Unit 5 : Human Population Dynamics

Street Market in Mumbai, India. Courtesy of David E. Bloom

Overview

What factors influence human population growth trends most strongly, and how does population growth or decline impact the environment? Does urbanization threaten our quality of life or offer a pathway to better living conditions? What are the social implications of an aging world population? Discover how demographers approach these questions through the study of human population dynamics.

Sections:

1. Introduction

Human population trends are centrally important to environmental science because they help to determine the environmental impact of human activities. Rising populations put increasing demands on natural resources such as land, water, and energy supplies. As human communities use more resources, they generate contaminants, such as air and water pollution and greenhouse gas emissions, along with increasing quantities of waste.

Population interacts with several other factors to determine a society's environmental impact. One widely-cited formula is the "I = PAT" equation, proposed by Paul R. Ehrlich and John P. Holdren in 1974 (footnote 1).

Environmental Impact = Population x Affluence (or consumption) x Technology

For generations people have tried to estimate Earth's carrying capacity, or the maximum population that it can support on a continuing basis. This is a slippery undertaking. Estimates of human carrying capacity over the past four centuries have varied from less than one billion people to more than one trillion, depending on how the authors defined carrying capacity. Some studies cast the issue solely in terms of food production, others as the availability of a broader set of resources.

In fact, the question depends on assumptions about human preferences. What standard of living is seen as acceptable, and what levels of risk and variability in living conditions will people tolerate? Many of these issues are not just matters of what humans want; rather, they intersect with physical limits, such as total arable land or the amount of energy available to do work. In such instances nature sets bounds on human choices (footnote 2).

Measuring Earth's carrying capacity at the global level obscures the fact that resources are not allocated equally around the world. In some areas such as the Sahel in West Africa (the transition zone between the Sahara desert and more humid woodlands to the south), population growth is putting heavy stresses on a fragile environment, so food needs are outstripping food production (Fig. 1). Other regions have better balances between populations and resources.

Figure 1. Gully erosion from over-cultivation, Sahel, West Africa

Courtesy United States Geological Survey, National Center for Earth Resources Observation Systems International Program.

Demography, the science of human population (or more specifically, the study of population structure and processes), draws together research from a number of disciplines, including economics, sociology, geography, public health, and genetics. In addition to the environmental impacts of population growth, population science also considers questions such as:

- How does population growth or decline influence economic and social well-being?
- Does population growth enhance or diminish economic growth?
- What impact does population growth have on poverty?
- Do specific aspects of population growth, such as age structure or sex imbalance, have bigger impacts on economic development and environmental quality than other aspects?
- What are the social and economic implications of population redistribution, through, for example, rural to urban or international migration?

This unit discusses basic population dynamics, including birth and death rates and factors that influence demographic change. It then summarizes the history of world population growth and projections through mid-century, with a focus on rising urbanization and the aging of the global population. Next we examine the environmental, economic, and institutional implications of population growth and some actions that governments can take to maximize benefits from population growth and limit harmful impacts. Finally, we consider whether nations' demographic patterns are becoming more similar, in spite of their different historic, cultural, and economic legacies, taking note of some regions that do not fit this general pattern.

2. Mathematics of Population Growth

Population experts can make demographic predictions with more confidence than many other social scientists. Several basic truths apply to the demographics of all human societies:

- Everyone who is alive one year from now will be one year older at that time than s/he is today.
- Ages 15 to 49 are humans' prime childbearing years, biologically speaking (although resource constraints and social and political factors shape childbearing decisions differently from one country to another).
- Human mortality is relatively high among infants, children, and adults over age 60, and relatively low at other parts of the life cycle.

Putting these observations together, population analysts can develop a reasonably accurate map of how a society's population size, births, deaths, and age structure are likely to evolve in the next several decades.

Birth and death rates are the most important determinants of population growth; in some countries, net migration is also important in this regard. To calculate population growth rates, demographers take the difference between births and deaths in a given time period, add the net number of migrants (which for the world as a whole is 0), and divide that number by the total population. For example, there are now about 136 million births and 58 million deaths worldwide annually, adding a net of 78 million new inhabitants to a global population of 6.7 billion, a growth rate of nearly 1.2 percent.

Until the mid-19th century birth rates were only slightly higher than death rates, so the human population grew very slowly. The industrial era changed many factors that affected birth and death rates, and in doing so, it triggered a dramatic expansion of the world's population (Fig. 2).

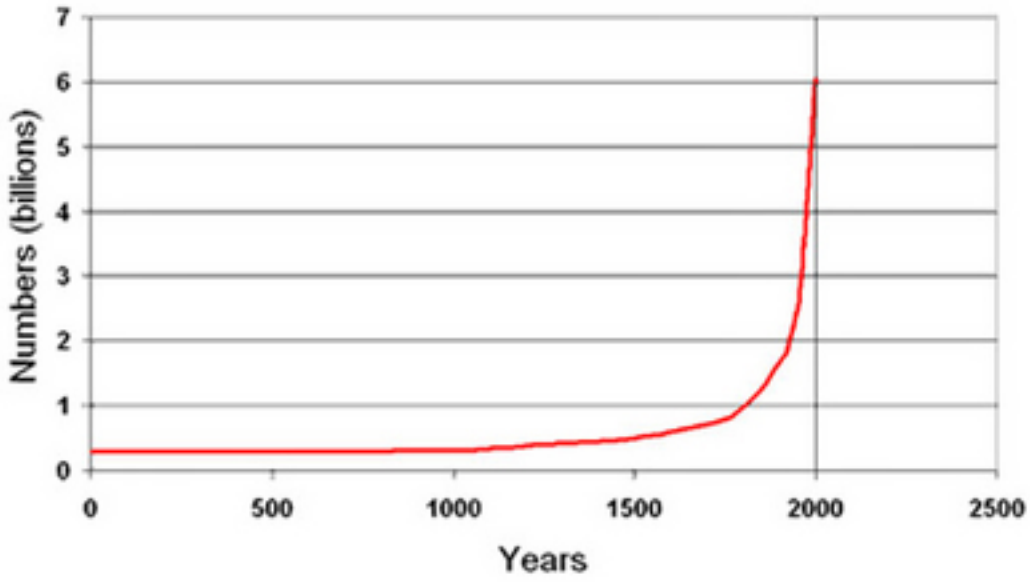

Figure 2. Past world population growth

Based on data from The World at Six Billion (1999). United Nations Secretariat, Department of Economic and Social Affairs.

How did industrialization alter population growth rates so sharply? One central factor was the mechanization of agriculture, which enabled societies to produce more food from available inputs. (For more information about increasing agricultural productivity, see Unit 7, "Agriculture.") As food supplies expanded, average levels of nourishment rose, and vulnerability to chronic and contagious diseases declined over succeeding generations. Improvements in medical care and public health services—which took place more in urban than in rural areas—also helped people to live longer, so death rates fell. After several decades of lower mortality, people realized that they did not have to have so many children to achieve their desired family size, so birth rates began to fall as well.

In addition, **desired** family size tended to decrease. As women found many more opportunities to enter the labor force, they were less inclined to devote resources to childrearing rather than paid work, and the jobs they had were not conducive to having children beside them as they worked. The costs of raising children also increased, as slightly wealthier families living in urban areas faced higher expenses for a larger array of physical and social necessities.

