Part II

Environmental Conditions and Trends

CHAPTER FOUR

Population and the Environment

At the most fundamental level, human activity clearly and profoundly affects the environment. For example, the simple act of lighting a campfire has environmental implications in terms of resource use (the wood used to build the fire), energy (the heat created by the fire), and waste generation (the emissions of ash and carbon dioxide and the waste left when the fire has burned out).

Assessing the environmental impact of such a simple event entails consideration of many factors. Was the fire lit in an area with abundant or scarce wood resources? How many other people are lighting fires in the same area? Have some people figured out a way to burn wood more efficiently, thus reducing the need for the resource? Do some people have sufficient resources to burn a fire continuously, while others can only burn a fire at night?

And what is the collective impact of *all* the residents of a particular region, or of the 263 million Americans, or 5.7 billion people living on the earth today? If only one person lights a fire, the impacts in terms of resource use, emissions, and wastes, are negligible. If 1 million or 1 billion people *each* light a fire, the local and global impacts are far more significant.

BACKGROUND

Importance of Demographics

Population size, distribution, mobility, age structure, and rate of growth all affect the environment. (See Box 4.1.) They affect what resources are used, where, when, how, at what rate, and with what attendant waste or conservation. For example, an increase in population will heighten demand for food, energy, water, health care, sanitation, and housing. Or, if 1 million people live on an island, but 80 percent are concentrated along its fragile coastline, that is going to have serious environmental impacts. For another example, because resources are not evenly distributed around the globe, some populations might have abundant coal deposits, while others may rely primarily on natural gas or oil—again, with serious environmental impacts.

Population data and demographics information thus can be a useful tool for understanding trends in some environmental problems. In the case of radon, for example, knowing population size and rate of change will help in estimating national or regional exposure rates; and migration effects can indicate the potential for increasing radon exposure in certain geographic regions.

Box 4.1
Population-Environment Linkages

Population—its size, distribution, and composition—can have a variety of effects on the environment. *The Population-Environment Connection*, a recent report of the Batelle Seattle Research Center prepared for the Environmental Protection Agency, provides some useful summaries of these effects.

Municipal Waste

- Even if per capita generation of municipal solid waste remained constant, population growth would lead to greater waste generation. However, per capita rates have been steadily increasing, further increasing pressures on the waste management system.
- There is some evidence that urban residents generate more municipal solid waste than rural residents, at least for some types of products.
- There is some evidence that smaller households generate more waste per person than large households. Household size has decreased and is likely to stay low in the near future.
- Construction wastes, which are not included in municipal solid waste, may also be affected by household size through the demand for new housing.

Drinking Water

- Increasing population size implies increasing demand for drinking water.
- Increasing population size within a watershed also implies greater potential for contamination of surface and groundwater sources.
- Population distribution affects local and regional demand for water and the distribution of sources of pollution.
- Population growth distributed among areas poorly served by sewer and water systems may have a greater impact on water quality than population growth in areas that are better served.
- Population growth concentrated near sensitive areas may also have a disproportionate effect on water quality.

Coastal and Estuarine Areas

- Increasing population size along a coastal or estuarine area implies greater potential for pollution of water resources.
- Increasing population also implies greater potential for habitat/land use alteration.
- Population growth in upstream areas can adversely affect estuarine and coastal water quality.
- Population distribution affects the distribution of sources of pollution.
- Population growth near sensitive areas may have a disproportionate effect on water quality.
- Increasing numbers of elderly may fuel retirement-driven migration to coastal states.
- Changes in household size and composition may augment effects due to population increases.
- Measures of income distribution may serve to identify greater recreational or second home buying in the coastal and estuarine zone.

Social Characteristics

Beyond the effects of demographics on resources—and the effects of available resources on a population's choice—a population's social characteristics also affect the environment. These factors include government policies, equitable access to capital and technology, and the efficiency of industrial production.

