

The Human Population: Dimensions

Key Topics

1. Human Population Expansion and Its Cause
2. Different Worlds
3. Consequences of Population Growth and Affluence
4. Dynamics of Population Growth

The Mombasa highway leads out from the center of Nairobi, Kenya, and is lined with factories for several miles. Outside every factory gate every morning is a crowd of people—mostly men—waiting for the gates to open. Dressed in tattered clothes and worn-out shoes, they are the “casual workers,” hired for periods of up to three months, but never under any employment contract. Many are there just hoping that they will be hired for the day. One such worker—let’s call him Charles—has worked at one of these factories for almost a year. He is paid 100 Kenyan shillings—about \$1.70—a day. He walks 10 km to work from his home in one of the shantytowns on the edge of the city. He can’t afford transportation and can only occasionally buy lunch, which is a bowl of *githeri*—a 10-shilling dish of corn and beans sold in the kiosks that cluster around every factory. Charles has no work contract, nor do any of his coworkers. Virtually all of the factories pay

Casual Workers in Kenya High population growth and slow economic development combine to produce a large unemployed and underemployed workforce. Competition for scarce, low-paying factory jobs leaves many men like these without employment.

workers 100 shillings a day; working six days a week for 10 hours a day, they earn, at most, \$50 a month.

Any worker who becomes a union representative is fired. Any worker who complains about an injury on the job is fired. For every job, there are scores of applicants, so no one dares attract attention. They work in dusty, dangerous conditions. Cement-factory workers have no masks to prevent them from breathing the dust. Metalworkers lack protective gear and often lose limbs or their lives due to the nature of the jobs, which are often monotonous, making the workers lose their concentration. There are 14,000 of these factories in cities like Nairobi, Mombasa, Kisumu, Nakuru, and Eldoret, in Kenya.

Scenes like those along the Mombasa highway can be found around most cities in the developing world. The staggering growth of cities is one of the stark realities of recent population growth in that world. The cities grow because the rural countryside provides only subsistence farming and livestock herding for most of its people—and with population growth rates as high as 3% per year, there are continually more people than there is land to till and cattle to herd. This is the tragic story described in *Cry the Beloved Country* (a novel by Alan Paton, set in

South Africa), multiplied by hundreds of thousands. Thus, the young people and the men migrate to cities, such as Nairobi, to find work. Kenya has an enormous unemployed and underemployed workforce—the legacy of decades of extremely high population growth rates.

In the World. In the last century, the global human population has undergone an unprecedented expansion, more than tripling its numbers. Now the rate of growth is slowing down, but the increase in absolute numbers continues to be great. Remarkable changes in technology and substantial improvements in human well-being have accompanied this growth. In just the last 30 years, average income per capita has increased by 37%, infant mortality has been cut in half, and adult illiteracy has dropped by 22%.

There is a downside to this remarkable growth, however. As the Mombasa highway story indicates, extreme poverty is still widespread. An estimated 1.2 billion people live on less than \$1 per day, and the income gap between the richest countries and the poorest ones is enormous and growing. Population growth and increasing affluence have placed great demands on the natural environment and will continue to do so: Ecosystems have been transformed for human uses, resulting in tremendous loss of biodiversity. Resources are being overexploited; forests and fisheries continue to decline, and soils are being

degraded. Finally, the waste products of our economy are polluting the air, land, and water, with grim consequences for the natural world as well as for human well-being.

What are the implications of these trends for sustainability, whereby some things are improving and some are getting worse? There is broad consensus that the only way to begin to eliminate poverty and undergo the transition to a sustainable society is to halt population growth. The focus is especially on the developing world, where 98% of the net world population growth is occurring. This is not an easy task, because the basic decisions on population are made by millions of couples, not by public policy.

However, public policy, health care, and reproductive technology can influence population growth. Indeed, efforts to provide family planning to couples have been mounted in almost every country. In turn, these efforts and other socioeconomic factors have brought about a remarkable decline in reproduction rates during the second half of the 20th century. There is every expectation that population growth rates will continue to decline during the present century.

Your objective in this chapter is to learn about the dynamics of population growth and its social and environmental consequences. A continually growing population is unsustainable, so the focus in this and the next chapter is population stability and what it takes to get there.

5.1 Human Population Expansion and Its Cause

Considering all the thousands of years of human history, the recent rapid expansion of the global human population is a unique event—a phenomenon of just the past 100 years (Fig. 5-1). Let us look more closely at this event and why it occurred.

From the dawn of human history until the beginning of the 1800s, population increased slowly and variably, with periodic setbacks. It was roughly 1830 before world population reached the 1 billion mark. By 1930, however, just 100 years later, the population had doubled to 2 billion. Barely 30 years later, in 1960, it reached 3 billion, and in only 15 more years, by 1975, it had climbed to 4 billion. Thus, the population doubled in just 45 years, from 1930 to 1975. Then, 12 years later, in 1987, it crossed the 5 billion mark! In 1999, world population passed 6 billion, and it is currently growing at the rate of nearly 77 million people per year. This rate is equivalent to adding to the world every year the combined populations of New York, Los Angeles, Chicago, Philadelphia, Detroit, Dallas, Boston, and 10 other U.S. metropolitan areas.

On the basis of current trends (which assume a continued decline in fertility rates), the U.N. Population Division

projects that world population will pass the 7 billion mark in 2013, the 8 billion mark in 2028, and the 9 billion mark in 2052, before population finally levels off at around 10 billion by the end of the 22nd century (Fig. 5-1).

Reasons for the Patterns of Growth

The main reason for the slow and fluctuating population growth prior to the early 1800s was the prevalence of diseases that were often fatal, such as smallpox, diphtheria, measles, and scarlet fever. These diseases hit infants and children particularly hard. It was not uncommon for a woman who had seven or eight live births to have only one or two children reach adulthood. In addition, epidemics of diseases such as the black plague of the 14th century, typhus, and cholera eliminated large numbers of adults. Famines also took their toll periodically.

Prior to the 1800s, therefore, the human population was essentially in a dynamic balance with natural enemies—mainly diseases—and other aspects of environmental resistance. High reproductive rates were largely balanced by high mortality, especially among infants and children. With high birth and death rates, the population growth rate was low in these preindustrial societies.

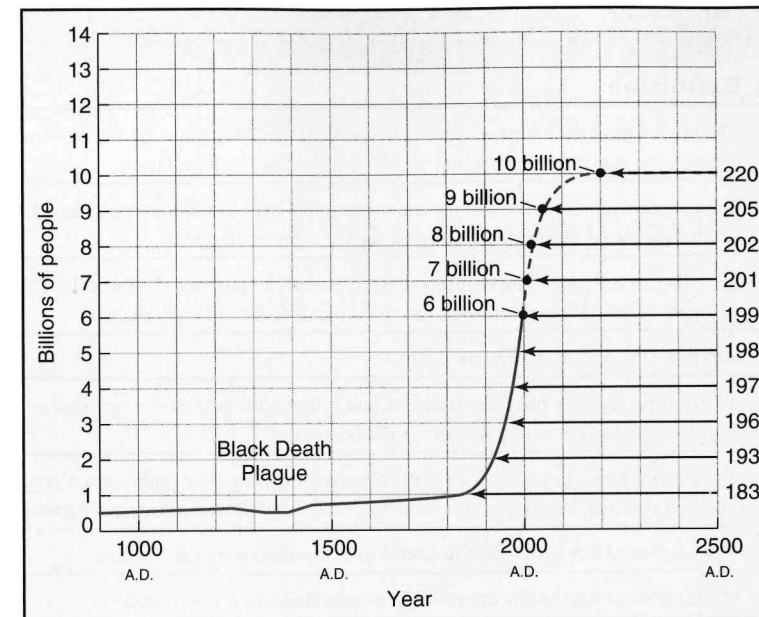


Figure 5-1 World population over the centuries. Population grew slowly for most of human history, but in modern times it has expanded greatly. (Sources: Basic plot from Joseph A. McFalls, Jr., "Population: A Lively Introduction," *Population Bulletin* 46, no. 2 [1991]: 4; updated from UN Population Division, median projection.)

Breakthroughs. In the late 1800s, Louis Pasteur and others discovered that diseases were caused by infectious agents (now identified as various bacteria, viruses, and parasites) and that these organisms were transmitted via water, food, insects, and rodents. Soon vaccinations were developed for the different diseases, and whole populations were immunized against such scourges as smallpox, diphtheria, and typhoid fever. At the same time, cities and towns began treating their sewage and drinking water. Later, in the 1930s, the discovery of penicillin, the first in a long line of antibiotics, resulted in cures for otherwise often-fatal diseases such as pneumonia and blood poisoning. Improvements in nutrition began to be significant as well. In short, better sanitation, medicine, and nutrition brought about spectacular reductions in

mortality, especially among infants and children, while birthrates remained high. From a biological point of view, the human population began growing almost exponentially, as does any natural population once it is freed from natural enemies and other environmental restraints.

Declines. During the 1960s, the world population growth rate peaked at 2.1 percent per year, after having risen steadily for decades. Then it began a steady decline (Fig. 5-2). Twenty years later, the number added per year peaked, at 87 million. The declines are primarily a consequence of the decline in the world total fertility rate—that is, the average number of babies born to a woman over her lifetime. (Table 5-1 gives a list of definitions of technical terms used in this chapter.) In the 1960s the total fertility rate was an average of 5.0 children per

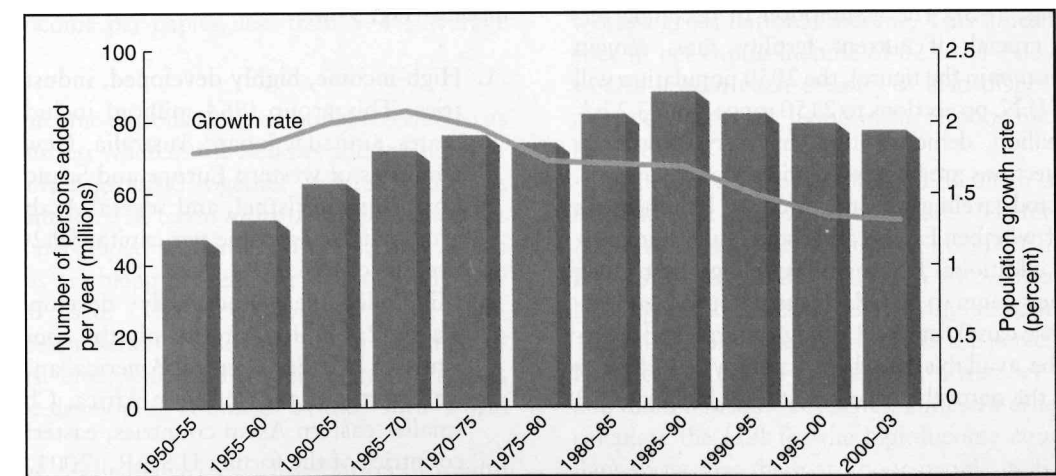


Figure 5-2 World population growth rate and absolute growth. Declining fertility rates in the last three decades have resulted in a decreasing rate of population growth. Absolute numbers, however, are still adding 77 million per year. [Source: Data from Shiro Horiuchi, "World Population Growth Rate," *Population Today* (June 1993): 7 and June/July 1996): 1; updated from U.S. Census Bureau, International Data Base.]

table 5-1 Demographic Terms Used in This Chapter

Term	Definition
Growth Rate (annual rate of increase)	The rate of growth of a population, as a percentage. Multiplied by the existing population, this rate gives the net yearly increase for the population.
Total Fertility Rate	The average number of children each woman has over her lifetime, expressed as a yearly rate based on fertility occurring during a particular year.
Replacement-level Fertility	A fertility rate that will just replace a woman and her partner, theoretically 2.0, but adjusted slightly higher because of mortality and failure to reproduce.
Infant Mortality	Infant deaths per thousand live births.
Population Profile (age structure)	A bar graph plotting numbers of males and females for successive ages in the population, starting with youngest at the bottom.
Population Momentum	The tendency of a population to continue growing even after replacement-level fertility has been reached, due to continued reproduction by already existing age groups.
Crude Birthrate	The number of live births per thousand in a population in a given year.
Crude Death Rate	The number of deaths per thousand in a population in a given year.
Doubling Time	The time it takes for a population increasing at a given growth rate to double in size.
Epidemiologic Transition	The shift from high death rates to low death rates in a population as a result of modern medical and sanitary developments.
Fertility Transition	The decline of birthrates from high levels to low levels in a population.
Demographic Transition	The tendency of a population to shift from high birth and death rates to low birth and death rates as a result of the epidemiologic and fertility transitions. The result is a population that grows very slowly, if at all.

woman: it has since declined to its present value of 2.8 children per woman.