This phased reduction in death and birth rates is a process called the demographic transition, which alters population growth rates in several stages (Fig. 3).

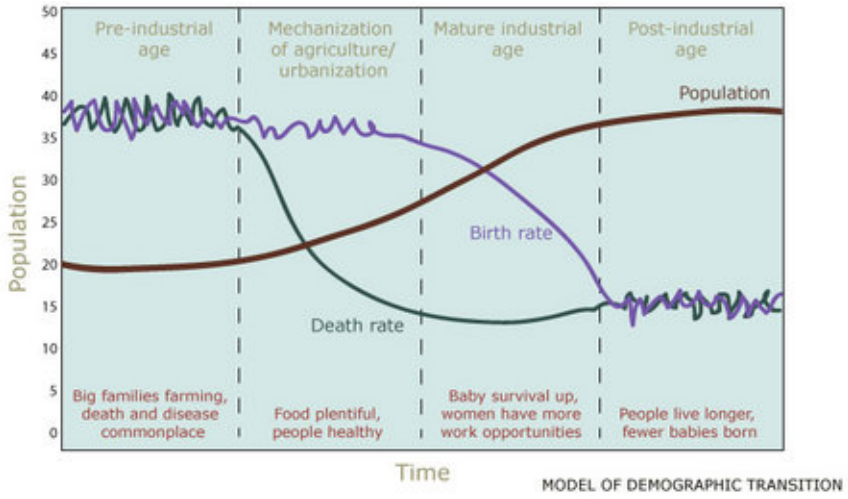

Figure 3. The demographic transition

Because death rates fall before birth rates, population growth initially speeds up (a phase sometimes referred to as the mortality transition), adding a large cohort of young people to society. This group in turn will have children, although probably fewer per family than their parents did, and because this group of childbearing-age people is large, population will continue to grow in absolute numbers even though on a per-capita basis birth rates will decline—a phenomenon that demographers call the fertility transition. Population momentum (i.e., continued population growth after a fall in birth rates) accounts for a significant portion of world population growth today even though the global fertility rate has declined from about 5 children born per woman in 1950 to a little over 2.5 in 2006.

Developed nations have passed through the demographic transition, and most developing countries are at some point in the process today. As a result, a "bulge," or baby-boom, generation, distinctly larger than those preceding or following it, is moving through the age structure of the population in nearly all countries. These large cohorts create both opportunities and challenges for society. Expanded work forces can help nations increase their economic output, raising living standards for everyone. They also can strain available resources and services, which in turn may cause shortages and economic disruption. (For more details, see section 7, "Other Consequences of Demographic Change.")

The demographic transition is a well-recognized pattern, but it has shown many variations from country to country. We cannot predict when specific demographic changes will occur in particular countries, and it is hard to specify precisely which factors will shape a given society's path. Looking forward, a major question for the 21st century is what happens after the demographic transition, and whether some countries in areas such as western Europe, where birth rates are very low, will start striving to raise fertility (footnote 3). More important in terms of environment and health, however, is the question of how to help countries that are lagging on the transition path.

3. Determinants of Demographic Change

What factors drive population growth rates? One major indicator and determinant of demographic change is fertility, which demographers express as the total fertility rate, the number of births that can be expected to occur to a typical woman in a given society during her childbearing years. Fertility is a function of a woman's fecundity (her physiological ability to conceive and bear children (footnote 4)) and of social, cultural, economic, and health factors that influence reproductive choices in the country in question. The most important non-physical factors influencing a country's total fertility rate include relationship status (the fraction of women who are married or in a relationship that exposes them to the possibility of becoming pregnant); use of contraception; the fraction of women who are infecund —for example, because they are breastfeeding a child; and the prevalence of induced abortion (footnote 5).

Fertility levels are lower in developed countries than in developing nations because more women in developed countries work outside of the home and tend to marry later and to use contraception and abortion to delay or prevent childbearing. Nevertheless, fertility rates in nearly all countries have been falling since the 1950s (Fig. 4). Most of the exceptions are in Central and Western Africa.

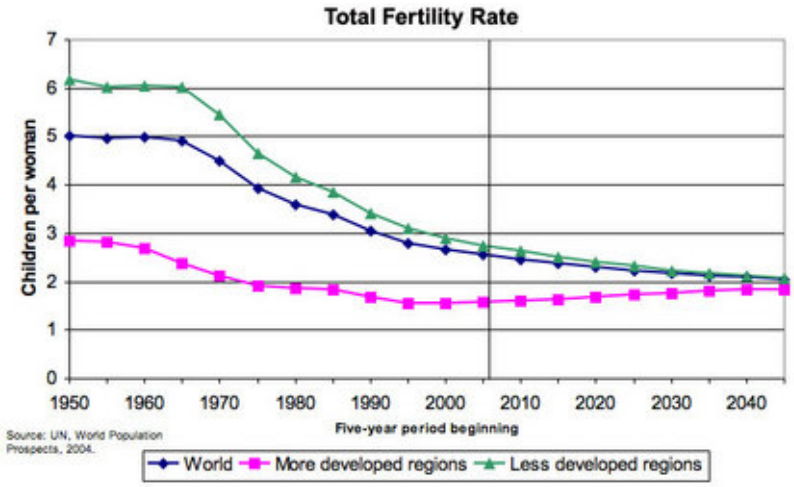

Figure 4. Total fertility rate

Fertility patterns can vary widely within countries. Racial and ethnic minorities may have higher fertility rates than the majority, and families with low incomes or low levels of education typically have more children than those that are affluent or well-educated. Women who work outside the home generally have fewer children than those who stay home, and rural families have more children than city dwellers. In 2006, the number of births per 1,000 people worldwide averaged 21, with extremes ranging from a low of 8 or 9 (mainly in northern and western Europe and some former Soviet republics) to 50 or more in a few west African nations (footnote 6).

Mortality is the second major variable that shapes population trends. A population's age structure is an important factor influencing its death rate. Death rates are highest among infants, young children, and the elderly, so societies with many elderly people are likely to have more deaths per 1,000 people than those where most citizens are young adults. Developed countries with good medical services have more people in older age brackets than developing countries, so the developed societies can have higher death rates even though they are healthier places to live overall.

To assess longevity in a society, demographers calculate life expectancy—the age that a newborn would, on average, live to, assuming she were subject to a particular set of age-specific mortality rates—usually those prevailing in a particular year. The probability that a child will die at a given age drops through childhood and adolescence after she passes through the vulnerable early years, then starts to rise gradually in mid-life. Figure 5 shows remaining life expectancy at birth, 65 years of age, and 75 years of age in the year 2000 for people in the United States. Americans who were age 65 or

75 by 2000 had already survived many common causes of death, so they could expect at that point to live to an older age than would a baby born in that year (if life expectancy did not change during the baby's lifetime).