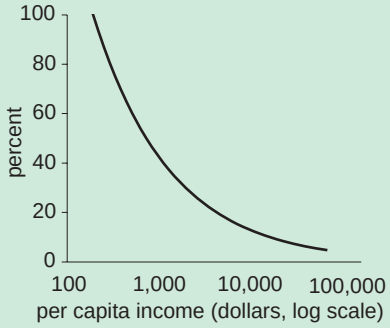
Government Policies. Federal, state, and local government policies can play a significant role in either mitigating or exacerbating the impact of human activities on the environment. Much federal environmental policymaking has profoundly altered the impact of population growth. For example, as discussed in Chapter 19, "Transportation," pollution caused by the rising number of vehicle-miles traveled in America has been substantially offset by reductions in pollutants emitted from new vehicles. On the other hand, many federal policies have encouraged the use of automobiles. In addition, infrastructure planning—transportation, electricity, sewer, and water systems—has generally tended to encourage growth outside of central cities.

Demographic factors have played a relatively minor role in government-backed environmental protection policies. For example, the U.S. National Environmental Policy Act (NEPA) acknowledges the relationship between population dynamics and environmental quality, stressing the "profound influences" of population growth and high-density urbanization on the natural environment. One of the declared duties of the federal government under NEPA is to "achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities." As part of the environmental impact statement process, however, there is no requirement that agencies assess population growth or other demographic effects. As a result, NEPA as currently implemented has not generally led to an awareness of population-environment linkages.

Similarly, the Environmental Protection Agency has traditionally used demographic information in its analysis of exposures to environmental risks, but has less frequently considered the ways in which demographic factors can be drivers of environmental change. However, certain offices have begun to explore ecosystem risks using models in which population growth, migration, or affluence are factors affecting sensitive ecosystems.

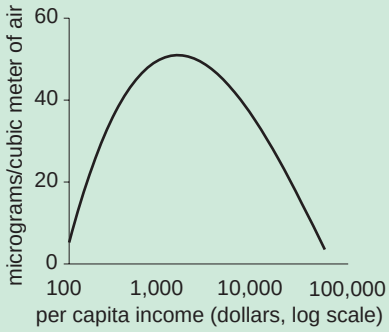
Income. Environmental problems tend to change with changes in national income. The World Bank, in its *World Development Report 1992*, describes

Figure 4.1 World Population Without Safe Water, 1980s



Source: World Bank, *World Development Report 1992*.
Note: Based on cross-country regression analysis.

Figure 4.2 World Urban SO_2 Concentrations, 1980s



Source: World Bank, *World Development Report 1992.*
Note: Based on cross-country regression analysis.

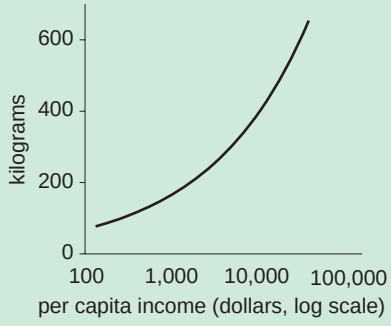
three patterns of change as national income increases.

- Some problems, such as the provision of sanitation and rural electricity services, tend to decline because of the increasing availability of resources to address these problems (Figure 4.1).
- Some problems, including most forms of air and water pollution, initially worsen but then improve as incomes rise (Figure 4.2). This occurs when countries deliberately introduce policies to ensure that additional resources are devoted to solving environmental problems.
- Some problems worsen as income increases. Emissions of carbon and of nitrogen oxides and municipal wastes are current examples (Figure 4.3). The costs of abatement tend to be relatively high, and, in most countries, individuals and firms have few incentives to cut back on wastes and CO_2 emissions.

The report emphasizes that countries can choose policies that result in much better (or much worse) environmental conditions than those in other countries at similar income levels. What seems unavoidable, however, is that rising national and per capita incomes stimulate greater personal consumption—which has a host of implications for resource use, energy, and waste. It also raises several difficult and controversial issues. One concerns equity between the industrialized and developing countries, since people in industrialized countries (such as the United States) consume far more than those in developing countries and have contributed disproportionately to global problems such as the buildup of carbon dioxide in the atmosphere. Another issue concerns the environmental impact of rising consumption in developing countries.