Extrapolating the trend of lower fertility rates leads to the U.N. Population Division's projection that the global human population will reach 8.9 billion by 2050, but will continue to increase, leveling off at around 10 billion well into the 22nd century. This projection is the U.N.'s *medium* scenario; other scenarios are based on different fertility assumptions (Fig. 5-3). The assumption of declining fertility rates is crucial; if current fertility rates remain unchanged (*constant* in the figure), the 2050 population will be 12.8 billion. U.N. projections to 2150 range from 3.2 billion to 24.8 billion, demonstrating that very long-range population projections are largely exercises in mathematics.

The projected leveling off at around 10 billion raises the question of whether Earth can sustain such numbers. Where are the additional billions of people going to live, and how are they going to be fed, clothed, housed, educated, and otherwise cared for? Will enough energy and material resources be available for them to enjoy a satisfying life? What will the natural environment look like by then?

5.2 Different Worlds

To begin to answer these questions, you must first understand the tremendous disparities among nations. In fact, people in wealthy and poor countries live almost in

separate worlds, isolated by radically different economic and demographic conditions.

Rich Nations, Poor Nations

The World Bank, an arm of the United Nations, divides the countries of the world into three main economic categories, according to average per capita gross national income (Fig. 5-4):

- 1. High-income, highly developed, industrialized countries.** This group (964 million) includes the United States, Canada, Japan, Australia, New Zealand, the countries of western Europe and Scandinavia, Singapore, Taiwan, Israel, and several Arab states. (2001 gross national income per capita, \$9,206 and above; average of \$26,710.)
- 2. Middle-income, moderately developed countries.** These (2.7 billion) are mainly the countries of Latin America (Mexico, Central America, and South America), northern and southern Africa, China and some smaller eastern Asian countries, eastern Europe, and countries of the former U.S.S.R. (2001 gross national income per capita ranges from \$745 to \$9,205; average of \$1,850.)
- 3. Low-income, developing countries.** This group (2.65 billion) comprises the countries of eastern, western, and central Africa, India and other countries of central

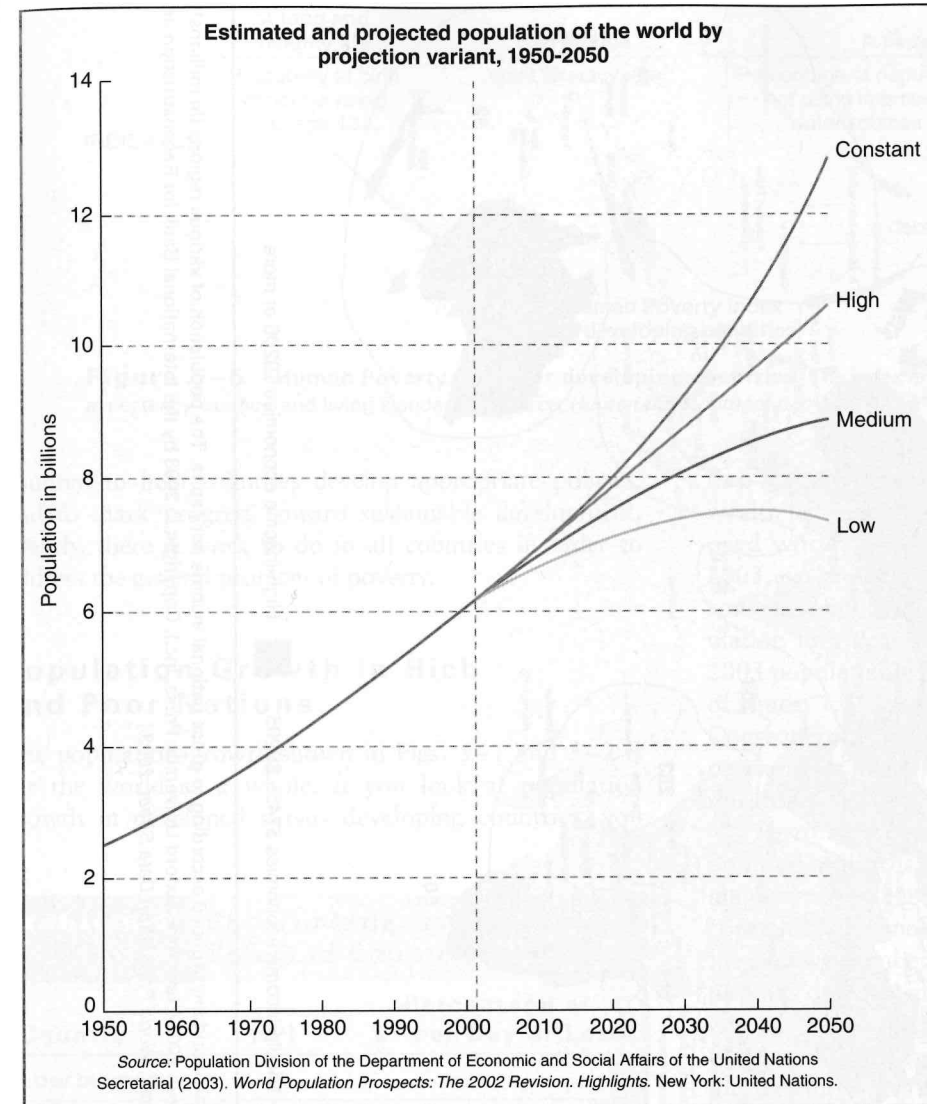


Figure 5-3 United Nations population projections. The most recent population projections demonstrate the vital role played by different fertility assumptions. [Source: United Nations Population Division, 2002 revision.]

Asia, and a few former Soviet republics. (2001 gross national income per capita, less than \$745; average of \$430.)

The high-income nations are commonly referred to as **developed countries**, whereas the middle- and low-income countries are often grouped together and referred to as **developing countries**. The terms *more developed countries* (MDCs), *less developed countries* (LDCs), and *Third World countries* are being phased out, although you may still hear them used. (The First World was the high-income countries, whereas the Second World was the former Communist bloc, which no longer exists. Therefore, referring to the developing countries as the Third World is obsolete.)

Disparities. The disparity in distribution of wealth among the countries of the world is mind boggling. The highly developed countries make up just 16% of the world's population, yet they control about 81% of the world's wealth, calculated on the basis of gross national income. The low-income developing countries, with 41%

of the world's population, control only 3.4% of the world's gross national income. This amounts to a difference in per capita income of 62 to 1! The distribution of wealth *within* each country is also disproportionate, so the poorest people living in these poor nations are really badly off.

The disparity of wealth is difficult to understand just by looking at general income figures. Therefore, the United Nations Development Program (UNDP) has devised the Human Poverty Index (HPI), based on information about life expectancy, literacy, and living standards (Fig. 5-5). Table 5-2 compares the HPI with the percentage of people living on \$1 per day or less, for a number of low-income and middle-income countries. Different criteria are used to calculate the HPI for the high-income countries, and the data show that there are poor people in every country in the world. In fact, between 10% and 15% of the people in developed countries are poor (unable to afford adequate food, shelter, or clothing), compared with about 45% of those in developing countries. These data have been used to focus attention on the most deprived people in a

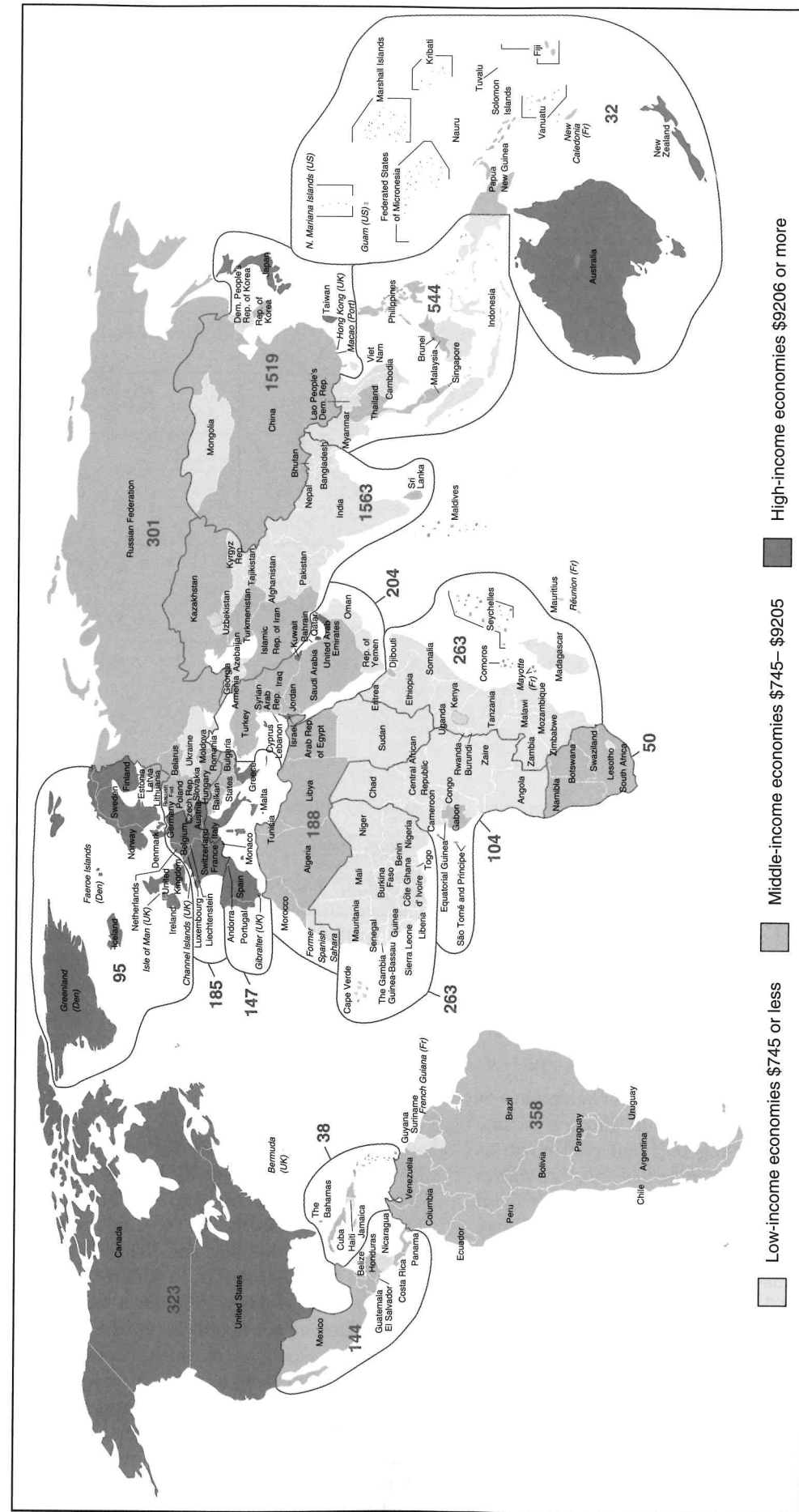


Figure 5-4 Major economic divisions of the world. Nations of the world are grouped according to gross national income per capita. The population of various regions (in millions) is also shown by magenta lines and numbers. [Sources: *World Development Report, 2003* (New York: Oxford University Press, Inc.), Copyright © 2003 by the International Bank for Reconstruction and Development/The World Bank. Populations from the Population Reference Bureau, *World Population Data Sheet, 2003*.]