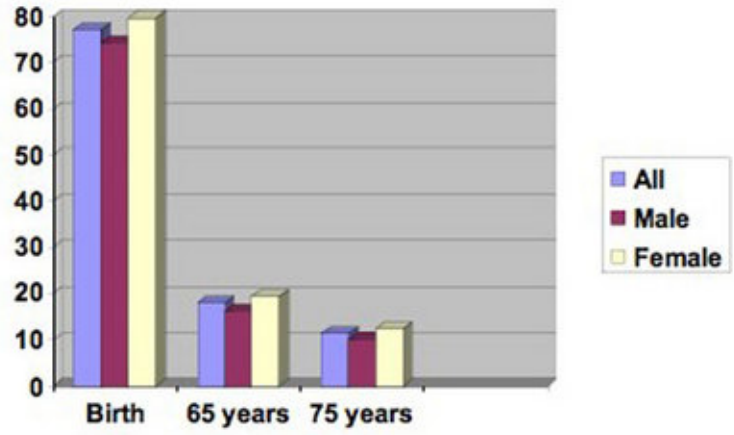

Figure 5. Life expectancy at birth, age 65, and age 75, United States, 2004

Courtesy National Center for Health Statistics, U.S. Health with Chartbook on Trends in the Health of Americans. 2006.

Life expectancy is trending upward around the world, but a substantial gap remains between developing and developed countries (Fig. 6). In 2006, life expectancies at birth ranged from the mid-30s in some African countries to the high 70s or low 80s in the United States, Australia, Japan, and some European countries (footnote 7).

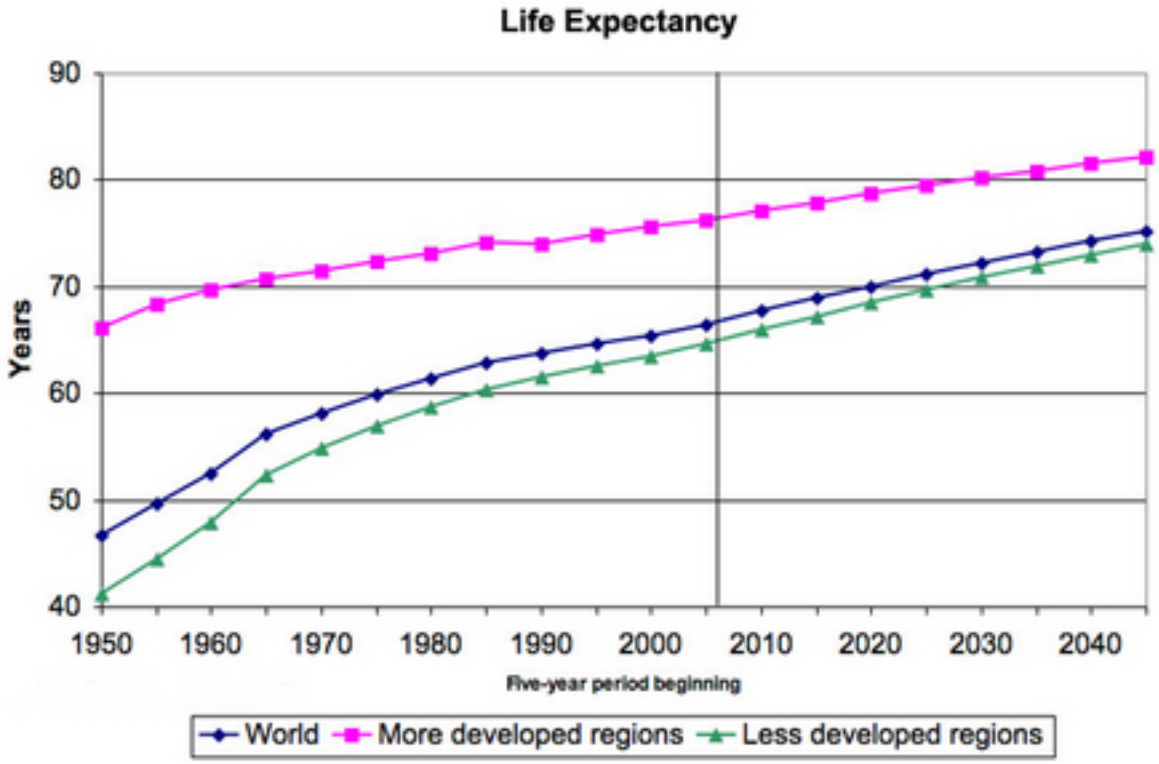

Figure 6. Life expectancy

What factors raise life expectancy? Because of the way in which it is calculated, life expectancy serves as a measure of the general health of the population, which depends on the satisfaction of many basic human needs such as adequate nutrition, clean water and sanitation, as well as access to medical services like vaccinations. Addressing these requirements reduces the incidence of many preventable illnesses. For example, nutritional deficiencies cause common illnesses like scurvy and pellagra, while dirty water and poor sanitation spread infectious agents such as cholera and typhoid. (For more details, see Unit 6, "Risk, Exposure, and Health," and Unit 8, "Water Resources.")

New threats to health are continually emerging, and often are spread across international borders through trade and human or animal migration. Recent examples that are severe enough to affect life expectancy in large areas include the HIV/AIDS pandemic and potentially avian flu and multi-drug-resistant malaria and tuberculosis. Researchers are also gaining new insight into existing threats, such as indoor air pollution from combustion of primitive biomass fuels like crop waste and

dung. Exposure to these pollutants is a major factor contributing to infant mortality and lower life expectancy in developing countries (Fig. 7). Environmental investments, such as providing cleaner energy sources and upgrading sewage treatment systems, can significantly improve public health.

Figure 7. Indian girls making tea, village of Than Gaon

Courtesy Wikimedia Commons. Creative Commons License.

Another step that increases life expectancy is creating a public health infrastructure that can identify and respond quickly to disease outbreaks, famines, and other threats. When severe acute respiratory syndrome (SARS) emerged as a disease that might cause an international epidemic, the U.S. Centers for Disease Control and Prevention (CDC) launched an emergency response program that required health departments to report suspect cases to CDC for evaluation, developed tests to identify the SARS virus, and kept health care providers and the public informed about the status of the outbreak. The United States and many other countries also reported their SARS cases to the World Health Organization. These types of close surveillance and preventive steps to control infections can help prevent diseases from spreading widely.

The third major factor that drives population trends is migration, which includes geographic population shifts within nations and across borders. Migration is less predictable over long periods than fertility or mortality, since it can happen in sudden waves—for example, when refugees flee a war—or slowly over many years. Immigration often changes host nations' or regions' ethnic mixes and strains social services. On the positive side, it can provide needed labor (both skilled and unskilled). For source

countries, however, immigration may drain away valuable talent, especially since educated and motivated people are most likely to migrate in search of opportunities.

4. World Population Growth Through History

Human population has grown very slowly for most of its existence on earth. Scientists currently estimate that modern human beings (**Homo sapiens**) evolved roughly 130,000 to 160,000 years ago. Many threats, from diseases to climate fluctuations, kept life expectancy short and death rates high in pre-industrial society, so it took until 1804 for the human population to reach one billion. From that point forward, however, population growth accelerated very quickly (Table 1).

Table 1. World population milestones.