Technological Advances. Technological changes also can significantly alter the population-environment linkage. For example, industrial efficiency improve-

Figure 4.3 World Municipal Waste Per Capita, 1980s



Source: World Bank, *World Development Report 1992.*
Note: Based on cross-country regression analysis.

ments are offsetting rising consumption caused by population growth. Wood use is a case in point. Many sawmills today produce twice as much usable lumber and other products per log input as they did a century ago. In addition, engineering standards and design improvements have reduced the volume of wood used per square foot of building space, and preservative treatments have substantially extended the service life of wood. These efficiency improvements help offset the rising demand for wood caused by population growth.

RECENT TRENDS

Global Population Growth

The scale of population growth in this century is unprecedented. If you were born in 1944, the population has more than doubled in your lifetime—rising from about 2.4 billion to about 5.6 billion people. And, before you die, the world population is likely to grow by an additional 2.5 billion, for a total of about 8 billion people or more.

Most industrialized countries have gone through a remarkable demographic change in this century. Thanks to improved health care and other factors, overall death rates, maternal death rates, and child and infant mortality rates have fallen dramatically. But birth rates have fallen as well, dropping close to or even below the "replacement" level (that is, an average of two children per family). The falling birth rates in industrialized countries are explained by a variety of factors, including the increasing share of the population living in urban areas, greater educational and employment opportunities for women, and greater access to reproductive health care. The result is that most industrialized countries are not expected to experience much increase in population over the next few decades. In fact, total population in all industrialized countries is expected to increase from today's 1.16 billion only to about 1.24 billion by the year 2025.

On the other hand, population in developing countries is expected to continue increasing at a rate of about 1.8 percent per year through the year 2025, rising from the 1995 total of about 4.5 billion to about 7 billion. Africa's population is growing at nearly 3 percent annu-

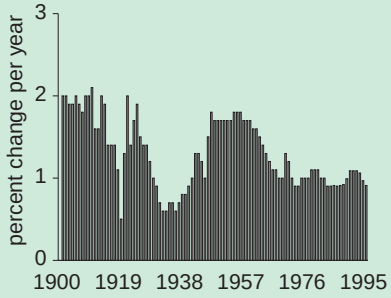
Photo Credit: Steve Delaney
U.S. Environmental Protection Agency

ally, while Asia's is growing at about 1.5 percent.

Over the past 30 years, many developing countries have made progress in primary health care, education, per capita income, and greater opportunities for women. As in industrialized countries, this has resulted in lower birth and death rates, increased life expectancy, and reduced infant mortality. But there is still a tremendous gap between the developed and developing worlds. For example, maternal death rates are 15 to 50 times higher in the developing world than in most developed countries.

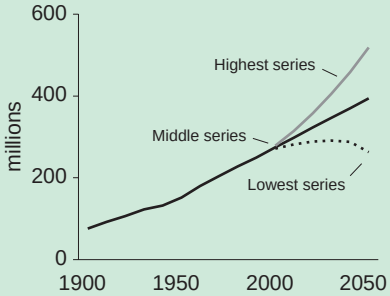
Growing global populations have important implications for worldwide energy consumption, resource use, and waste. For example, China and India may depend largely on coal to support the expansion of their energy sectors. Such a strategy could substantially increase total emissions of carbon dioxide, the principal "greenhouse" gas; this in turn could have significant implications for global climate.

Figure 4.4 U.S. Population Growth Rate, 1900-1995



Source: See Part III, Table 1.

Figure 4.5 U.S. Resident Population, 1900-2050



Source: Bureau of the Census, *Current Population Reports*, Series P-25, No. 311,519,917,1095, and 1127.
Note: Based on census data and projections.

U.S. Population Growth and Demographics

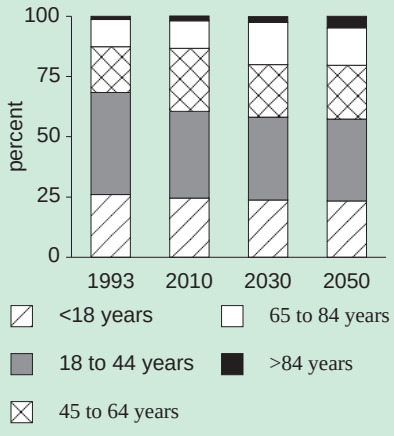
At the turn of the century, U.S. population growth often hit 2 percent annually and did not dip below 1.5 percent until 1915. The Great Depression years decisively broke this strong growth pattern, with population growth rates falling to 0.6 percent in 1932 and 1933. Low rates prevailed until the "baby boom" years after World War II (1946 to 1964). By the mid-1960s, the rate was falling again; it began to level off at about 1 percent—an average annual rate of population growth retained over the past three decades (Figure 4.4).