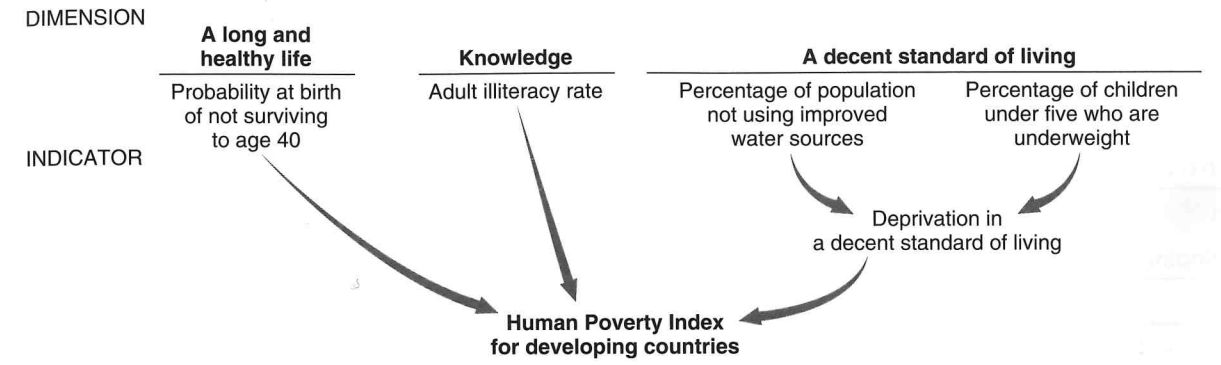


Figure 5-5 Human Poverty Index for developing countries. The index is based on information about life expectancy, literacy, and living standards. (Source: *Human Development Report 2002*, U.N. Development Program.)

country, to help countries develop appropriate policies, and to mark progress toward sustainable development. Clearly, there is work to do in all countries in order to address the general problem of poverty.

Population Growth in Rich and Poor Nations

The population growth shown in Figs. 5-1 and 5-2 is for the world as a whole. If you look at population growth in developed versus developing countries, you

find a discrepancy that parallels the great difference in wealth between these two groups of countries. The developed world, with a population of 965 million in mid-2003, is growing at a rate of 0.1% per year. These countries will add less than 1 million to the world's population in a year. The remaining countries, whose mid-2003 population was 5.35 billion, are increasing at a rate of almost 1.6% per year, adding over 76 million in a year. Consequently, *over 98% of world population growth is occurring in the developing countries.* What's lies behind this discrepancy?

Fertility. Population growth occurs when births outnumber deaths. In the absence of high *mortality*, the major determining factor for population growth is births, conventionally measured using the *total fertility rate*—the average number of children each woman in a population has over her lifetime. A total fertility rate of 2.0 will give a stable population, because two children per woman will just replace a couple when they eventually die. Fertility rates greater than 2.0 will give a growing population, because each generation is replaced by a larger one, and, barring immigration, a total fertility rate less than 2.0 will lead to a declining population, because each generation will eventually be replaced by a smaller one. Given that infant and childhood mortality are not in fact zero, and that some women do not reproduce, **replacement-level fertility**—the fertility rate that will just replace the population of parents—is 2.1 for developed countries and higher for developing countries, which have higher infant and childhood mortality.

Total fertility rates in developed countries have declined over the past several decades to the point where they now average 1.5. The one major exception is the United States, with a total fertility rate of 2.0 in 2003. In developing countries, fertility rates have come down considerably in recent years, but they still average 3.1. Some rates are as high as 5 or more, however, which will cause the populations of those countries to double in just 20 to 40 years (Table 5-3). Thus, the populations of developing countries, half of which are the poor (low-income) countries, will continue growing, while the populations of developed countries will stabilize or even decline. As a consequence, the percentage of the world's population living in developing

table 5-2 Poverty Indexes for Selected Countries		
Country	HPI	Percentage at \$1 per Day or Less
Low Income		
Pakistan	41	31
Bangladesh	42	29
Nigeria	35	70
Mali	47	73
Ethiopia	57	31
Gambia	49	59
Yemen	42	16
India	33	44
Middle Income		
Algeria	23	<2
Guatemala	24	10
Mexico	9.4	16
Brazil	12	12
Turkey	13	2.4
China	15	19
Costa Rica	4.0	13

table 5-3 Population Data for Selected Countries

Country	Total Fertility Rate	Doubling Time of Population (Years)
World	2.8	54
Developing Countries		
Average	3.1	44
(excluding China)	3.5	37
Egypt	3.5	33
Kenya	4.4	35
Madagascar	5.8	23
India	3.1	41
Iraq	5.4	28
Vietnam	2.3	54
Haiti	4.7	39
Brazil	2.2	54
Mexico	2.8	29
Developed Countries		
Average	1.5	700
United States	2.0	117
Canada	1.5	233
Japan	1.3	700
Denmark	1.7	700
Germany	1.3	—
Italy	1.2	—
Spain	1.2	700

Note: Dash indicates doubling time cannot be calculated, because growth is negative.

Source: Data from 2003 World Population Data Sheet (Washington, DC: Population Reference Bureau, 2003).

countries—already 84%—is expected to climb steadily to over 90% by 2075 (Fig. 5-6). Nevertheless, it is not just the developing countries that have problems.

Different Populations, Different Problems

Some time ago, ecologists Paul Ehrlich and John Holdren proposed a formula to account for the human factors that contribute to environmental pollution and the depletion of resources. They reasoned that human pressure on the environment was the outcome of three factors: *population*, *affluence*, and *technology*. They offered the following formula:

$$I = P \times A \times T.$$

According to this equation, called the *IPAT formula*, environmental impact (*I*) is proportional to population (*P*), multiplied by the affluence of the average lifestyle (*A*), and multiplied by the level of technology of the society (*T*). Although the equation is a simplification, there is broad agreement that these three factors play the major role in putting pressure on the environment. Given the high level of technology in the industrialized countries, and the affluent lifestyle that accompanies it, a fairly small population can have a very large impact on the environment. As a result, it is hypocritical to criticize developing countries for continuing to grow their populations. Those who live in wealthy, but population-stable, developed countries are equally guilty of environmental misuse.

Big Footprints. For example, it is estimated that, because of differences in consumption, the average American places at least 20 times the demand on Earth's resources, including its ability to absorb pollutants, as does the average person in Bangladesh, a poor Asian country. Major world pollution problems, including the depletion of the ozone layer, the impacts of global climate change, and the accumulation of toxic wastes in the environment, are largely the consequence of the high consumption associated with affluent lifestyles in the developed countries. For instance, the United States, with only 5% of the world's population, is currently responsible for over 24% of the total global emissions of carbon dioxide, the major greenhouse gas. Likewise, much of the global deforestation and loss of biodiversity is due to consumer demands in developed countries. When it comes to the ecological footprint, ours in the developed world is extremely large and heavy (Fig. 5-7).

The developing countries do have a population problem, and it is making their progress toward sustainable development that much more difficult. Their people are plagued by all of the consequences of poverty. They are often hungry, poorly educated, out of work, sickened by common diseases, and vulnerable to natural hazards such as droughts, floods, and forest fires. They may look with hope to the future, but often that hope is crushed by decades of grinding poverty. Their needs are great: economic growth, more employment, wise leaders, effective public policies, fair treatment by other nations, and, especially, technological and financial help from the wealthy nations. Much of this is a matter of justice, one of the key components of stewardly care.

Enter Stewardship. Despite a fairly stable population, the developed countries have an equally daunting problem, but one having to do with consumption, affluence, damaging technologies, and burgeoning wastes. These issues must be addressed to achieve sustainability, and this, too, requires wise leaders and effective public policies. Fortunately, the environmental impacts of affluent lifestyles may be moderated to a large extent by practicing environmental stewardship. For example, suitable attention to wildlife conservation, pollution control, energy conservation and efficiency, and recycling

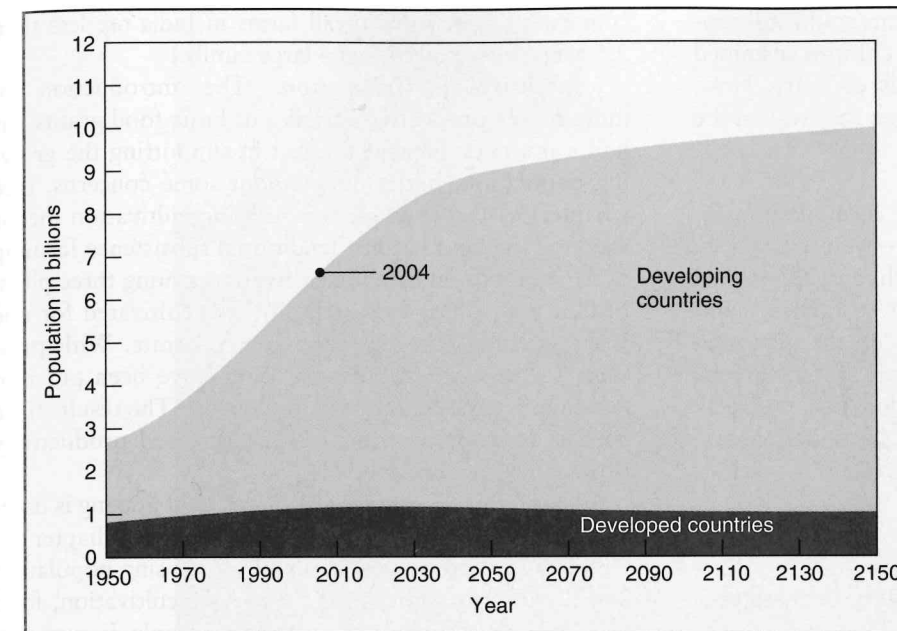


Figure 5-6 Population increase in developed and developing countries. Because of higher populations and higher birthrates, developing countries represent a larger and larger share of the world's population.

may offset, to some extent, the negative impact of a consumer lifestyle. In fact, a life devoted to conservation or other aspects of environmental stewardship might entirely offset the negatives and have a highly positive effect overall. As a result, the IPAT formula might be modified to

$$I = \frac{P \times A \times T}{S},$$

where *S* stands for stewardly concern and practice.

Some people argue that population growth is the main problem, others claim that our highly consumption-oriented lifestyle is chiefly to blame, and still others maintain that it is our inattention to stewardship that is the prime shortcoming. In order to reach sustainability, however, all *three* areas must be addressed. That is, the population must stabilize, consumption must decrease, and stewardly action must increase. The next section focuses on the factors and consequences of population growth, principally in developing countries.

5.3 Consequences of Population Growth and Affluence

Expanding populations and increasing affluence—it sounds like trouble for the environment, and it is. It also means trouble for people, particularly in the developing countries.

The Developing Countries

Prior to the Industrial Revolution, most of the human population survived through subsistence agriculture. That is, families lived on the land and produced enough food for their own consumption and perhaps some extra to barter for other essentials. Natural forests provided firewood, structural materials for housing, and wild game for meat. With a small, stable population, this system was basically sustainable. As the older generation

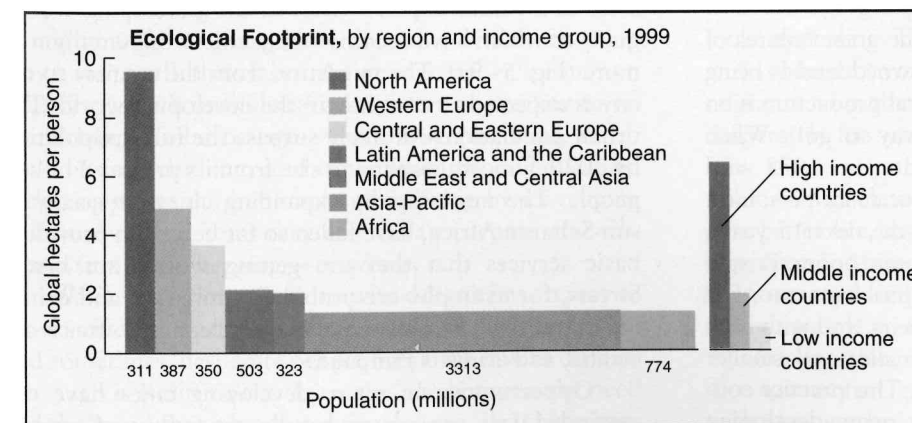


Figure 5-7 Ecological footprints of world regions. The footprint of developed countries is compared with that of developing regions. Populations are shown on the horizontal axis. (Source: *Living Planet Report 2002*, World Wide Fund for Nature.)

passed away, the land and natural systems could still support the next generation. Indeed, many cultures sustained themselves in this way over thousands of years. Now, however, except for a few primitive tribes, that way of life is history.