World population reached:	Year	Time to add 1 billion
1 billion	1804	
2 billion	1927	123 years
3 billion	1960	33 years
4 billion	1974	14 years
5 billion	1987	13 years
6 billion	1999	12 years

Through the early decades of the Industrial Revolution, life expectancies were low in western Europe and the United States. Thousands of people died from infectious diseases such as typhoid and cholera, which spread rapidly in the crowded, filthy conditions that were common in early factory towns and major cities, or were weakened by poor nutrition. But from about 1850 through 1950, a cascade of health and safety advances radically improved living conditions in industrialized nations. Major milestones included:

- improving urban sanitation and waste removal;
- improving the quality of the water supply and expanding access to it;
- forming public health boards to detect illnesses and quarantine the sick;
- researching causes and means of transmission of infectious diseases;
- developing vaccines and antibiotics;
- adopting workplace safety laws and limits on child labor; and

- promoting nutrition through steps such as fortifying milk, breads, and cereals with vitamins.

By the mid-20th century, most industrialized nations had passed through the demographic transition. As health technologies were transferred to developing nations, many of these countries entered the mortality transition and their population swelled. The world's population growth rate peaked in the late 1960s at just over 2 percent per year (2.5 percent in developing countries).

Demographers currently project that Earth's population will reach just over nine billion by 2050, with virtually all growth occurring in developing countries (Fig. 8). Future fertility trends will strongly affect the course of population growth. This estimate assumes that fertility will decline from 2.6 children per woman in 2005 to slightly over 2 children per woman in 2050. If the rate falls more sharply, to 1.5 children per woman, world population would be 7.7 billion in 2050, whereas a slower decline to 2.5 children per woman would increase world population to 10.6 billion by 2050.

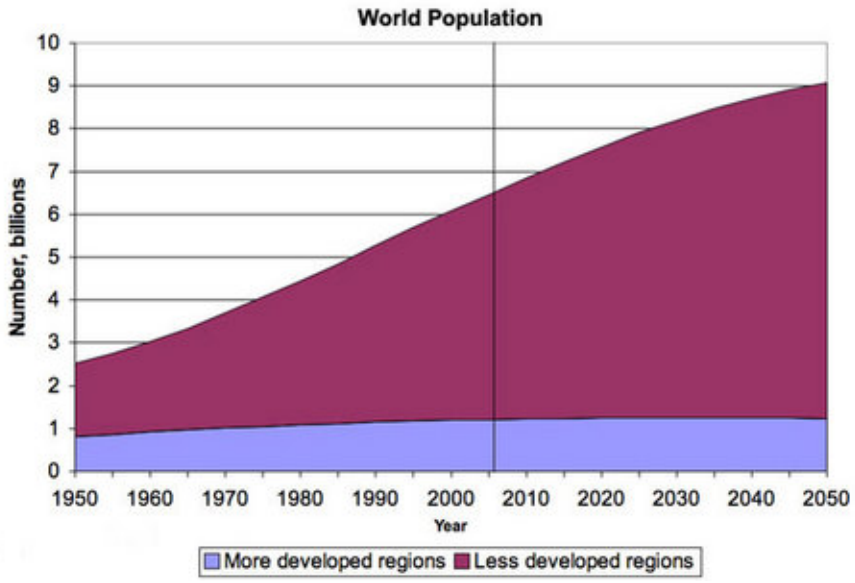

Figure 8. World population

Many people interpret forecasts like this to mean that population growth is out of control. In fact, as noted above, world population growth rates peaked in the late 1960s and have declined sharply in the past four decades (Fig. 9). The world's total population is still rising because of population momentum stemming from large increases that occurred in developing countries in the 1950s and early 1960s. But fertility rates are falling as many developing countries pass through the demographic transition,

thanks to factors that include lower infant mortality rates; expanding rights, education, and labor market opportunities for women; and increased access to family planning services.

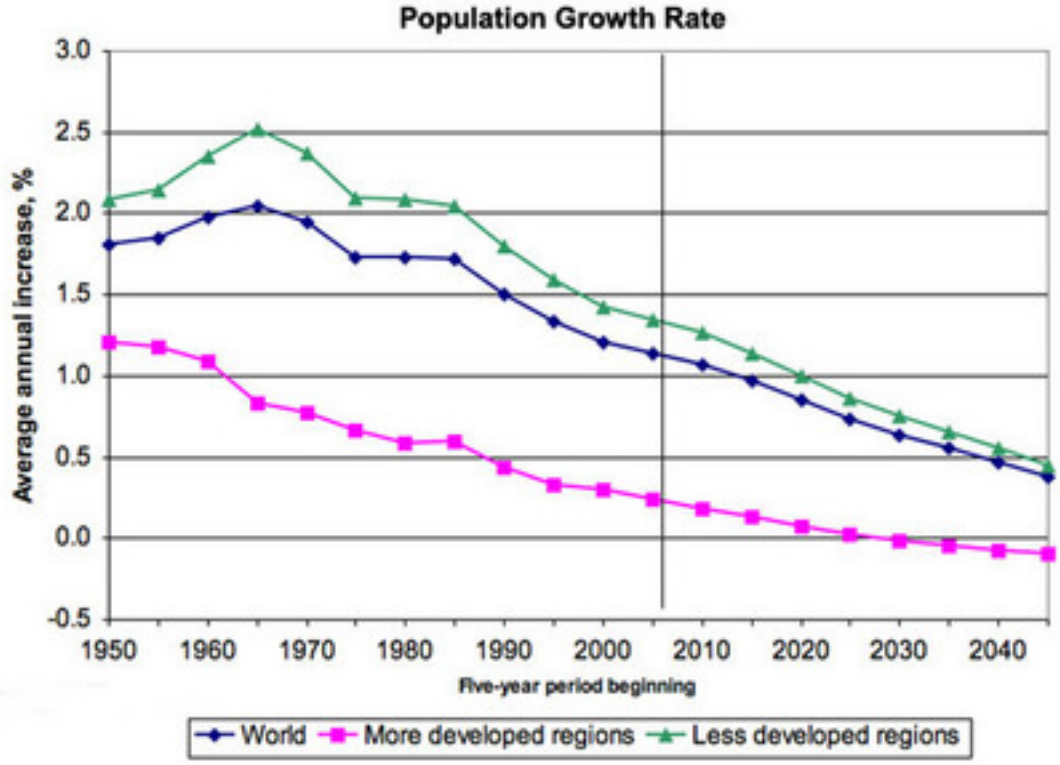

Figure 9. Population growth rate

World population growth in the 21st century will be different from previous decades in several important ways. First, humans are living longer and having fewer children, so there will be more older people (age 60 and above) than very young people (age zero to four). Second, nearly all population growth will take place in urban areas. Third, fertility rates will continue to decline (footnote 8).

All of these trends will affect nations' economic development. (On urbanization, see section 6, "Urbanization and Megacities.") Senior citizens can be active and productive members of society, but they have many unique needs in areas ranging from medical care to housing and transportation. Growing elderly populations will strain social services, especially in countries that do not have well-developed social safety nets to guarantee adequate incomes for older citizens. In countries that have "Pay As You Go" social security programs, increasing ratios of older to younger people may create

budget imbalances because fewer workers are paying funds into the system to support growing numbers of retirees.

As societies age, demand for younger workers will increase, drawing more people into the labor force and attracting immigrants in search of work. Declining fertility rates allow more women to work outside of the home, which increases the labor supply and may further accelerate the demographic transition (Fig. 10).