Population projections by the U.S. Bureau of the Census and other institutions are based on assumptions about fertility, life expectancy, and net immigration. Most discussions refer to "middle series" projections, but the Census Bureau has developed nine other alternative projections series. The lowest projection, for example, assumes a 15 percent

decrease in fertility rates by 2010 for all four non-Hispanic race groups and the Hispanic-origin population, a combined life expectancy of 74.8 years, and an annual net immigration of 300,000. The highest projection for that year assumes a 15 percent *increase* in fertility for these groups, a life expectancy of 89.4 years, and annual immigration of 1.37 million people. Thus, under the low series, population grows from the current 263 million to 282 million by 2050; under the high series, it increases to 519 million (Figure 4.5).

The rate of population growth is projected to decrease over the next six decades, from about 0.9 percent currently to about 0.63 percent by the 2040–50 period, according to the middle series projection of the U.S. Census Bureau (-0.18 percent by 2050 in the lowest series, 1.24 percent in the highest series).

Figure 4.6 U.S. Population Distribution by Age, 1993-2050



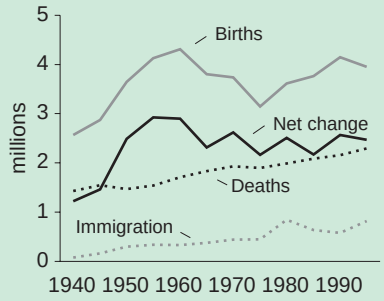
Source: See Part III, Table 3.
Note: Based on census data and projections.

The decrease is largely due to the aging of the U.S. population and, consequently, an increase in the annual number of deaths from 2.3 million per year in 1995 to an estimated 4 million per year in 2050.

Note that even with this decline in the population growth rate, the U.S. population as a whole is projected to grow substantially over the next few decades. Even as fertility declines, demographic "momentum" (each women is having fewer children, but many more women are giving birth) will continue to boost population totals. If fertility were currently at the replacement level, the U.S. population would still grow because of this built-in momentum. According to middle series population projections, the U.S. resident population should reach 274 million in the year 2000, 298 million in 2010, 347 million in 2030, and 394 million by 2050—or fully 50 percent more than today's total.

Age Composition. Population aging is a common feature of most industrialized countries, including the United States. And in fact, the future median age structure of the U.S. population will be older than it is now. As the baby boom population ages, the median age of the population will rise from the 1995 total of 34.3, peaking at a projected 38.7 years of age in the year 2035. After 2010, when the baby boom generation begins to reach 65, the United States will experience a strong surge in the proportion of the population that is 65 and over; the last of the "baby boomers" will reach age 65 in 2029 (Figure 4.6). Another important recent trend, which is expected to continue for several decades, is an increase in

Figure 4.7 Components of U.S. Population Change, 1940-1994



Source: See Part III, Table 2.

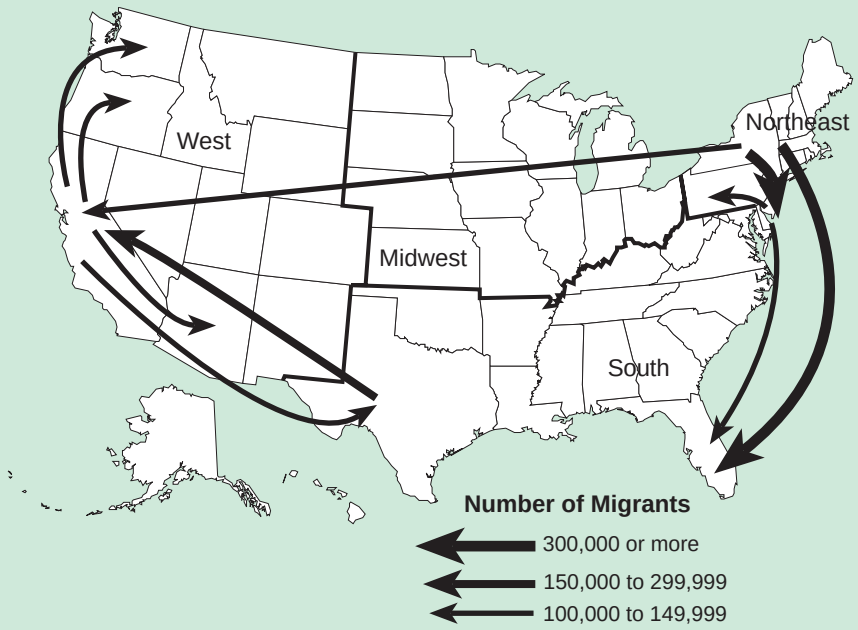
the proportion of the population that is 75 years or older.