Rural Populations. After World War II, modern medicines—chiefly vaccines and antibiotics—were introduced into developing nations, whereupon death rates plummeted and populations grew rapidly. Today, 60% of the developing world—over 2.5 billion people—is directly engaged in agriculture, most at the subsistence level. What are the impacts of rapid growth on a population that is largely engaged in subsistence agriculture? Six basic options are possible, all of which are being played out to various degrees by people in these societies:

1. Reform the system of land ownership.
2. Intensify cultivation of existing land to increase production per unit area.
3. Open up new land to farm.
4. Move to cities and seek employment.
5. Engage in illicit activities for income.
6. Emigrate to other countries, either legally or illegally.

In addition, rapid population growth especially affects women and children. Let us look at each of the options and their consequences in a little more detail.

Land Reform. Rising population growth in rural developing countries has put increasing pressure on the need to reform the system of land ownership. Collectivization and ownership by the wealthy few are two patterns of agricultural land ownership that have historically kept rural peoples in poverty. Collectivization emerged from 20th century communism, and ownership by the wealthy few was the result of colonialism in the 19th and 20th centuries. South Africa, recently emerging from its apartheid past, demonstrates the kind of inequities perpetuated by colonialism. Whites still own 87% of the land, and the average landholding of whites is 3,800 acres, as opposed to 2½ acres for blacks. Resolving these kinds of inequities can disrupt the social order, as events in Zimbabwe have shown. In that country, a chaotic land reform program has virtually destroyed the country's agricultural economy.

Collective agriculture was one of the great failures of the former Soviet Union. Today, state-owned land is being privatized, with the result that agricultural production is on the rise (although it still has a long way to go!). When China abandoned collective agriculture in 1978 and assigned most agricultural land to small-scale farmers, farm output grew more than 6% a year for the next 15 years, paving the way for China's recent economic boom. Private ownership, however, can have its own problems, too. For example, plots are often subdivided to heirs, and with each succeeding generation, the plots get smaller and smaller until they are too small to feed a family. This practice continues to be an enormous problem in many developing

countries. (Three-fifths of all farms in India are less than 2.5 acres, too small to feed a large family.)

Intensifying Cultivation. The introduction of more highly productive varieties of basic food grains has had a dramatic beneficial effect in supporting the growing population, but is not without some concerns. (See Chapter 9.) For example, intensifying cultivation means working the land harder. Traditional subsistence farming in Africa involved rotating cultivation among three plots. In that way, the soil in each plot was cultivated for one year and then had two years to regenerate. With pressures to increase productivity, plots have been put into continuous production with no time off. The results have been a deterioration of the soil, decreased productivity (ironically), and erosion.

In addition, the increasing intensity of grazing is damaging the land, causing desertification. (See Chapter 8.) Given the countertrends of rapidly increasing population and the deterioration of land from overcultivation, food production per capita in Africa, for example, is currently decreasing.

Opening Up New Lands for Agriculture. Opening up new lands for agriculture may sound like a good idea, but there is really no such thing as “new land,” and most good agricultural land is already in production. Opening up new land always means converting natural ecosystems to agricultural production, which means losing the goods and services those ecosystems were contributing. Even then, converted land is often not well suited for agriculture, unless it is irrigated. Irrigation, in turn, is costly and has its own environmental problems. Most of the tropical deforestation in South and Central America has occurred in order to increase agricultural production (Fig. 5–8). Much of this deforestation is done by poor, young people who are seeking an opportunity to get ahead, but are unskilled and untrained in the unique requirements of maintaining tropical soils. In a short time, the cleared land becomes unproductive for agriculture, leaving the people again in poverty. It is then taken over by large livestock companies.

Migration to Cities. Faced with the poverty and hardship of the countryside, many hundreds of millions of people in developing nations continue to migrate to cities in search of employment and a better life. By 2000, there were 292 “million-plus” cities in the developing world, many of which have become “megacities” of 10 million or more (Fig. 5–9a). The migration from the country to the city is expected to continue in the developing world. The urban population will likely surpass the rural population by 2020, almost doubling in size from its present 2 billion people. The most rapidly expanding cities, especially in sub-Saharan Africa, have fallen so far behind in providing basic services that they are getting worse, not better. Streets, for example, are potholed, sanitation and drinking water are poor, electricity and telephone service are erratic, and crime is rampant.

Opportunities in many developing cities have not expanded fast enough to handle the influx of people.



Figure 5–8 Deforestation in the tropics. Millions of acres of rain forest in Central and South America are being cut down each year to make room for agriculture, as shown in this photograph from Peru.

Many are forced to live in sprawling, wretched shantytowns and slums that do not even provide adequate water and sewers, much less other services (Fig. 5–9b). Diseases like malaria and malnutrition are endemic, and the incidence of HIV/AIDS is much higher in the cities than in the countryside, a consequence of much higher numbers of single men seeking work and also seeking the “services” of prostitutes or multiple sex partners—both of which are high risk factors for the spread of HIV/AIDS.

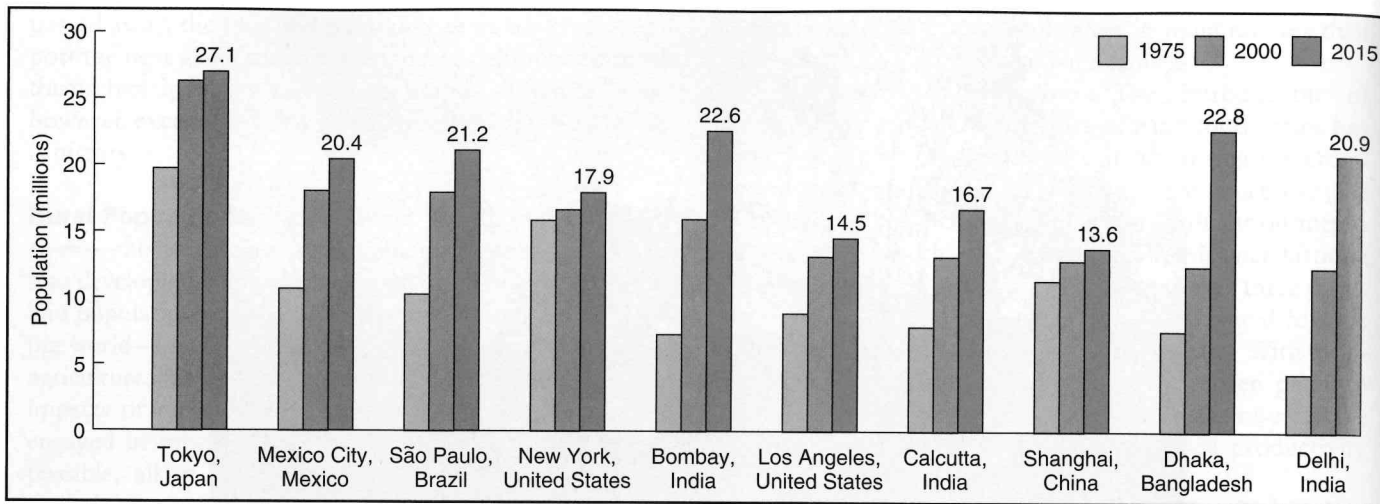
Worse, these cities often do not even provide the jobs people are looking for. Indeed, the high numbers of rural immigrants in the cities dilute the value of the one thing they have to sell: their labor. As we saw earlier, a common wage for a day's unskilled work is often equivalent to no more than a dollar or two—not enough for food, much less housing, clothing, and other amenities. Thousands, including many children, make their living by scavenging in dumps to find items they can salvage, repair, and sell. Many survive by begging—or worse.

Illicit Activities. Anyone who doesn't have a way to grow sufficient food must gain enough income to buy it—and sometimes, desperate people break the law to do this. Although it is difficult to draw the line between the need and the greed that also draws people into illicit activities,

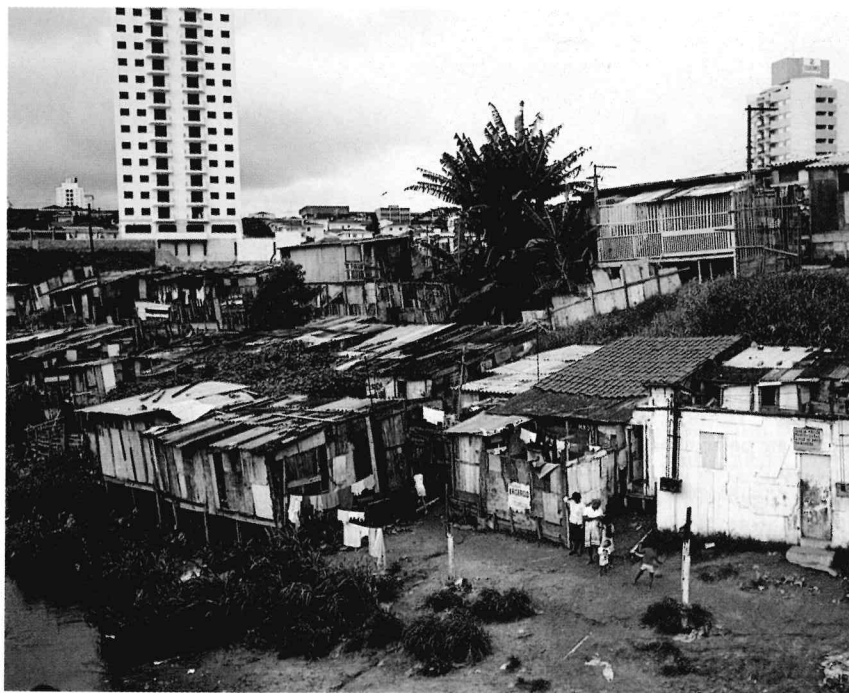
it is undeniable that the shortage of adequate employment exacerbates the problem. Besides the rampant petty thievery and corruption that pervade many developing countries, income is also obtained from illegal activities such as raising drug-related crops and poaching wildlife.

Emigration and Immigration. The gap between high- and low-income countries is reflected in the perception of many in the poorer countries who believe they can improve their well-being by migrating to a wealthier country. The fact that populations in the wealthy countries are aging suggests a strategy that, on the surface, looks appealing. That is, the wealthy countries need more and younger workers, so they should welcome the migrants from the low-income countries who are looking desperately for work. To some extent, and in some countries, this is exactly what is happening: Each year, many millions migrate to the United States and Europe in search of a better life, a shift that has been called “replacement migration.” More millions migrate to neighboring countries to escape civil wars and ethnic persecution. Some 150 million people now live outside of their countries of birth.

Immigration, however, has its problems, too. Prejudice against foreigners is common, especially in countries with strong ethnic and cultural homogeneity, like Japan



(a)



(b)

Figure 5-9A Growing cities. (a) The top 10 world metropolitan areas. Since 1975, cities in the developing world have grown phenomenally, and a number of them are now among the world's largest. (b) Slums on the outskirts of São Paulo, Brazil. Thirty-two percent of the city's population lives in these blighted areas. [Source: Data for part (a) from *World Urbanization Prospects: The 2001 Revision*. U.N. Population Division.]

and Germany. Even though the United States is a nation largely built on immigration, opposition to foreigners has intensified since the September 11, 2001, terrorist attacks. Nor have European countries welcomed immigrants: Although Western Europe's population is 42% larger than that of the United States, its immigration is only about half that of ours. (See the Ethics essay, "The Dilemma of Immigration," p. 135).

Refugee immigration leads to temporary refugee camps, where diseases and hunger often take a terrible toll on human life. Some "migrants" are little more than slaves. Recruiters from plantations in the Ivory Coast pay parents

in neighboring Burkina Faso and Mali to send their children to work on the plantations, where they are kept under guard, sometimes for years.