Figure 10. Woman supervising 25 employees at the Vegetable Dehydrates Factory, Parwan Province, Afghanistan

Courtesy Jeremy Foster, United States Agency for International Development.

As fertility rates fall, some countries have already dropped below replacement level—the number of children per woman that keeps population levels constant when births and deaths are considered together over time (assuming no net migration). Replacement-level fertility requires a total fertility rate of about 2.1 to offset the fact that some children will die before they reach adulthood and have their own families (in a society with higher mortality rates, replacement-level fertility would require more births) (footnote 9). Total fertility rates in most European and some Asian and Caribbean countries currently range from about 1.2 to 1.8, well below replacement level.

Some observers argue that declining fertility rates in both industrialized and developing countries will lead to a "birth dearth," with shrinking populations draining national savings and reducing tax revenues. However, societies can transition successfully from high mortality and fertility to low mortality and fertility with sound planning. Promoting good health standards (especially for children), expanding education, carefully opening up to international trade, and supporting older citizens

through retirement are all policies that can help to offset the negative impacts on society of an aging population (footnote 10).

5. Population Growth and the Environment

Many people (including national leaders) worry that population growth depletes resources and can trigger social or economic catastrophe if it is not contained. As discussed in the preceding section, most of the projected population growth during this century will take place in developing nations. These countries have faced many challenges in recent decades, including low levels of education, poor health standards, poverty, scarce housing, natural resource depletion, wars, and economic and political domination by other countries. In Sub-Saharan Africa industrial development has stalled and most workers still make a living from subsistence agriculture.

Countries in this situation generally have devoted less energy to addressing environmental issues than their wealthier neighbors, so these problems have intensified. Especially in the poorest countries, therefore, future population growth is likely to make environmental deterioration worse (although it does not automatically follow that countries with low population growth rates will have cleaner environments).

However, the relationship between population and the environment is complex. As noted in section 1, human societies' impacts on the environment are a function of three major, interconnected elements: population size, affluence or consumption, and technology. An expanded version of the IPAT equation separates technology into two factors: resource-intensity (how many resources are used to produce each unit of consumption) and waste-intensity (how much waste each unit of consumption generates), and also considers the sensitivity of the environment (footnote 11).

Societies' environmental impacts take two major forms. First, we consume resources such as land, food, water, soils, and services from healthy ecosystems, such as water filtration through wetlands. (For more on ecosystem services, see Unit 9, "Biodiversity Decline.") Over-consumption uses up or severely depletes supplies of non-renewable resources, such as fossil fuels, and depletes renewable resources such as fisheries and forests if we use them up faster than they can replenish themselves (Fig. 11).

Figure 11. Land conversion for grazing in the Amazon rainforest

Courtesy National Aeronautics and Space Administration, Goddard Space Flight Center.

Second, we emit wastes as a product of our consumption activities, including air and water pollutants, toxic materials, greenhouse gases, and excess nutrients. Some wastes, such as untreated sewage and many pollutants, threaten human health. Others disrupt natural ecosystem functions: for example, excess nitrogen in water supplies causes algal blooms that deplete oxygen and kill fish. (For more on these pollutants, see Unit 8, "Water Resources"; Unit 10, "Energy Challenges"; Unit 11, "Atmospheric Pollution"; and Unit 12, "Earth's Changing Climate.")

Rising population growth rates in the 1950s spurred worries that developing countries could deplete their food supplies. Starting with India in 1951, dozens of countries launched family planning programs with support from international organizations and western governments. As shown above in Figure 4, total fertility rates in developing countries declined from six children per woman to three between 1950 and 2000. National programs were particularly effective in Asia, which accounted for roughly 80 percent of global fertility decline from the 1950s through 2000 (footnote 12). It is important to note, however, that this conclusion is controversial. Some researchers have argued that **desired** fertility falls as incomes grow—and that family planning has essentially no independent influence (footnote 13).

These programs sought to speed the demographic transition by convincing citizens that having large numbers of children was bad for the nation and for individual families. Generally they focused on educating married couples about birth control and distributing contraceptives, but some programs

took more coercive approaches. China imposed a limit of one child per family in 1979, with two children allowed in special cases (Fig. 12).

Figure 12. Poster advertising China's one-child policy, 1980s

Artist Zhou Yuwei. Courtesy of the International Institute of Social History Stefan R. Landsberger Collection, http://www.iisg.nl/~landsberger.

In some parts of China the one-child policy reportedly has been enforced through methods including forced abortions and sterilizations. Forced sterilizations also occurred in India in the 1970s. These policies have spurred some Indian and Chinese families to practice selective abortion and infanticide of female babies, since boys are more valued culturally and as workers. Population sex ratios in both countries are skewed as a result. In 2005 there were 107.5 males per 100 females in India and 106.8 males per 100 females in China, compared to a worldwide average of 101.6 males per 100 females. Females slightly outnumber males on every continent other than Asia (footnote 14).

Large societies consume more resources than small ones, but consumption patterns and technology choices may account for more environmental harms than sheer numbers of people. The U.S. population is about one-fourth as large as that of China or India, but the United States currently uses far more energy because Americans are more affluent and use their wealth to buy energy-intensive goods like cars and electronics. But China and India are growing and becoming more affluent, so their environmental impacts will increase because of both population size and consumption levels in the next several decades. For example, in 2006 China surpassed the United States as the world's largest emitter of carbon dioxide (CO_2), the main greenhouse gas produced as a result of human activities (footnote 15).

Economies tend to become more high-polluting during early stages of economic development because they first adapt inexpensive technologies that are relatively inefficient—for example, simple manufacturing systems and basic consumer goods such as cars. As income rises and technologies diffuse through society, consumers start to value environmental quality more highly and become more able to pay for it.

Some analysts have argued that developing countries can skip the early stage of industrialization through "leapfrogging"—deploying advanced, clean technologies as soon as they are fielded in developed nations, or even earlier. For example, some developing countries have skipped past installing telephone poles and wires and moved straight to cell phones as a primary communication system. If fast-growing nations like China and India can leapfrog to clean technologies, they can reduce the environmental impacts of their large and growing populations (Fig. 13). However, many new technologies will not flow easily across borders in the absence of special efforts. Developed countries and international financial institutions can promote technology transfer to reduce the environmental impacts of growth in developing countries.

Figure 13. Youths installing solar panels to power a rural computer center, São João, Brazil

Courtesy United States Agency for International Development.

6. Urbanization and Megacities

The year 2007 marked a new milestone for human population growth: for the first time, more people worldwide were living in cities than in rural areas (footnote 16). This trend is driven by several factors: people migrating from rural regions to cities; rural areas being reclassified as urban areas because of population growth; and urban populations growing and expanding their boundaries to incorporate land that was formerly classified as rural.

Urbanization is a predictable outcome of industrialization and the demographic transition. As nations shift to mechanized agriculture they can produce more food with less labor, so there are fewer work opportunities in rural areas. More investment flows into industry and service businesses, which concentrate in urban areas near customers and infrastructure such as highways and telecommunications services. As these sectors become the main arenas of economic activity, people who once might have spent their lives in rural areas move to cities in search of higher-paying work and better living standards.