Life expectancy is projected to increase from 76.0 years in 1995 (72.5 for males, 79.3 for females) to 82 years (79.7 for males, 84.3 for females) in 2050, under the Census Bureau's middle series projection.

The nation's changing age structure has a number of implications for environmental policy. For example, since the elderly are more susceptible to respiratory and other ailments, an aging population may increase the importance of air quality management. Growing numbers of relatively affluent retirees also may lead to an increase in second home ownership, some of which may occur in ecologically sensitive areas.

Migration. Net international migration for the United States—that is, the net difference between those emigrating

Figure 4.8 Ten Largest Interstate Migration Streams, 1985-1990



Source: U.S. Bureau of the Census, "1990 Selected Place of Birth and Migration Statistics for States," CPH-L-121 (1993) and Gober, 1993.

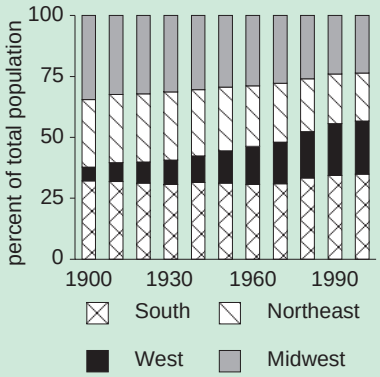
from and those immigrating to the country—was 731,000 in 1995. Net immigration is projected to remain constant at 820,000 annually over the 1995—2050 period, under the middle series projection. To put these totals in context, note that net migration has been averaging 757,000 per year during the 1990s, which is substantially higher than the average of 634,000 in the 1980s. This increase is due at least in part to the 1990 Immigration Act, which reduced the limiting effect of quotas on family reunifications (Figure 4.7).

Mobility. Americans are a nation of movers. Over the last 40 to 50 years, about one out of every five people changed residence every year. This figure has declined slightly in recent years, dropping from 20 percent to 17 percent. The average American currently makes 11.7 moves during a lifetime. About 42 million Americans moved between March 1992 and March 1993. About two thirds of these moves were "local" moves within the same county. Recent data show that Westerners are 80 percent more likely than Northeasterners to change their residence in any given year (Figure 4.8).

For the past several decades, the Northeast and Midwest have been losing population to the South and West. This shift was tied to faster job growth in the South and West in recent decades and the loss of manufacturing jobs in the Northeast and Midwest. The Midwest, however, rebounded somewhat in the late 1980s. Currently, the South is the nation's most populous region, with 91 million inhabitants, or about 3.7 times what it was in 1900. The population of the West has doubled since 1960, and 8 of the country's 10 fastest growing states are in the West. Additionally, the West has the lowest median age (32.7 years), while the Northeast has the highest (35.3 years) (Figure 4.9).