Impoverished Women and Children. The hardships and deprivation of poverty fall most heavily on women and children. Men are freer to roam and pick up whatever work is available, and they may keep their wages for themselves. Some men take no responsibility at all for the women they impregnate, much less the children they sire. Even many married men, under the stress of poverty, abandon wives and children. Few developing countries

ethics

The Dilemma of Immigration

For people trapped by poverty or lack of opportunity in their homeland, emigration to another country has always seemed a way to achieve a better life. As the New World opened up, many millions of people recognized this dream by emigrating to the United States and other countries. The United States and Canada are countries composed largely of immigrants and their descendants. Until 1875, all immigration into the United States was legal, so all who could manage to arrive could stay and become citizens. This openness was inscribed on the Statue of Liberty. The inscription reads, in part, "Give me your tired, your poor, your huddled masses yearning to breathe free, the wretched refuse of your teeming shore. . . . Send these, the homeless, tempest-tossed to me."

History

Emigration from the Old World created a flood of migrants immigrating to the New World. This emigration relieved population pressures in European countries and aided in the development of the New World. A totally open policy toward immigration today, however, would be untenable. The United States, with its current population of 292 million, is no longer a vast, open land awaiting development. Still, hundreds of millions of people would immigrate if they could. How much immigration should be permitted, and should some groups be favored over others? In 1882, for example, the U.S. Congress passed the Chinese Exclusion Act, which barred the immigration of Chinese laborers, but not Chinese teachers, diplomats, students, merchants, or tourists. This act remained in effect until 1943, when China and the United States became allies in World War II. However, the current immigration policy still makes it easier for trained people to gain citizenship and relatively difficult for untrained people to do so. This policy has created what is commonly referred to as a "brain drain." Brainpower, many point out, is the "export" that developing nations can least afford.

Now

Current immigration laws officially admit almost 900,000 new immigrants per year, a number larger than we have received at any time since the 1920s and larger than is accepted by all other countries combined. At present, immigration accounts for about 40% of U.S. population growth, which translates into 2.7 million people per year. The remainder of the population growth, called the natural increase, is the excess of the number of births over the number of deaths. If the fertility rate remains low, immigration will account for a growing proportion of our population growth. If the children born to new immigrants are added up (immigrants often have large families), immigration accounted for two-thirds of the growth of the American population in the 1990s.

Illegal Immigration

The preceding discussion addresses only legal immigration. Illegal immigration is another matter. Hundreds of thousands, unable to gain access through legal channels, seek ways to enter the country illegally. The United States maintains an active border patrol, especially along the border with Mexico, which several thousand people try to cross each night. Most are caught and returned, but an undetermined number—estimated at 200,000 to 300,000 per year—slip through. The Illegal Immigration Reform Act of 1996 addressed this problem by strengthening the border patrol and stepping up efforts to locate and deport illegal aliens—actions that are supported by most observers. However, there are currently far more illegal agricultural workers than legal "guest workers"; the number of illegal farm workers is estimated at 650,000. Employers often prefer the illegal workers, because they work for lower wages and place fewer demands on employer services.

September 11, 2001

The terrible events of September 11, 2001, have had their impact on immigration into the United States and on border

issues, because some of the terrorists had entered from Canada and their visas revealed many irregularities. Prospective tourists or students now seeking U.S. visas are far more thoroughly screened, especially if they originate from Middle Eastern countries. Also, border security has been tightened at the many entry points from Canada and Mexico, and it has become more difficult to enter the country illegally.

A recent report by the National Research Council examined the economic impacts of our immigration policies and concluded that legal immigration basically benefits the U.S. economy and has little negative impact on native-born Americans. A few areas of the country where immigrants are especially numerous (for example, California, Texas, and Florida) experience some challenges in assimilating new immigrants, but the overall impact is positive, according to the Council.

Immigration Reform

In 1990, Congress established the U.S. Commission on Immigration Reform and directed it to submit a report at the end of 1997. The Commission report recommended cutting back immigration to a core level of 550,000 per year and allowing 150,000 additional visas annually for spouses and minor children of legal permanent residents. (Currently, spouses and minor children of legal residents make up the largest component of immigration, 580,000 per year.) This policy is to be phased out when the existing backlog is eliminated—judged to take up to eight years. Interestingly, the Commission recommended discontinuing the immigration of unskilled laborers, while continuing to welcome more highly skilled immigrants (albeit under quotas). The Commission has now disbanded, and it is up to Congress to take up the report and act on it—or not to do so. (To date, it has *not*.) The commission's recommendations, if adopted, will result in only a small reduction in the current rate of legal immigration. Neither political party in the United States seems willing

to take on this issue; in fact, both parties constantly seek the votes of immigrant communities. It appears that immigration will continue to be a large and increasing part of growth in the United States well into the future.

As population pressures in developing countries continue to mount, the questions of how many immigrants to accept, from what countries, and where to draw the line regarding asylum seem certain to become more and more

pressing. In addition to compassion, the social, economic, and environmental consequences—both national and global—of the alternatives must be weighed in making the final decision. Where do you stand?

have a welfare system that will provide care in such situations. Too often, the women cannot cope, so their children are abandoned, and the women turn to begging, stealing, or prostitution.

Street Children. What happens to the children of these women? If they survive at all, it is by begging, scrounging through garbage, stealing, and finding shelter in any hole or crevice they can find (Fig. 5-10). The problem is so great that nearly every sizable city in the developing world has thousands of these “street children”—on the order of 25 million in all by some estimates—and their numbers are growing. Forced child labor, child prostitution, and the sale of children for adoption are all too common in developing countries. One can only speculate as to the kinds of adults such children become—if they survive. At the very least, all of these factors tend to lock impoverished women and children into the vicious cycle of illiteracy and squalid conditions that defines and perpetuates absolute poverty.

A summary of the consequences of rapid population growth in developing countries is given in Fig. 5-11. Population growth, poverty, and environmental degradation are not separate issues, but are, to the contrary, very much interrelated.

Affluence

The United States has the dubious distinction of leading the world in the consumption of many resources. We are a large country and we are affluent. We consume the largest share of 11 of 20 major commodities: aluminum,

coffee, copper, corn, lead, oil, oilseeds, natural gas, rubber, tin, and zinc. We lead in per capita consumption of many other items, such as meat. The average American eats more than three times the global average of meat. We lead the world in paper consumption, too, at 725 lb per person per year. All of these factors (and many more like them) contribute to the enormous ecological footprint each of us makes on the world.

Despite the adverse effects of affluence, increasing the average wealth of a population can affect the environment positively. An affluent country like ours provides such amenities as safe drinking water, sanitary sewage systems and sewage treatment, and the collection and disposal of refuse. Thus, many forms of pollution are held in check, and the environment improves with increasing affluence. In addition, if we can afford gas and electricity, we are not destroying our parks and woodlands for firewood. In short, we can afford conservation and management, better agricultural practices, and pollution control, thereby improving our environment.

The Dark Side. Still, because the United States consumes so many resources, we also lead the world in the production of many pollutants. For example, by using such large quantities of fossil fuel (coal, oil, and natural gas) to drive our cars, heat and cool our homes, and generate electricity, the United States is responsible for a large share of the carbon dioxide produced. As mentioned, with about 5% of the world's population, the United States generates 24% of the emissions of carbon dioxide that may be changing global climate. Similarly, emissions of chlorofluorocarbons (CFCs) that have degraded the ozone layer,

Figure 5-10 Foraging in trash. In cities of the developing world, many poor people, including mothers and children, subsist only by scrounging through refuse for bits of food and items they can resell.

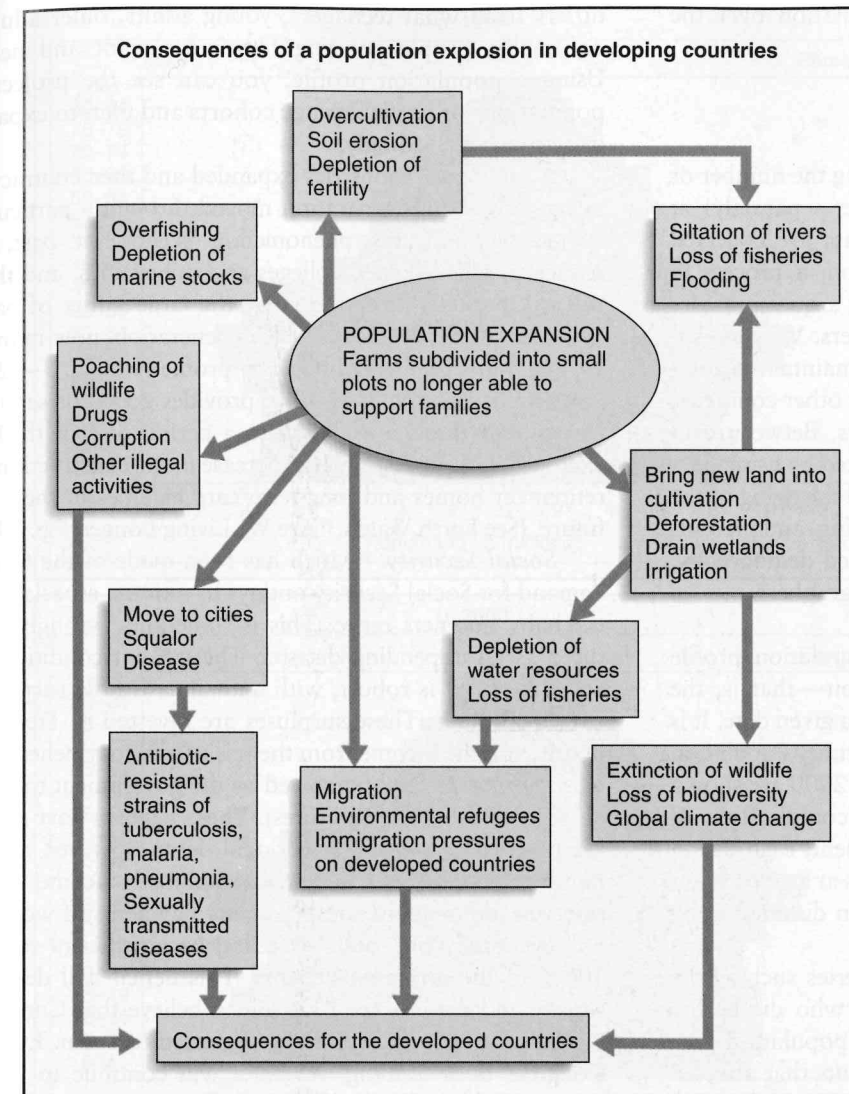


Figure 5-11 Consequences of expanding populations in the developing world. The diagram shows the numerous connections between unchecked population growth and social and environmental problems.

emissions of chemicals that cause acid rain, emissions of hazardous chemicals, and the production of nuclear wastes are all largely the by-products of affluent societies.

Economic factors place further demands on the environment and the developing world. The world's wealthy 20% is responsible for 86% of all private consumption and 80% of world trade. As a consequence, 11 of the 15 major world fisheries are either fully exploited or over-exploited, and old-growth forests in southern South America are being clear-cut and turned into chips to make fax paper. Oil spills are a “by-product” of our appetite for energy. Tropical forests are harvested to satisfy the desires of the affluent for exotic wood furnishings. Metals are mined, timber harvested, commodities grown, and oil extracted, all far from the industrialized countries where these goods are used. Every one of these activities has a significant environmental impact. As increasing numbers of people strive for and achieve greater affluence, it seems more than likely that such pressures, and other ones like them, will mount.

Out of Touch. One way of generalizing the effect of affluence is to say that it enables the wealthy to clean

up their immediate environment by transferring their wastes to more distant locations. It also allows them to obtain resources from more distant locations, so they neither see nor feel the impacts of getting those resources. In many respects, therefore, the affluent isolate themselves and may become totally unaware of the environmental stresses they cause with their consumption-oriented lifestyles. Still, affluence also provides people with opportunities to exercise lifestyle choices that are consistent with the concerns for stewardship and sustainability.

With this picture of population growth and its impacts in view, the next section discusses some additional dimensions of the problem, in order to provide a more thorough understanding of the issues.

5.4 Dynamics of Population Growth

In studying population growth, you must consider more than just the increase in numbers, which is simply births minus deaths. You must also consider how the number of

births ultimately affects the entire population over the longevity, or lifetimes, of the individuals.

Population Profiles

A **population profile** is a bar graph showing the number or proportion of people (males and females separately) at each age for a given population. The data are collected through a census of the entire population, a process in which each household is asked to fill out a questionnaire concerning the status of each of its members. Various estimates are made for those who do not maintain regular households. In the United States and most other countries, a detailed census is taken every 10 years. Between censuses, the population profile may be adjusted by using data regarding births, deaths, immigration, and the aging of the population. The field of collecting, compiling, and presenting information about populations is called **demography**; the people engaged in this work are **demographers**.