Nearly all of the urban growth projected in this century will occur in developing countries. About three-quarters of the world's urban population lives in small or intermediate-sized cities, which have fewer than 1 million inhabitants or 1 to 5 million inhabitants, respectively (footnote 17). Most urban dwellers will continue to live in small and medium cities, but there also will be major growth in megacities (more than 10 million people) and metacities (more than 20 million people). In the 1950s only New York and Tokyo were large enough to qualify as megacities, but population experts project that six cities—São Paulo, Mexico City, Mumbai (formerly Bombay), Delhi, Dhaka, and Tokyo—will have topped the 20 million mark by 2015, with New York, Jakarta, and Lagos close behind (Fig. 14).

Figure 14. The world's largest cities in 2015

Urban growth can contribute to sustainable development if it is managed effectively. Because cities concentrate economic activities and large numbers of people close together, the unit cost of providing basic infrastructure and services like piped water, roads, and sewage treatment is lower than in rural areas. Governments can make cities more efficient and livable by investing in public transportation systems and clean energy sources, and by planning ahead for growth so that they are able to provide basic services when populations expand.

But city life can also be dirty, unhealthy, and dangerous. Many people moving to cities, especially in the developing world, end up living in slums, just like earlier migrants to places like Manchester, England, and New York City's notorious Five Points slum in the 19th century. In 2007 the number of slum dwellers worldwide exceeds one billion, about one-third of all city residents, with more than 90 percent of slum dwellers residing in developing countries (footnote 18). Slums are a large and entrenched sector of many cities in the developing world. Some, like Brazil's favelas and South Africa's townships, have become sightseeing attractions for adventurous tourists.

Urban poverty can be as severe as rural poverty for people in slum neighborhoods who do not have access to the benefits of city life. The United Nations defines a slum as "a contiguous settlement where the inhabitants are characterized as having inadequate housing and basic services" such as drinking water and sanitation (footnote 19, Fig. 15). Slum dwellers typically live in crowded conditions without durable shelter or reliable access to safe drinking water or proper toilets. Many are not protected by tenants' rights, so they can easily be evicted or forced out and become homeless.

Figure 15. Shanty town in Manila beside Manila City Jail

Courtesy Mike Gonzalez. Wikimedia Commons, GNU Free Documentation License.

People who live in slums have lower life expectancies than their neighbors in more affluent areas, and more slum residents are killed or sickened by environmental hazards like indoor air pollution and water-borne or water-related diseases. (For more about these threats, see Unit 6, "Risk, Exposure, and Health," and Unit 8, "Water Resources.") Ironically, many slum dwellers use less energy and resources and generate less waste than their upscale neighbors, but the poor live in dirtier areas and receive fewer resources and services, so they bear the burdens generated by higher-income consumers.

The scale of urban poverty, already a pressing issue in many developing countries, may become even worse, as most population growth in the 21st century will happen in cities. Ameliorating the conditions described above is essential for sustainable human development. Some countries, including Brazil, Cuba, Egypt, South Africa, Sri Lanka, Thailand, and Tunisia, have reduced or limited slum growth. These governments have made serious political commitments to upgrading slum neighborhoods, improving housing, giving more people access to clean water and sanitation, preventing more "informal" settlements (shanty neighborhoods), and investing in services like education and transportation that benefit poor communities. And after decades of focusing on rural communities, international aid organizations are paying increasing attention to urbanization.

"As I walk through the slums of Africa, I find it hard to witness children suffering under what can only be described as an urban penalty. I am astonished at how women manage to raise their families under such appalling circumstances, without water or a decent toilet. The promise of independence has given way to the harsh realities of urban living mainly because too many of us were ill prepared for our urban future. Many cities are confronting not only the problems of urban poverty, but the very worst of environmental pollution. From Banda Aceh to New Orleans, whole communities are being wiped out through no fault of the innocent victims."

Anna Tibaijuka, Executive Director, UN-HABITAT(Worldwatch Institute, **State of the World 2007: Our Urban Future**)

7. Other Consequences of Demographic Change

The environmental consequences of population growth are a subset of broader interactions between population and national economic development. Scholars have debated for many years whether population growth helps or hinders economic growth. And the issue of economic growth (which is affected in various ways by demographic change) is relevant to the environment because people in wealthier nations are generally healthier, more interested in environmental quality, and better able to afford cleaner technologies than those in poor countries (although, as discussed above, they also tend to choose high-consumption lifestyles and generate relatively large amounts of waste and air, land, and water pollution per capita).

It may seem intuitively obvious that large family size is associated with poverty. Indeed, family planning efforts in the 1960s were spurred by worries that rapidly growing populations would lead to slower economic growth in developing countries. However, some scholars have argued that population growth helps the economy by stimulating innovation and providing bigger markets. Recent studies confirm that high fertility tends to slow economic growth and keep poor families poor, while declines in fertility reduce poverty (footnote 20). They also cite another important factor: the age structure of the population.

All societies can be divided into dependents (people who are too young or too old to work, so they depend on their families or on pensions for support) and workers who generate economic activity, generally defined as people ages 15 to 64. The ratio of dependents to the working-age population is called the dependency ratio. For example, as shown below in Table 2, there are 81 dependents (75 children and 6 elderly people) for every 100 working-age people in Africa. Developing countries tend to have higher dependency ratios than developed nations, and children account for a larger fraction of dependents in developing countries.

Table 2. Dependency ratios by region, 2005. (Because of rounding, Child + Old-age does not necessarily equal Total.)

Region	Total (Dependents per 100 working-age people)	Children per 100 working-age people	Old-age per 100 working-age people
World	55	44	11
Africa	81	75	6
Latin America/ Caribbean	57	47	10
Oceania	54	36	16
Asia	52	43	10
North America	49	31	18
Europe	47	23	23

Dependency ratios are key influences on economic growth. Nations with high dependency ratios spend large shares of their resources taking care of dependents, while those with lower ratios are able to devote more resources to investment in physical capital, technological progress, and education. When countries lower their fertility rates, they reduce the child component of the dependency ratio, which lightens the financial burden on wage earners and frees up more women to enter the work force.

Countries that reduce fertility rates have an important opportunity to reap a demographic dividend. As discussed above in section 2, the demographic transition produces a "bulge" generation—a large cohort of people who are born after mortality rates fall but before fertility rates decline in response. Many developing countries are currently at this stage, with large numbers of people at or near working age and relatively few older dependents (Fig. 16).