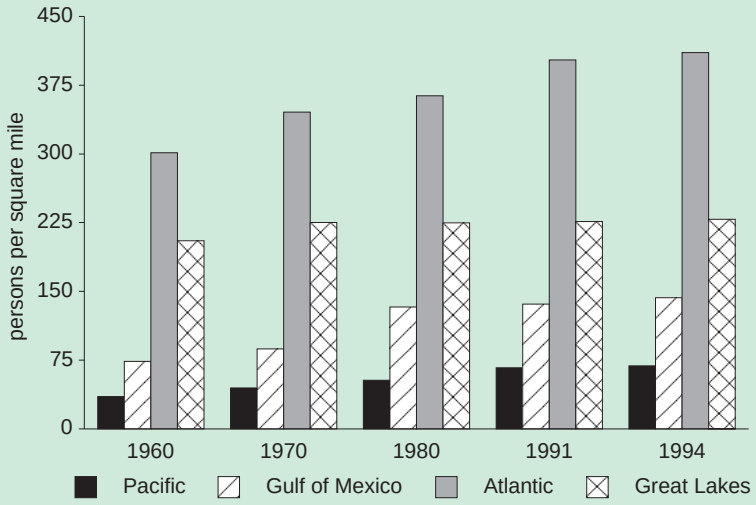
Coastal areas account for more than half of the nation's population and have grown faster than the interior since 1960. In the Pacific and Gulf of Mexico coastal regions, population per square mile nearly doubled between 1960 and 1994 (Figure 4.10). The National Oceanic and Atmospheric Administration notes that between 1970 and 1989, almost half of all building construction occurred in coastal regions, even though they represent only 11 percent of the nation's total land area. Over the next few decades, a significant amount of growth also is expected to occur in inland areas 20—70 miles from coastal areas.

Figure 4.9 U.S. Population by Region, 1900-1994



Source: See Part III, Table 5.

Figure 4.10 U.S. Coastal Population Density, 1960-1994



Source: See Part III, Table 6.

Urbanization. Like other industrialized countries, the proportion of the U.S. population living in urban areas has increased significantly in this century. Today, about three out of every four Americans lives in an urban area; during the 1980s, about 90 percent of U.S. population growth occurred in such areas. The nation now includes 39 metropolitan areas with more than 1 million people; all told, these account for fully half of the total U.S. population.

Urbanization is concentrated in the South and West and is dominated by Florida, which has 9 of the 11 fastest growing cities in the nation. Urban growth is spreading outward to suburban and "exurban" areas—these latter lie beyond the suburbs but are still within commuting distance. It is estimated that one-third of the nation's population growth between 1960 and 1985 took place in exurban counties. A variety of factors have contributed to this trend, including federal policies that stimulate development and home ownership; the desire to escape the negative aspects of urban life; the desire for space and access to environmental resources; and new developments in transportation, communications, and employment.

Urbanization and the redistribution of population can have a wide variety of environmental impacts, affecting the demand for energy to heat and cool homes, the demand placed on specific aquifers, the pace of land development, the number of vehicle-miles traveled per day, and the conversion of farmland and wetland habitats.

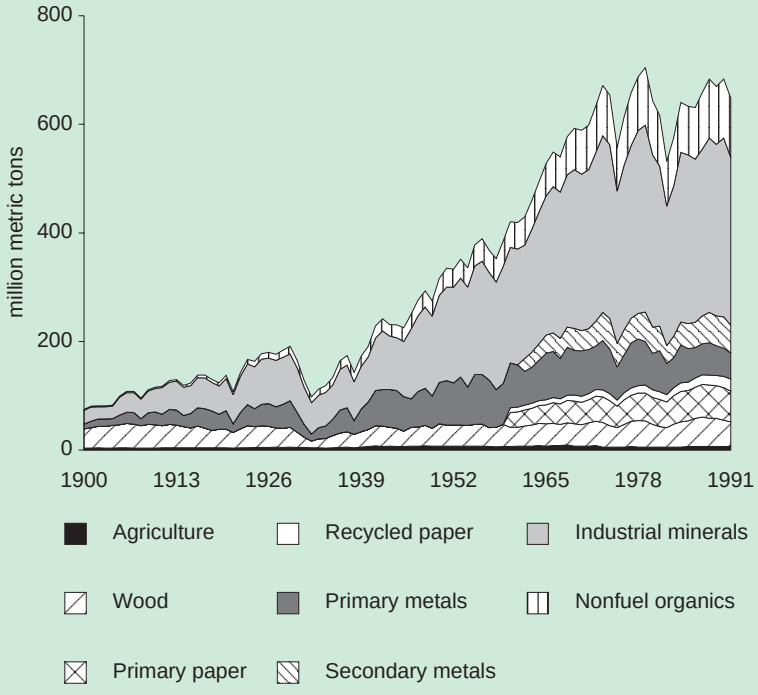
Trends in U.S. Consumption

According to *World Resources 1994—95*, the United States in 1989 consumed a total of about 4.5 billion metric tons of natural resources, or about 18 metric tons per person. Construction material (stone, sand, and gravel) accounted for 1.8 billion metric tons, energy fuel for 1.7 billion metric tons, food for 317 million metric tons, and industrial minerals for 317 million metric tons.