Profile for the United States. A population profile shows the **age structure** of the population—that is, the proportion of people in each age group at a given date. It is a snapshot of the population at a given time. Population profiles of the United States for 1990 and 2000 are shown in Figs. 5-12a and b. Leaving out the complication of emigration and immigration for the moment, each bar in the profile started out as a *cohort* of babies at a given point in the past, and that cohort has only been diminished by deaths as it has aged.

Boom or Bust? In developed countries such as the United States, the proportion of people who die before age 60 is relatively small. Therefore, the population profile below age 60 is an “echo” of past events that affected birthrates. Figure 5-12a shows, for example, that smaller numbers of people were born between 1931 and 1935 (ages 55-59 in 1990). This is a reflection of lower birthrates during the Great Depression. The dramatic increase in people born in 1946 and for 14 years thereafter (ages 30-44 in 1990) is a reflection of returning veterans and others starting families and choosing to have relatively large numbers of children following World War II—the “baby boom.” The general drop in numbers of people born from 1961 to 1976 (ages 10-29 in 1990) is a reflection of sharply declining fertility rates, with people choosing to have significantly fewer children—the “baby bust.” The rise in numbers of people born in more recent years (ages 0-9 in 1990) is termed the “baby boom echo” and is due to the large baby-boom generation producing a similarly large number of children, even though the actual total fertility rate remained near 2.0. These changes in fertility are shown in Figure 5-13.

Planning Tool. More than a view of the past, a population profile provides governments and businesses with a means of realistic planning for future demand for various goods and services, ranging from elementary schools to retirement homes. Consumer demands are largely age specific; that is, what children need and want

differs from what teenagers, young adults, older adults, or, finally, people entering retirement want and need. Using a population profile, you can see the projected populations of particular age cohorts and plan to expand or retrench accordingly.

A number of industries expanded and then contracted as the baby-boom generation moved through a particular age range, and this phenomenon is not yet past. In sequence, schools, then colleges and universities, and then the job market were affected by the large influx of baby boomers. As the large baby-boom generation, now in middle age, moves up the population profile (see Fig. 5-12b), any business or profession that provides goods or services to seniors is looking forward to a period of growth. For example, look for a dramatic increase in the construction of retirement homes and long-term-care facilities in the near future. (See Earth Watch, “Are We Living Longer?” p. 140.)

Social Security. Much has been made of the future demand for Social Security outlays to retirees, especially as the baby boomers retire. This is sometimes wrongly pictured as an impending disaster. The current condition of Social Security is robust, with annual cash flow surpluses of \$150 billion. These surpluses are invested in Treasury bonds, and the income from them is used to pay benefits to existing retirees (and borrowed by the government to fund all sorts of other expenditures). These benefits have nothing to do with our rising national debt. However, as the number of retirees rises, the combined income from reserves and ongoing Social Security payments of workers will eventually (in about 40 years) be insufficient to pay 100% of the promised benefits. This deficit will develop slowly, and there is every reason to believe that Congress will address it long before it is expected to occur. Even if Congress does nothing, revenues will continue to cover approximately 73% of benefits.

Future Populations

Current population growth in a country is calculated from three vital statistics: births, deaths, and migration. For instance, the population of the United States grew by nearly 2.7 million people during the year following July 1, 2000. This growth was the result of 4.05 million births, 2.43 million deaths, and a net migration of 1.1 million. Thus, about 40% of the population increase was due to immigration and 60% to natural increase.

Predictions. Demographers used to make population *forecasts*. Most often, they took current birth and death rates, factored in expected immigration, and then extrapolated the data into the future. They were virtually always wrong. For example, in 1964, the total fertility rate (TFR) in the United States was around 3.0. The U.S. Census Bureau forecast that the TFR would range between 2.5 and 3.5 up to 2000 and projected a 2000 population of 362 million under the higher fertility assumption—81 million more than the actual number. The agency totally missed the baby bust of the late sixties and seventies, although the trend in 1964 was definitely downward.

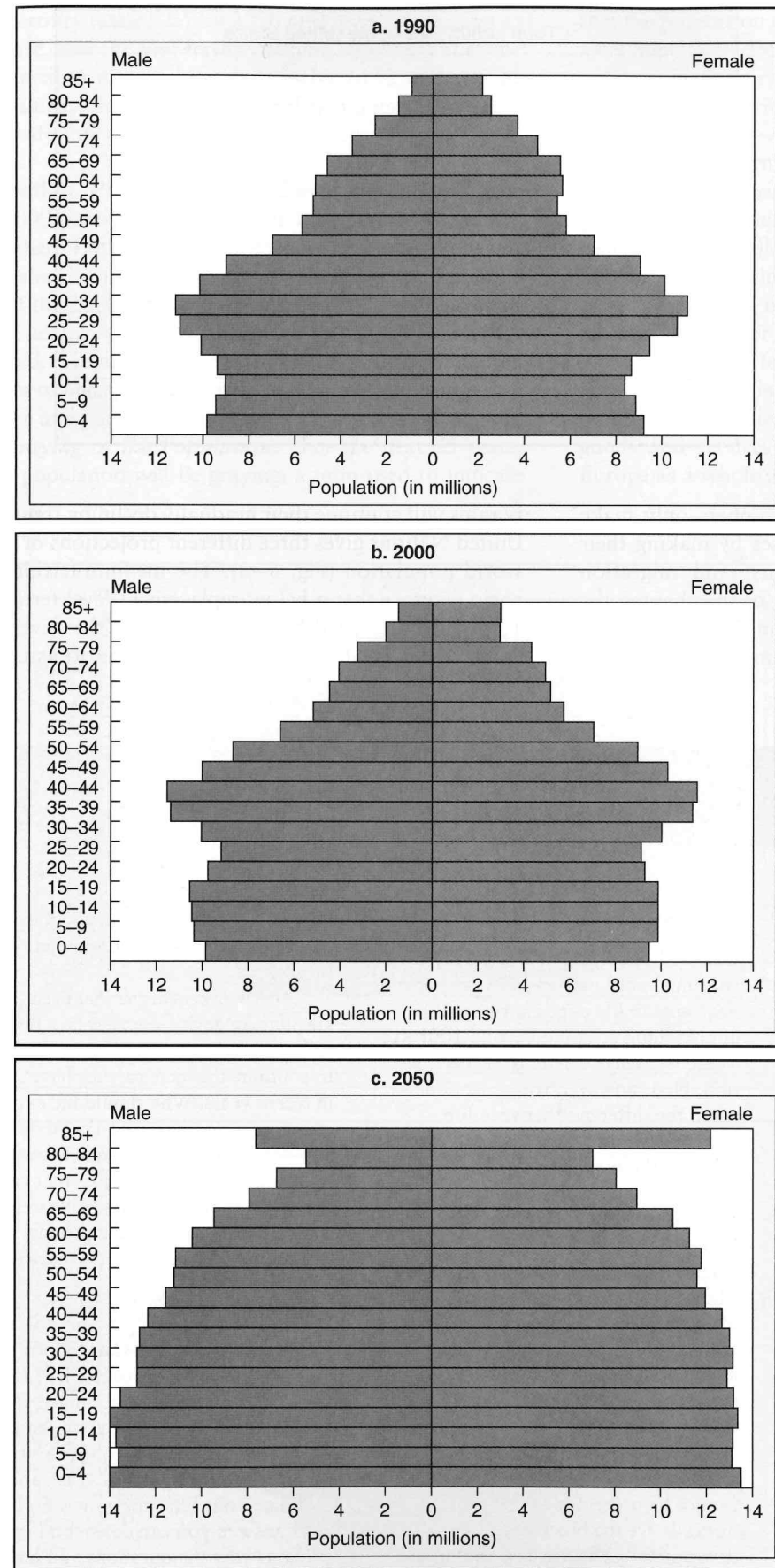
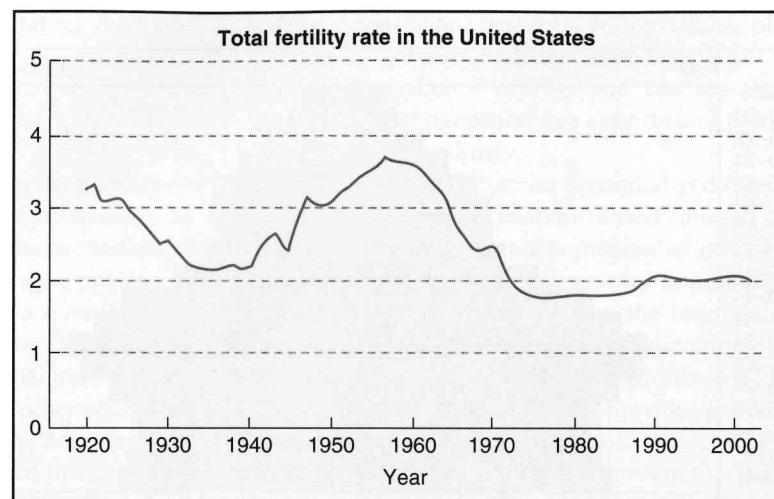


Figure 5-12 Population profiles of the United States.

The age structure of the U.S. population (a) in 1990, (b) in 2000, and (c) projected to 2050. (Source: U.S. Census Bureau, International Data Base.)

Figure 5-13 Total fertility rate, United States, 1920-2001. The changes in fertility led to the baby boom and baby bust in the United States. The rate now hovers about the replacement level. [Source: Population Reference Bureau, Population Bulletin 57 (4): *What Drives U.S. Population Growth?* December 2002.]



Projections. Nowadays demographers only make *projections*, and they cover their bases by making their assumptions about fertility, mortality, and migration very clear. As noted at the beginning of the chapter, the projection that the world population will level off at around 10 billion is based on the assumption that ferti-

ty rates will continue their gradually declining trend. The United Nations gives three different projections of future world population (Fig. 5-3). The medium-fertility scenario assumes that a below-replacement-level fertility of 1.85 will be reached by three-fourths of the developing countries by 2050, the high-fertility scenario assumes a

earth watch

Are We Living Longer?

Most of us would like to live a long and prosperous life, hopefully just slipping away in our sleep at some advanced age. With the advent of modern medicine and disease control, this has become possible for more and more people. Average **life expectancy** (*the number of years a newborn can expect to live under current mortality rates*) has been increasing dramatically. Over the past two centuries, world life expectancy increased from about 25 years to 65 for men and 69 for women. Life expectancy and mortality rates are linked, and as infant mortality in particular has declined, life expectancy in the developing countries has climbed sharply. Life expectancies in those countries are now within 10 years of life expectancies in the developed countries. (The latter are now 72 for men and 79 for women.) What is not well known is that life expectancy has also continued to climb about 2½ years every decade for the low-mortality developed countries. Mortality rates have declined for every age.

Longevity

Can we hope that this trend will continue, until perhaps a century from now human life expectancies will be approaching or going beyond 100? There is intense debate over this question. First, however, you must understand the difference between life expectancy and longevity. **Longevity** refers to the *maximum life span for a species*. The verifiable record for humans is held by Madame Jeanne Louise Calment, who died in France on August 4, 1997, at 122 years of age. The record for the United States is that of a man who died at 115 years of age in 1882! These figures suggest that human longevity has not really increased over the years. Indeed, many workers in the field of gerontology (the study of aging) are convinced that, in humans (as in all species), there is an aging process that cannot be prevented—that built into our cells are the biochemical seeds of destruction. Cells, tissues, and organs wear out at variable rates in different people. Thus, we will not likely find

life expectancies to rise beyond about 85 years anywhere or anytime in the future.

Other workers argue that even though absolute longevity seems to be a limiting process, we can expect life expectancies to continue the increase they have shown in recent years. Why should life expectancies stop at 85, they ask? The trend of a 2½-year increase per decade is based on reducing many of the factors that cause mortality at different ages. This trend should continue, given the medical prowess of our 21st-century science.