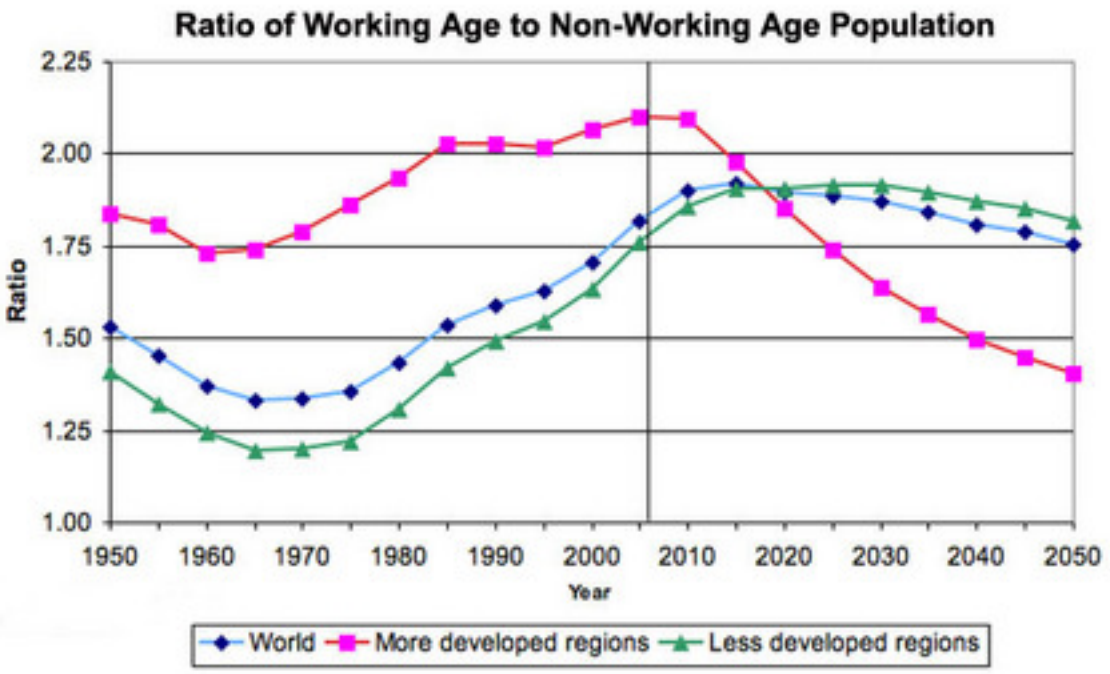

Figure 16. Ratio of working age to non-working age population

Nations that have a particularly high ratio of working-age people to dependents can quickly build up capital and increase national per-capita income. Economists estimate that this demographic dividend accounted for roughly 20 to 40 percent of East Asia's economic boom between 1965 and 1990 (footnote 21). But the dividend does not pay out automatically. To earn it, nations must invest in education to train the large generation of young workers, and then manage their economies so that conditions are stable and workers can find rewarding jobs. Countries will not be able to reap the demographic dividend if they fail to create productive work opportunities.

The window of opportunity to earn a demographic dividend lasts for at least several decades, with the time depending largely on how quickly national fertility rates fall. As the boom generation matures and starts to retire from the work force, the dependency ratio goes up again since fewer workers follow in the wake of the boom cohort. In developed countries, the population of older citizens is growing more quickly than the population of workers. But nations that provide strong support for elderly citizens and that encourage workers to save for retirement may reap a second, longer-lasting demographic dividend spurred by such savings (footnote 22).

8. Demographic Convergence and Human Lifespan Trends

As the graphs in this unit illustrate, nations of the world appear to be converging demographically in several ways. The gaps between developed and developing countries for major indicators such as fertility rates and life expectancies have narrowed significantly in the past half-century and are projected to become smaller in coming decades. In 1950 life expectancy in developing countries as a whole lagged that of developed countries by 25 years. That gap has decreased to 12 years and is projected to be 8 years by 2050. Some developing countries have fertility and mortality rates that are lower than those in developed nations.

This trend indicates that the demographic transition is a widespread phenomenon and that life will continue to improve for people in poor countries as fertility rates decline further—especially if their governments adopt policies that recognize changing demographic realities, as discussed in section 7. But demographic convergence is not automatic. Some countries, including many in sub-Saharan Africa, are stuck in high fertility/low-growth traps, and others have hit speed bumps on the road toward longer, healthier lives. The HIV/AIDS pandemic has dramatically reduced life expectancy across Africa (Fig. 17). Life expectancy for men in Russia fell by more than seven years during the economic crisis and political instability that followed the breakup of the Soviet Union. Wars have left lasting marks on population distribution in some countries.

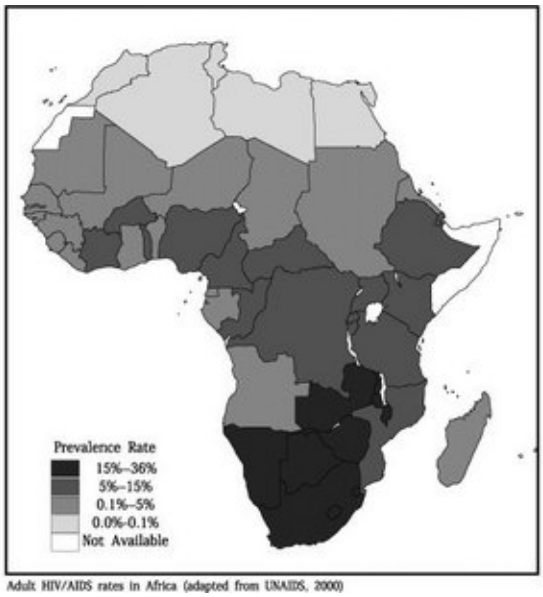

Figure 17. Adult HIV/AIDS rates in Africa, 2000

Courtesy United States Institute for Peace, http://www.usip.org.

Economist Jeffrey Sachs argues that extremely poor nations lag behind the rest of the world for several reasons. Impoverished areas such as sub-Saharan Africa, Central Asia, and the highlands of South America have climates and land resources that are poorly suited to large-scale agriculture. They also are economically and geographically isolated, and malaria is widespread in Africa.

Sachs and his colleagues estimate that if wealthy countries doubled their foreign aid spending from $80 billion to $160 billion per year, the world's poorest nations could cut poverty in half by 2015 and eliminate it by 2025. Key investments would address core environmental needs such as clean drinking water and sanitation, along with health, education, and food production (footnote 23). In sum, for very poor countries, population is just one of a set of issues that must be addressed to jump-start economic development.

Other experts contend that massive aid plans conceived by foreign experts and imposed from the top down by international agencies and wealthy donor nations have produced very poor returns and done little to reduce global poverty. Economist William Easterly writes of Sachs and other antipoverty advocates, "Poor people die not only because of the world's indifference to their poverty, but also because of ineffective efforts by those who do care." The right approach, in Easterly's view, is to

focus on smaller-scale tasks (such as delivering specific drugs to control specific diseases), relying on local channels and providers to the greatest extent possible (footnote 24).

In contrast to the situation in poor nations, most people in wealthy countries are living longer, healthier lives than at any time in history. This trend raises its own issues. For example, most of the acute illnesses that killed many people a century ago, such as tuberculosis, tetanus, and poliomyelitis, have been brought under control; one major killer, smallpox, has been eliminated. Most deaths in developed countries are now caused by chronic diseases such as cancer, heart disease, stroke, and chronic lower respiratory diseases such as emphysema. Tobacco use causes more deaths in the United States each year than HIV, alcohol use, illegal drug use, motor vehicle injuries, suicides, and murders combined (footnote 25).

Many chronic diseases develop slowly, and many are linked to personal choices such as diet. This means that effective public health programs must increasingly focus on long-term prevention and reducing risky behaviors such as smoking (Fig. 18).