Historical consumption trends for some of those materials are shown in Figure 4.11. Among the notable trends are the following:

- Primary metal consumption has declined because of increased recycling and production from scrap.
- Nonfuel organic material consumption is rising because of increased use of plastic, synthetic fiber in carpets and textiles, synthetic rubber, and petrochemical products.
- There has been a growing use of more highly engineered and generally lighter material, packaging material, and paper. As a result, per capita consumption of forestry products, metal, and plastic measured by weight has been declining over the past 20 years,

Figure 4.11 U.S. Consumption of Raw Materials, 1900-1991



Source: Bureau of Mines, Branch of Materials.
Note: Does not include stone, sand, and gravel.

Photo Credit: Steve Delaney
U.S. Environmental Protection Agency

but per capita consumption measured by volume has been expanding slowly.

The top two income groups in the United States, representing 40 percent of the population, consume more than half of all resources, including utilities (51 percent), food (57 percent), housing (62 percent), transportation (62 percent), and clothing (64 percent). Spending on housing and transportation are significant across all income groups, varying from 23 to 25 percent for housing and between 16 and 19 percent for transportation.

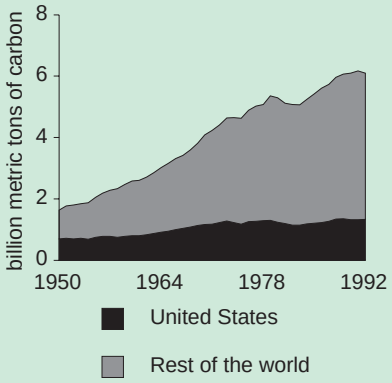
Not surprisingly, the per capita generation of municipal solid waste also has risen steadily, especially in the nonfood categories of paper products and plastics. Aside from population growth, other factors contribute to this, including socioeconomic status, household size, demands for convenience, and degree of urbanization. Note, however, that the amount of solid waste deposited in landfills has been substantially offset by recycling programs. (See Chapter 20, "Solid Waste.")

The Global Dimension

As a group, Americans consume far more per person than people in developing countries, so the environmental impact of the average American is substantially greater than the impact of the average person in a developing country.

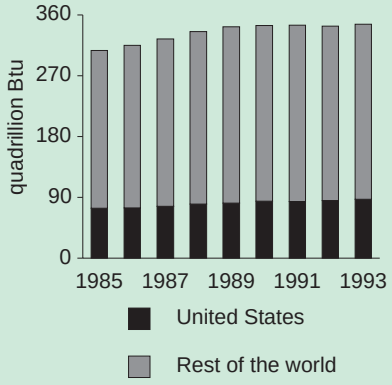
Resource consumption in the United States has an important global dimension. For example, primarily as a result of fossil fuel consumption and resulting carbon dioxide emissions, the United States

Figure 4.12 World CO_2 Emissions, 1950-1992



Source: Marland, G., Oak Ridge National Laboratory.

Figure 4.13 World Energy Consumption, 1985-1993



Source: DOE, Energy Information Administration.

is the world's leading producer of greenhouse gas emissions.

Private utilities account for about 40 percent of U.S. carbon dioxide emissions. Other significant contributions are made by petroleum refining, wholesale and retail trade, new construction, transportation, and coal mining. The fact that carbon dioxide emissions are spread across so many sectors of the economy suggests that significant changes in U.S. emissions could require complex policy adjustments (Figure 4.12).

In the area of energy use, the United States made great strides in energy efficiency in the last few decades even as its population continued to grow. Yet, with just 5 percent of the world's population, the United States still accounts for approximately 25 percent of global energy use on an annual basis (Figure 4.13). According to the report of the President's Council on Sustainable Development, U.S. energy use per unit of gross domestic product is about 36 percent greater than in Germany and 79 percent greater than in Japan. Use of petroleum feedstocks is seven times the global per capita average. U.S. oil consumption, at 19.9 million barrels per day in 1994, is nearly as great as the 23.8 million barrels per day collectively consumed by the remaining 24 members of the Organisation for Economic Co-operation and Development in Europe and Japan.