Take a Test

So, how long do you want to live? How long do you expect to live? It is encouraging that there are many steps you can take to increase your chances of living longer. Check the Web site <http://www.livingto100.com>, and calculate your life expectancy. Following your answer, you can consult a key that explains why the questions you have answered are related to life expectancy. How did you do?

total fertility rate of 2.5 by 2050 and the continuation of that rate, and the low-fertility scenario assumes that the total fertility rate will reach 1.54 by 2050 and will be maintained. Note how each fertility assumption generates profoundly different world populations.

Population Projections for Developed Countries.

The 2000 population profile of Italy, a developed country in southern Europe, shown in Fig. 5-14a, reflects the fact that Italian women have had a low fertility rate for some time. If the 2000 total fertility rate of 1.2 remains constant for the next 25 years, the profile presented in Fig. 5-14b is obtained. This profile shows a dramatic increase in the number of older people, a great reduction in the number of children and young people, and a net decline of 1.5 million.

Graying of the Population. For the next 25 years, Italy's population will be **graying**, a term used to indicate

that the proportion of elderly people is increasing. Overall, a net population decrease of 6% is expected to occur. What opportunities and risks does the changing population profile imply for Italy? If you were an adviser to the Italian government, what would your advice be for the short term? For the longer term? Unless a smaller population is the goal, it might be wise to encourage, and to provide incentives for, Italian couples to bear more children. It might also be a good idea to allow more immigration (*replacement migration*). But allowing the declining numbers of Italian people to be replaced by a non-Italian immigrant population has implications for Italian culture, religion, etc.

The very low fertility rate and the expected declining population seen in Italy are typical of an increasing number of highly developed nations. Who will produce the goods and services needed by their aging populations? Europe as a whole is on a trajectory of population decline

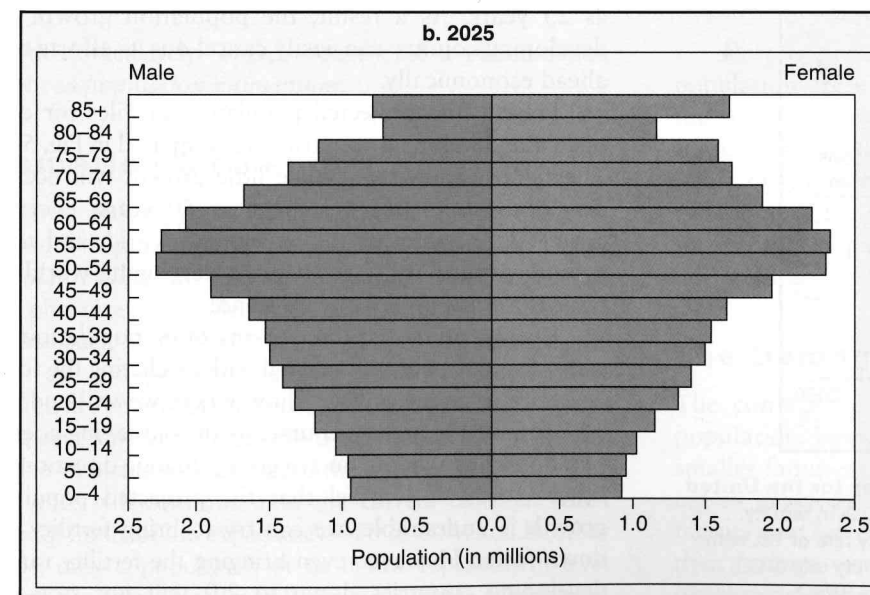
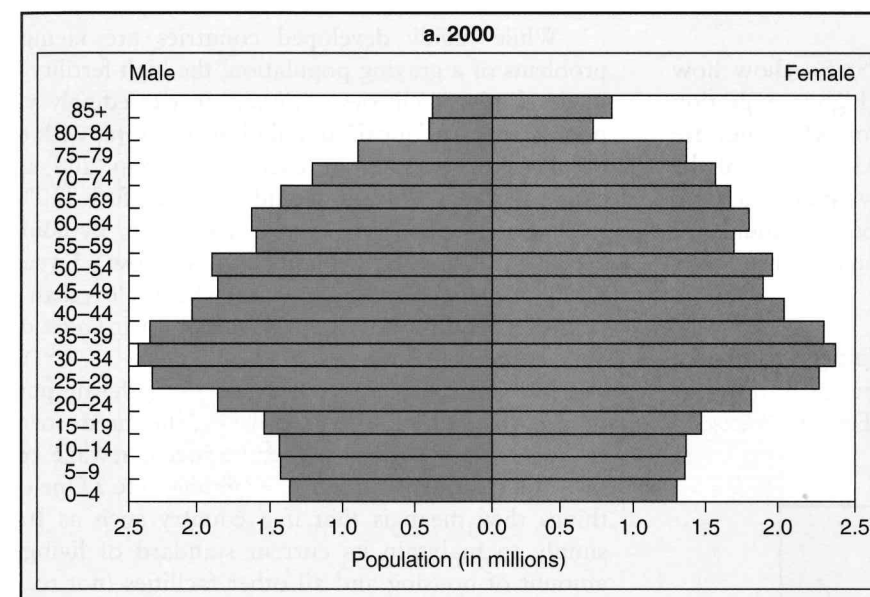


Figure 5-14 Projecting future populations: developed country. A population profile of Italy, representative of a highly developed country, (a) in 2000 and (b) projected to 2025. Note how larger numbers of persons are moving into older age groups and the number of children is diminishing. (Source: U.S. Census Bureau, International Data Base.)

if only natural increase is considered. In fact, Europe is in the midst of a migration crisis. Some 20 million foreigners now live and work in the countries of Western Europe, most of whom do not have resident status. In many of these countries, fear and mistrust of these “guest workers” has led to violent attacks on them. Many Europeans do not want more immigration, even to prevent the loss of the labor force and population decline. Yet just to maintain their current populations, most of these countries will have to triple their current immigration levels in the near future.

No Graying Here. In contrast to other developed countries, the fertility rate in the United States reversed directions in the late 1980s and started back up. On the basis of the lower fertility rate, the U.S. population had been projected to stabilize at between 290 and 300 million toward the middle of the next century. With a higher fertility rate of 2.0, the U.S. population is projected to be 420 million by 2050 (see Fig. 5-12c for a profile) and to continue growing indefinitely (Fig. 5-15). For this projection, immigration is assumed to remain constant at current levels—880,000 per year.

These projections for the United States show how differences in the total fertility rate and high immigration profoundly affect estimates of population when they are extrapolated 50 or more years forward. In light of the concerns for sustainable development, what do you think the population policy of the United States should be? Can you picture some scenarios that could lead to lower future growth?

Population Projections for Developing Countries.

Developing countries are in a situation vastly different from that of developed countries. Fertility rates in

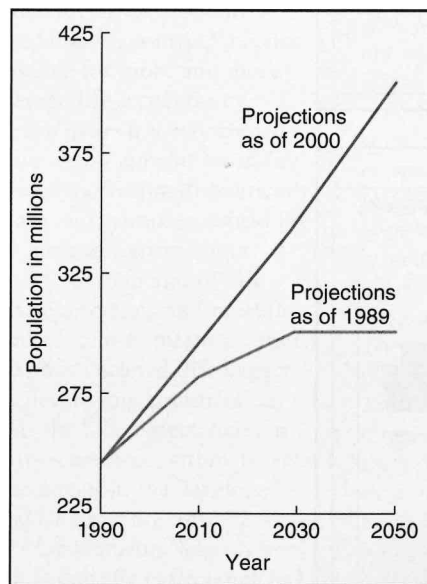


Figure 5-15 Population projections for the United States. Projections shift drastically with changes in fertility. Contrast the 1988 projection, based on a fertility rate of 1.8, with the 2000 projection, based on an increased fertility rate of 2.1. (Source: U.S. Census Bureau, International Data Base.)

developing countries are generally declining, but they are still well above replacement level. The average TFR (excluding China, where it is 1.7) is currently 3.5, which is comparable to the United States at the peak of the baby boom. Because of even higher past fertility rates, the population profiles of developing countries have a pyramidal shape.

Iraq. For example, the 2000 population profile for the western Asian country of Iraq, which has a fertility rate of 5.4, is shown in Fig. 5-16a. Even assuming that this fertility rate will gradually decline to 2.7 by 2025, the population will increase from 23 to 40 million, yielding the profile shown in Fig. 5-16b. Even the high infant mortality rate (currently 103 per thousand) comes nowhere close to offsetting the high fertility rate. Thus, the pyramidal form of the profile remains the same, because, for many years, the rising generation of young adults produces an even larger generation of children. The pyramid gets wider and wider, until the projected declining fertility rate begins to take effect.

While highly developed countries are facing the problems of a graying population, the high fertility rates in developing countries maintain an exceedingly young population. An “ideal” population structure, with equal numbers of persons in each age group and a life expectancy of 75 years, would have one-fifth (20%) of the population in each 15-year age group. By comparison, 40%–50% of the population is below 15 years of age in many developing countries, whereas less than 20% of the population is below the age of 15 in most developed countries (Table 5-4).

Growth Impacts. What do these differing population structures mean in terms of the need for new schools, housing units, hospitals, roads, sewage collection and treatment facilities, telephones, etc.? One of the things they mean is that if a country such as Iraq is simply to maintain its current standard of living, the amount of housing and all other facilities (not to mention food production) must be almost doubled in as little as 25 years. As a result, the population growth of a developing country can easily cancel out its efforts to get ahead economically.

Present and projected population profiles for developed and developing countries are compared in Fig. 5-17. The figure shows that, while little growth will occur in developed countries over the next 50 years, enormous growth is in store for the developing world, and this is assuming that fertility rates in the developing world continue their current downward trend!

Keep in mind that these or any other population projections should *not* be confused with predicting the future. They are intended only to show where we will end up if we continue the present course. As the old saying goes, “If you don’t like where you are going, change direction.” In other words, if we feel that the projected population growth is undesirable, we can try to bring fertility rates down faster. However, even bringing the fertility rates of developing countries down to 2.0 will not stop their

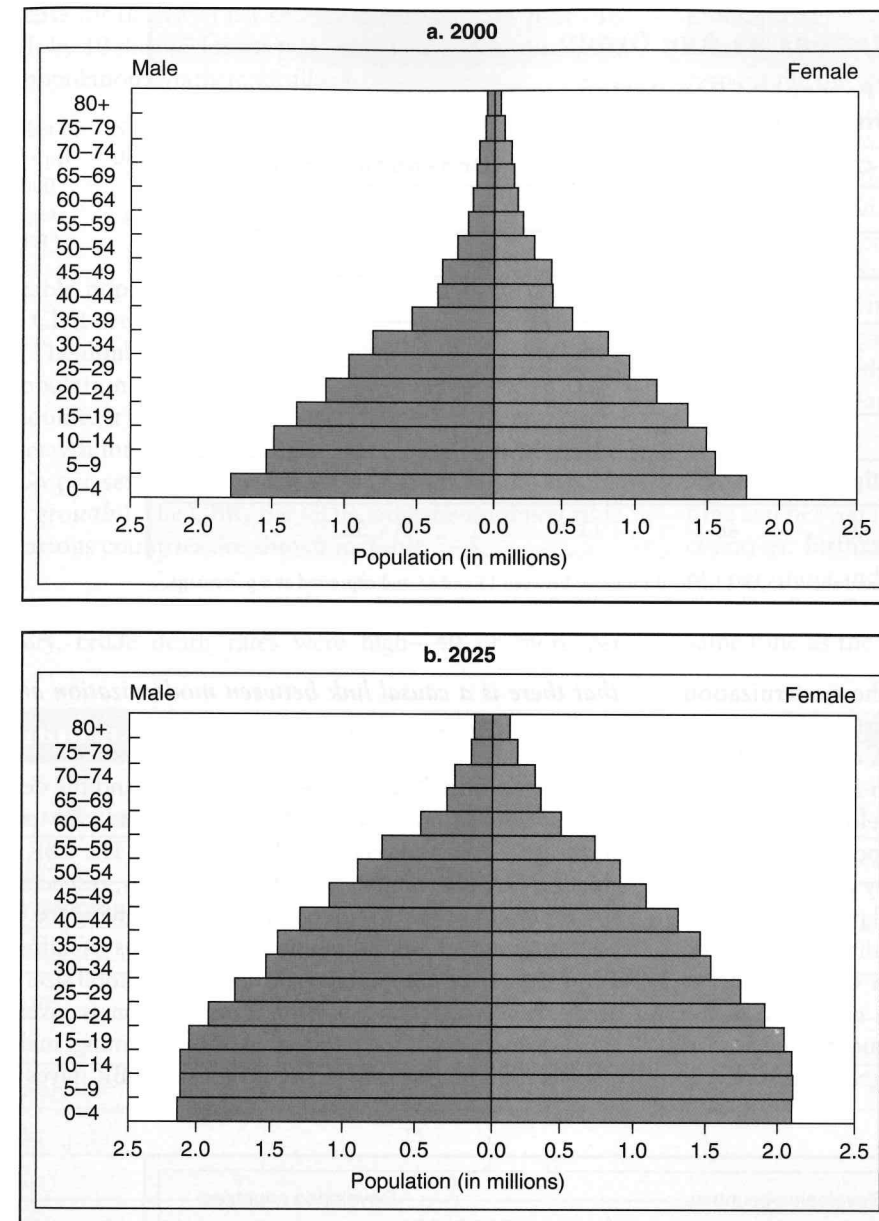


Figure 5-16 Projecting future populations: developing country. (a) The 2000 population profile of Iraq, a developing country. (b) Projection for the year 2025, based on the assumption that the total fertility rate of 5.7 will decline to 2.7 by 2025. (Source: U.S. Census Bureau, International Data Base.)

growth immediately. This is because of a phenomenon known as *population momentum*.

