever on the key pieces that became the basis for molds to make the multiple plates, cups, bowls, etc., for one set of dinnerware. In response, Josiah's master sculptors would carve the wax pieces used to produce a set of molds with scenes full of myriad Greek gods, women, satyrs, and their ilk. Then Wedgwood would have a few of the carved characters scraped off the original and produce a new set of molds for a whole new set of pots. Sometimes he'd even follow this reduction procedure again! The result: Wedgwood ceramics became England's standard domestic pottery and the products of his factories began to supply a worldwide market.

Wedgwood may have been the Henry Ford of pottery mass production. But he had nothing to teach the Late Postclassic Maya, who made incensarios (large and hollow ceramics in which an extremely pungent incense—copal—was burned) as generic full-figure god effigies and then personalized them with a mold-made head and a plethora of mold-made applique features, such as beards, goggles, and various items for the gods to hold in their hands. Thus, incredible diversity resulted from mass production. As the Burger King assembly-line promotes itself today, "have it your way."

But nothing illustrates cost control and mass replication—what a systems theorist called "progressive

mechanization"—as well as the story of Egypt's great pyramids. A total of 30-some were built between 2700 and 1700 B.C.E. The really big ones were numbers 3, 4, and 5. After that, the sizes were diminished considerably. But more than the size changed. The big ones were fashioned out of Tura limestone blocks carried from the other side of the Nile River and cut so carefully that, as the guides gleefully tell the tourists, "You can't fit a knife blade between them!" That was at the beginning of the sequence. Soon, the cut blocks at the heart of the pyramid were replaced by rubble. Soon after that, the outer facing of Tura limestone was supplanted with poorer quality limestone and then mud bricks. The last chapter is the saddest. Late in the dynastic cycle of the Old Kingdom, when Neb-hepet-Re-Mentuhotep built the last pyramid (between 2130–2080 B.C.E.), an interesting change took place. The architects of Mentuhotep's pyramid solved the technological and labor costs of inner-chamber construction by deleting it and making the pyramid solid. The pharaoh's body was placed in the associated mortuary complex next door. Poor pharaoh!

Why don't we build "Great Pyramids" today? Because they would be such a great "waste" by the definitions of today's society.

Kufu's pyramid, the greatest of the Great Pyramids, was 90 million cubic feet of limestone with a small passageway up the middle to a burial chamber about the size of a very large motel room. It isn't that we can't duplicate the Great Pyramids; it is that nobody wants to! Instead, our megacities and corporations build structures like the World Trade Center—some 70 times Kufu's pyramid in volume—with more than 800 acres of rental space inside!

What does this all mean? In the 1970s, I remember a movement among policy makers to make durables more durable—refrigerators and stoves and so forth that would keep functioning faithfully for 50 years. And no manufacturer would add any "new" conveniences. Of course, it didn't work. But I am not unhappy. If consumers didn't constantly replace their still-functional durables, where else would my graduate students and other less economically privileged elements of our society obtain used appliances? Furthermore, if the computer industry weren't the archetype of rapid change and new features, I would be trying to carry a two-ton Univac with me as I travel rather than a five-pound laptop.

So when your plastic grocery bag breaks, smile and say, "*C'est la vie*!" For that is the way it has been for thousands of years and probably the way it will stay—*they don't make 'em like they used to . . . and never did!*

Decadence Now!

Based on their meticulous studies of ancient garbage, archaeologists are accustomed to the idea that all great cultures move unrelentingly through a set series of stages: their Florescent (flowering) Period, when they begin a dramatic rise; their Classic Period, when they reach a pinnacle; and the Postclassic Period, often referred to as the Decadent Period, when they decline and finally collapse. All of the great cultures encountered so far have followed this simple trajectory.

So where are we? We hear all the time, especially from environmentalists, that North American culture is "decadent." Is that really true, anthropologically speaking?

For the past 13 years the Garbage Project has been attempting to categorize modern culture by excavating fresh garbage from MSW landfills across North America, just like an archaeologist would excavate middens at Troy or Nineveh. So far the landfill tally has reached 19, including four in the Toronto Metroplex in Canada (and I will come back to the Toronto four in a moment).

One of the goals of these excavations was, in fact, to determine where our society stands in the familiar rise-and-fall trajectory of civilizations. To summarize the overall pattern, a small, relatively poor society finds a hook to major wealth—agricultural intensification, mineral exploitation, warfare, extensive trade, and so on—and the Florescent Period begins. When the resources really start pouring in defines the start of the Classic Period—and most Classic societies are hard-pressed to squander their riches fast enough. But eventually, due to competition from other cultures and also often to environmental degradation, the flow of resources begins to slow and dwindles to only a trickle. When the handwriting is on the wall and the society decides to read it, the Decadent Period has begun. At that point, impoverished and strapped

for resources the populace begins to reduce, reuse, and recycle for all it is worth. The problem is: it is already too late, and the downward spiral accelerates to a bitter end.

Where are we in this cycle? The answer is obvious: betrayed by conspicuous consumption, as exemplified by sport utility vehicles (SUVs) and the ballooning tract house-mansions in our ever-burgeoning suburbs, the United States is in its Classic Period, equivalent to the Classic Maya of Mesoamerica. The daring 19th-century archaeologists who discovered Maya sites like Tikal and Yaxchilan called them Classic because their builders left behind grandiose overt displays of resources as symbols of their prosperity: 90-foot-high temples and multiacre palaces whose imposing facades covered breathtaking riches ensconced in a labyrinth of tombs and caches.