Clearly, there is a great opportunity for further improvements in energy efficiency in the United States; this challenge will become more evident and pressing as the U.S. population grows in the next century.

FUTURE CHALLENGES

What does a rise in population portend for resource use and the state of the environment? Clearly, population growth and rising per capita consumption will

The Cairo Action Plan

In 1994, the United States took part in forgoing an extraordinary consensus around the goals of human rights and health, equality and environmental protection, economic and social justice. The International Conference on Population and Development in Cairo embraced a comprehensive approach, recognizing that family planning and development each play a role in slowing population growth, but they work best when pursued together. The strategies for stabilizing population— quality health care, education, and opportunity— enhance the ability of individuals and societies to meet their needs and the needs of future generations.

As the first aspect of a comprehensive approach, Cairo participants committed their nations to high quality, voluntary family planning and reproductive health programs, with the aim of making them universally available early in the next century. A new sense of urgency emerged in support of making every effort to enable couples and individuals to fulfill the basic right to decide freely and responsibly the number and spacing of their children, and to have the information, education, and means to do so.

To complement, reinforce, and promote health, the Cairo conference agreed to make economic and environmental progress the second component of the effort. The integrated strategy would promote free trade, private investmen, and development assistance, and recognize the close relationships between population, sustained economic growth, and environmental integrity.

The Cairo Plan of Action underscores the importance of women's equal participation in the struggle to create a better future. Recognizing women's value to development, and empowering them to contribute their wisdom and talents to society, constitute the third component of the plan.

A fourth element is investing in education for all people, including women, because inadequate education is a powerful determinant of high fertility. A fifth aspect is ensuring that men fulfill their responsibilities, including preventing unintended pregnancies, helping to raise children, and stemming the spread of HIV/AIDS and sexually transmitted disease.

This comprehensive and integrated approach represents a powerful step to alleviate poverty, stabilize global population and promote sustainable development. The world took a major step forward at Cairo.

put more pressure on the environment. As noted earlier, the United States now consumes more than 4.5 billion metric tons of materials annually to produce the goods and services that make up its unparalleled economic activity. Based on current trends, efficiency in the use of all resources would have to increase by more than 50 percent over the next four or five decades just to keep pace with population growth.

The international Factor 10 Club, which consists of 16 distinguished scientists and economists from 10 countries, argues that over the next 30 to 50 years the industrialized countries "must work toward cutting in half present global nonrenewable material flows, including minerals, freshwater, and nonrenewable energy carriers. To achieve this, it is our view that a political commitment to a tenfold increase in the average resource productivity of the presently industrialized countries is a prerequisite for meeting the goal of long-term global sustainability." This conclusion was noted in the February 1996 communique of the OECD ministerial-level environmental policy committee.

Yet there are some grounds for optimism. In the area of solid waste, for example, recycling and reuse is now projected to absorb most additional waste in the next few years, so that net generation of waste (after recycling) is projected to go down slightly in this decade. This is a remarkable achievement, because it is built on innumerable local initiatives and on the willingness of many Americans to support community recycling programs. Because population growth and economic growth will continue to boost waste generation from 2000 to 2010, recovery rates will have to rise to 40 percent or more to absorb this growth. (See Chapter 20, "Solid Waste.")

According to the PCSD report,

> *continued population growth steadily makes more difficult the job of mitigating the environmental impact of American resource use and waste production patterns . . . Managing population growth, resources, and wastes is essential to ensuring that the total impact of these factors is within the bounds of sustainability. Stabilizing the population without changing consumption and waste production patterns would not be enough, but it would make an immensely challenging task more manageable. In the United States, each is necessary; neither alone is sufficient.*

If current population projections are correct, the U.S. population will grow substantially larger in the next few decades. This will pose difficult new challenges in many areas, including energy use, materials consumption, and waste disposal. Further progress in energy efficiency, pollution prevention, and reuse and recycling of materials will be essential to lessen the environmental impact of this larger population.

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