Figure 18. Warning on a pack of British cigarettes

If we bring chronic diseases under control, could humans live even longer than they do today? On average, 1 out of 10,000 people in developed countries lives beyond age 100; the longest documented human life was that of a French woman who died in 1997 at age 122. There is great scientific interest in exploring the limits of the human life span, although no agreement on a best means for extending life or how long humans could live under optimum conditions. Most scholars

believe that, absent major wars or unforeseen epidemics, life expectancy will increase during this century, to at least 85 in today's wealthy industrial countries, and perhaps to as high as 100.

9. Further Reading

Jeffrey Sachs, **The End of Poverty: Economic Possibilities For Our Time** (New York: Penguin, 2006). Economist Jeffrey Sachs offers a plan to eliminate extreme poverty around the world by 2025, focusing on actions to improve the lives of the world's one billion poorest citizens.

John Bongaarts, "How Long Will We Live?" **Population and Development Review**, vol. 32, no. 4 (December 2006), pp. 605–628. A look at the factors that have increased life expectancy in high-income countries since 1800 and at prospects for continued gains.

Joel E. Cohen, "Human Population Grows Up," **Scientific American**, September 2005, pp. 48–55. In the next 50 years, Earth's human population will be larger, slower-growing, more urban, and older than in the 20th century, with significant implications for sustainability.

"The Economics of Demographics," (whole issue) **Finance & Development**, vol. 43, no. 3, September 2006. A detailed look at policy adjustments that can help world leaders cope with demographic change.

Mike Davis, "Slum Ecology," **Orion**, March/April 2006. Living conditions in urban slums invert the principles of good urban planning: houses stand on unstable slopes, people live next to polluted and toxic sites, and open space is scarce or lacking.

Malcolm Gladwell, "The Risk Pool," **New Yorker**, August 28, 2006. Population age structures and dependency ratios explain Ireland's recent economic boom and the woes of many U.S. corporate pension plans.

Paul Harrison and Fred Pearce, **AAAS Atlas of Population and the Environment** (Berkeley: American Association for the Advancement of Science and University of California Press, 2000), http://atlas.aaas.org/index.php?sub=intro. An online source of information on the relationships between human population and the environment, with text, maps, and diagrams.

Footnotes

1. J.P. Holdren and P.R. Ehrlich, "Human Population and the Global Environment," American Scientist, vol. 62 (1974), pp. 282–92.

2. Joel E. Cohen, **How Many People Can the Earth Support?** (New York: Norton, 1995), pp. 212-36, 261–62.

3. Dudley Kirk, "Demographic Transition Theory," **Population Studies**, Vol. 50, No. 3 (November 1996), pp. 381–87.

4. In popular usage, "fertility" means what demographers call "fecundity." This chapter uses "fertility" as demographers do.

5. Joseph A. McFalls, Jr., "Population: A Lively Introduction," **Population Bulletin**, December 2003, p. 5.

6. Population Reference Bureau, **2006 World Population Data Sheet**, http://www.prb.org/pdf06/06WorldDataSheet.pdf, pp. 5, 9.

7. Ibid., pp. 5–10.

8. Joel E. Cohen, "Human Population Grows Up," **Scientific American**, September 2005, pp. 48–55.

9. A technical note: 2.1 is the long-run replacement level when the baby-boom generation has aged and the overall age structure has stabilized. Before then, a population can continue to grow with the total fertility rate at or below 2.1, depending on its age structure, a manifestation of the concept of population momentum described earlier.

10. David E. Bloom and David Canning, "Booms, Busts, and Echoes," **Finance & Development**, September 2006, p. 13.

11. Paul Harrison and Fred Pearce, **AAAS Atlas of Population and Environment** (Berkeley: American Association for the Advancement of Science and University of California Press, 2000), p. 7.

12. John C. Caldwell, James F. Phillips, and Barkat-e-Khuda, "The Future of Family Planning Programs," **Studies in Family Planning**, Vol. 33, No. 1, March 2002, p. 2.

13. Lant Pritchett, "Desired Fertility and the Impact of Population Policies," **Population and Development Review**, Vol. 1, No. 20, March 1994, pp. 1–55.

14. United Nations, Department of Economic and Social Affairs, World Population Prospects: The 2006 Revision, Population Database, http://esa.un.org/unpp/index.asp?panel=2.

15. Netherlands Environmental Assessment Agency, "China Now No. 1 in CO Emissions; USA In Second Position," press release, June 19, 2007.

16. United Nations Human Settlements Programme (UN-HABITAT), **State of the World's Cities 2006/7** (London: Earthscan, 2006), p. viii.

17. Ibid., p. 5.

18. UN-HABITAT, **State of the World's Cities 2006/7**, p. 5.

19. United Nations Statistics Division, http://unstats.un.org/unsd/cdb/cdb_dict_xrxx.asp?def_code=487.

20. Nancy Birdsall and Steven W. Sinding, "How and Why Population Matters: New Findings, New Issues," in Nancy Birdsall, Allen C. Kelley, and Steven W. Sinding, eds., **Population Matters** (Oxford University Press, 2003), p. 14.

21. "Banking the 'Demographic Dividend,'" **Rand Policy Brief**, RB-5065-WFHF-DLPF-RF (2002); David E. Bloom and Jeffrey Williamson, "Demographic Transitions and Economic Miracles in Emerging Asia," **World Bank Economic Review**, Vol. 12, No. 3 (1998), pp. 419–55.

22. Ronald D. Lee and Andrew Mason, "What is the Demographic Dividend?" **Finance & Development**, September 2006, pp. 16–17.

23. Jeffrey D. Sachs, "Can Extreme Poverty Be Eliminated?" **Scientific American**, September 2005, pp. 56–65.

24. William Easterly, **The White Man's Burden: Why the West's Efforts To Aid the Rest Have Done So Much Ill and So Little Good** (New York: Penguin, 2006), p. 7.

25. U.S. Centers for Disease Control and Prevention, "Tobacco-Related Mortality," fact sheet, September 2006.

Glossary

carrying capacity : The number of individuals an environment can support without significant negative impacts to the given organism and its environment.

demographic convergence : When the gaps narrow between developed and developing countries for major indicators such as fertility rates and life expectancies.

demographic dividend : A rise in the rate of economic growth due to a rising share of working age people in a population.

demographic transition : The pattern of population growth exhibited by the now-developed countries during the 19th and early 20th centuries.

dependency ratio : The ratio of non-workers (children and retirees) to workers in a human population: the higher the ratio, the greater the dependency load.

fecundity : A measure of the capacity of an organism to produce offspring.

fertility : A measure of reproduction: the number of children born per couple, person, or population.

life expectancy : Term usually used at birth, indicating the average age that a newborn can be expected to attain.

migration : When living organisms move from one biome to another. It can also describe geographic population shifts within nations and across borders.

mortality : The loss of members of a population through death.

population momentum : The impetus for continued expansion of the number of people in a country when the age structure is characterized by a large number of children. Even if birth control efforts are

effective in the adult community and the number of new births per person decreases, the number of people in the country expands as the large population of children reach reproductive age.

replacement level : The number of children per woman necessary to keep population levels constant when births and deaths are considered together over time; estimated to be an average of 2.1 children for every woman.