Today, given our culture's current concerns with efficient resource management, many of us might describe Tikal's and Yaxchilan's awesome Classic temples and palaces, burials, and offerings as "wasteful."

In contrast to Classic Maya sites, for decades archaeologists have used the term *decadent* to describe the remains of the latter part of the Maya Postclassic Period. Temples were diminutive, palaces dinky. Both were often constructed of cut stones that had once been part of the facades of Classic structures. Burial and cache offerings were composed of once-fine cutting tools with now badly chipped and worn blades, broken pieces of simply decorated pottery—my favorite type is called "Dribble Ware," and justly so—and perhaps some "gold" beads actually made of clay and covered by thin gold foil.

Today, of course, instead of seeing a society gone to ruin, many of us would appreciatively point out that, during their last hurrah, the Late Postclassic Maya succeeded in *really* reducing, reusing, and recycling. A foil-covered clay bead looks just like a solid gold bead, but uses tons less energy in its production.

So what's in store for North American culture? Here we are, in the midst of a Classic Period, and it's dawning on us that the future of our civilization depends on what we do now. That's why, in October 1991, the Garbage Project dug into those four disposal sites near Toronto.

The usual rationales for our digging were present: we wanted an opportunity to characterize Canadian landfills by hands-on excavations in terms of the volumes of specific contents, of biodegradation processes, and of the migration of hazardous wastes. But there was an additional rationale for these digs, one with real-world drama attached: we would determine whether Canada's famous Blue Box program—America's longest-running curbside recycling project, now more that 13 years old—had had a measurable impact on the volume of landfilled refuse. That had been, after all, the Blue Box program's stated goal. The drama existed because we were about to answer critics who doubted Canadians' claims of faithful participation in the recycling program and who questioned the money spent and landfill volumes saved.

No doubt about it, the Blue Box program was beginning to cost real currency. It had long run into small bumps in the recycling road due to fluctuating markets, but these difficulties had multiplied as the garbage barge's odyssey in 1987 spurred many U.S. communities to collect recyclables curbside and dump them into the same vacillating markets.

The Blue Box critics' bottom-line question was clear: was continued support justified by a significant reduction in the volume of garbage landfilled? Recycling advocates everywhere held their collective breath . . .

When we were done with our analyses, the sigh of relief could be heard from Toronto to Ottawa and across the United States.

The Garbage Project documented only two statistically significant changes between pre–Blue Box (pre-1982) and post–Blue Box (1982–90) levels of landfilled refuse volumes. First, newspapers decreased by more than 60 percent (from 12.9 percent of refuse volume to just 6.7 percent). Second, glass decreased more than 50 percent (from 2.1 percent of volume to 0.8 percent). Newspaper and glass were the initial Blue Box targets. Wow!

For metal cans, PET bottles, and corrugated—only heavily collected after the mid-1980s—differences in quantities were not yet statistically significant within landfill samples exhumed in 1991. This is not a cause for concern. For both newspaper and glass, there was a lag time of one or two years between their appearance in Blue Boxes and their disappearance from landfills. Although not yet significant, in the very latest landfill levels,

project workers did note a decrease in the recyclables newly added to Blue Box collection.

What do I make of this? I feel that if we're going to protect our environment while we continue economically in the style to which we're accustomed, we're going to have to buck cultural tradition and move into a newly defined archaeological period: the Blue Box/Decadent Period.

Can we make a conscious, unprecedented decision to embrace the frugality—the source reduction, reuse, and recycling—of the Decadent Period before it's too late—while we're still riding high in our Classic Period? Will we thereby extend our golden days?

It is clear to me that you have to "think Decadent" to maintain a comfortable "Classic lifestyle." So, let the call go out: *"Decadence now!"*

The Rime of the "Garbage" Mariner

(reverently adapted from Samuel T. Coleridge)

It was the "garbage mariner"
Who stopped me on the street.
"'Tis twenty-five years since first Earth Day,"
'Twas thus began his speech.

"I was there on tug *Break of Dawn*
Pushing *Mobro* barge to sea.
'Twas April of '87—
The "garbage" odyssey.

U.S. East Coast to Carib'ean Sea
The *4000* did sail.
To dump our garbage albatross
But all to no avail.

Mocked and shunned, home did we run
And that garbage did we burn.
But it's not gone, the albatross lives on
'Til its lessons we've all learned,

I'm not a preacher in my heart
But I have seen doomsday.
I fear the garbage albatross
We tried to send away.

Recycling we've now taken home.
And markets we have built,
Those who've Recycling's lesson learned
Say, "Alone it'll end our guilt."

So Recycling's come. Is our war won?
It seems not so to me.
The *Mobro* and two thousand tons
Would still be sent to sea.

Time for lesson Two: "source reduce,"
Which means to "use less stuff."
In our towns where overuse abounds,
Learning "less is more" is tough.

But think, friend, what was in *Mobro*'s bin,*
Mostly Papers, Office White.
Using front and back means shorter stacks
And much less waste to fight,

Buying paper of lighter-weights,"
He added with a laugh,
"Together with two-sided use
Cuts waste by more than half,

Recycling has been Lesson One.
"Use Less Stuff" is Lesson Two.
We'll see gardens like sweet Babylon's
If both by us are used,"

The Mariner, eyes burning bright,
Went dreaming on his way.
Thanks to him, I'm a wiser man,
'N I'll do my part today.

*The original *Mobro* carried 3,000 tons of MSW

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