Population Momentum

Countries with a pyramid-shaped population profile, such as Iraq, will continue to grow for 50–60 years, *even after the total fertility rate is reduced to the replacement level*. This phenomenon, called **population momentum**, occurs because such a small portion of the population is in the upper age groups (where most deaths occur) and many children are entering their reproductive years. Even if these rising generations have only two children per woman, the number of births will far exceed the number of deaths. The imbalance will continue until the current children reach the Iraqi limits of life expectancy—50 to 60 years. In other words, only a population at or below replacement-level fertility for many decades will achieve a stable population.

Despite population momentum, efforts to stabilize population are not fruitless. It just means that population growth cannot be halted quickly. Like a speeding train, there is a long time between applying the brakes and stopping completely. The earlier the fertility rates are reduced, the greater is the likelihood of achieving a steady-state population and a sustainable society in the near future.

The Demographic Transition

The concept of a stable, nongrowing global human population based on people freely choosing to have smaller families is possible because it is already happening in developed countries. If we can understand the factors that have brought this about in those countries, then perhaps we can figure out how to make it occur in developing countries, too.

table 5-4 Populations by Age Group

Region or Country	Percent of Population in Specific Age Groups			Dependency Ratio*
	<15	15 to 65	>65	
sub-Saharan Africa	44	53	3	89
Latin America	32	62	6	61
Asia	30	64	6	56
Iraq	47	50	3	100
Europe	17	68	15	47
Germany	15	68	17	47
China	22	71	7	41
United States	21	66	13	52

*Number of individuals below 15 and above 65, divided by the number between 15 and 65 and expressed as a percentage.
Source: Data from 2003 *World Population Data Sheet* (Washington, DC: Population Reference Bureau, 2003).

Early demographers observed that the modernization of a nation brings about more than just a lower death rate resulting from better health care: A decline in fertility rate also occurs as people choose to limit the size of their families. Thus, as economic development occurs, human societies move from a primitive population stability, in which high birthrates are offset by high infant and childhood mortality, to a modern population stability, in which low infant and childhood mortality are balanced by low birthrates. This gradual shift in birth and death rates from the primitive to the modern condition in the industrialized societies is called the **demographic transition**. *The basic premise of the demographic transition is*

that there is a causal link between modernization and a decline in birth and death rates.

Birthrates and Death Rates. To understand the demographic transition, you need to understand the **crude birthrate (CBR)** and **crude death rate (CDR)**. The CBR and the CDR are *the number of births and deaths, respectively, per thousand of the population per year*. By giving the data per thousand of the population, populations of different countries can be compared regardless of their total size. The term *crude* is used because no consideration is given to what proportion of the population is old or young, male or female. Subtracting the CDR from the CBR gives the

increase (or decrease) per thousand per year. Dividing this result by 10 then yields the *percent* increase (or decrease) of the population. Mathematically,

$$\frac{\text{Number of births per 1,000 per year (CBR)} - \text{Number of deaths per 1,000 per year (CDR)}}{\text{Number of births per 1,000 per year (CBR)}} \div 10 = \text{Percent increase (or decrease) in population per year}$$

A stable population is achieved if, and only if, the CBR and CDR are equal.

The **doubling time** is the number of years it will take a population growing at a constant percentage per year to double. It is calculated by dividing the percentage rate of growth into 70. (The 70 has nothing to do with population per se; it is derived from an equation for population *growth*.) The CBR, the CDR, and the doubling time of various countries are shown in Table 5-5.

Epidemiologic Transition. Throughout most of human history, crude death rates were high—40 or more per

thousand for most societies. By the middle of the 19th century, however, the epidemics and other social conditions responsible for high death rates began to recede, and death rates in Europe and North America declined. The decline was gradual in the now-developed countries, lasting for many decades and finally stabilizing at a CDR of about 11 per thousand. At present, cancer and cardiovascular disease and other degenerative diseases account for most mortality, and many people survive to old age. This pattern of change in mortality factors has been called the *epidemiologic transition* (Fig. 5-18) and represents one element of the demographic transition. (Epidemiology is the study of diseases in human societies.)

Fertility Transition. Another pattern of change over time can be seen in crude birthrates. In the now-developed countries, birthrates have declined from a high of 40 to 50 per thousand to 8 to 12 per thousand—a *fertility transition*. As Fig. 5-18 shows, this did not happen at the same time as the epidemiologic transition; instead, it was

table 5-5 Crude Birth and Death Rates for Selected Countries

Country or Region	Crude Birthrate	Crude Death Rate	Annual Rate of Increase (%)	Doubling Time (Years)
World	22	9	1.3	54
Developing Nations				
Average (excluding China)	28	9	1.9	37
Egypt	27	6	2.1	33
Kenya	35	15	2.0	35
Madagascar	43	13	3.0	23
India	25	8	1.7	41
Iraq	35	10	2.5	28
Vietnam	19	6	1.3	54
Haiti	32	14	1.8	39
Brazil	20	7	1.3	54
Mexico	29	5	2.4	29
Developed Nations				
Average	11	10	0.1	700
United States	14	9	0.6	117
Canada	11	7	0.3	233
Japan	9	8	0.1	700
Denmark	12	11	0.1	700
Germany	9	10	-0.1	-
Italy	9	10	-0.1	-
Spain	10	9	0.1	700

Note: Dash indicates doubling time cannot be calculated, because growth is negative.
Source: Data from 2003 *World Population Data Sheet* (Washington, DC: Population Reference Bureau, 2003).

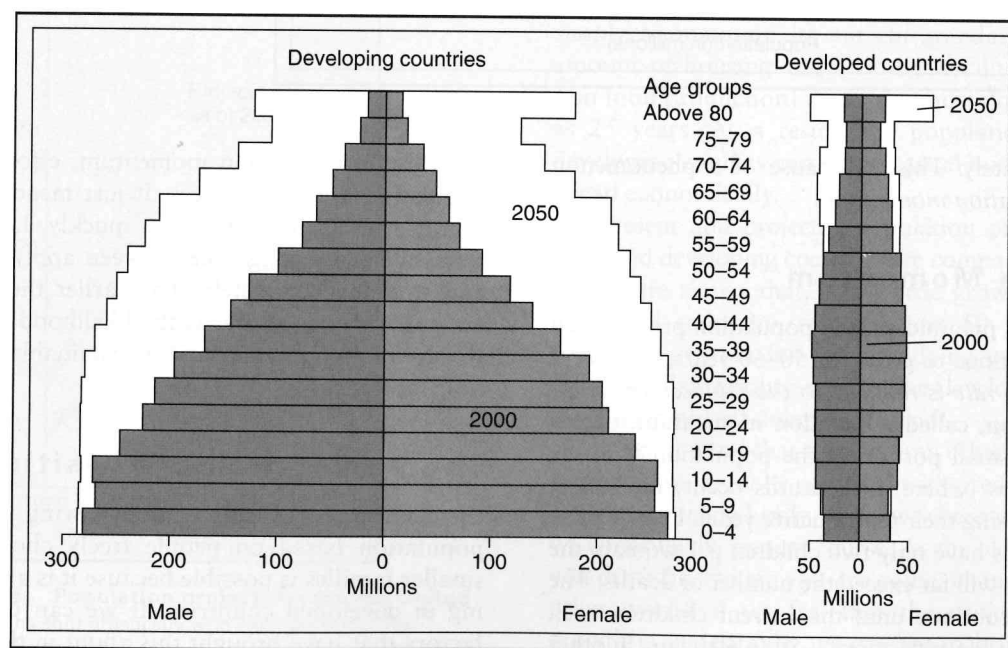


Figure 5-17 Comparing projected populations. 2000 population profiles for developed and developing countries, projected to the year 2050. (Source: U.S. Census Bureau, International Data Base.)

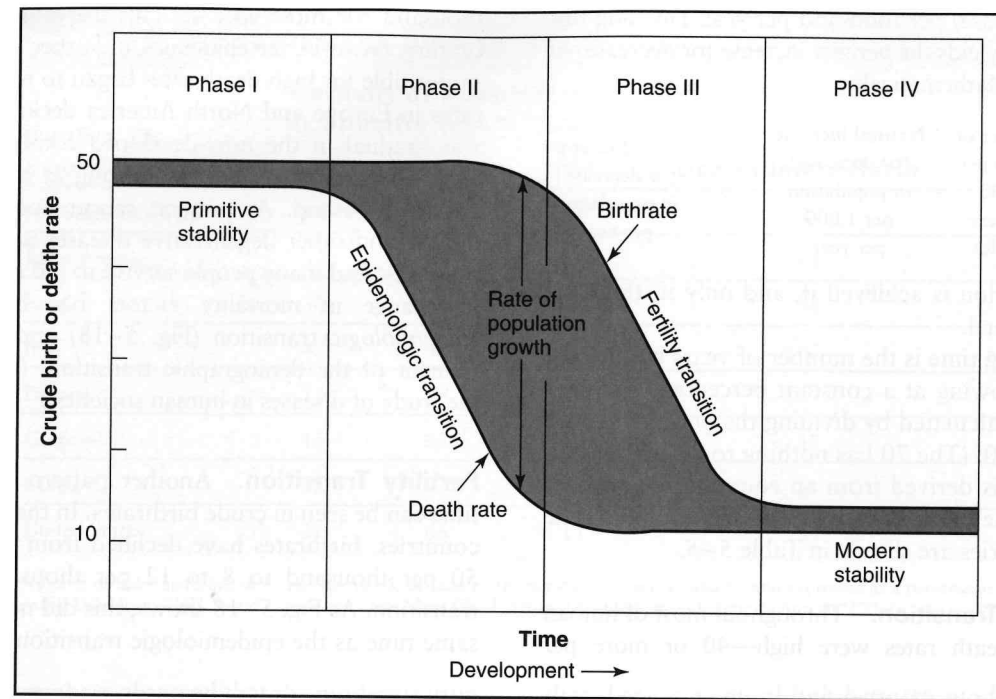


Figure 5-18 The demographic transition. The epidemiologic transition and the fertility transition combined to produce the demographic transition in the developed countries over many decades. (Adapted from Joseph A. McFalls, Jr., "Population: A Lively Introduction," *Population Bulletin* 53, no. 3[1998]: 39. Courtesy of Population Reference Bureau, 2000.)

delayed by decades or more. Because net growth is the difference between the CBR and the CDR, the time during which these two patterns are out of phase is a time of rapid population growth. The developed countries underwent such growth during the 19th and early 20th centuries, partly a result of massive emigration from the Old World to the less populated New World.

Phases of the Demographic Transition. The demographic transition is typically presented as occurring in the four phases shown in Fig. 5-18. **Phase I** is the primitive stability resulting from a high CBR being offset by an equally high CDR. **Phase II** is marked by a declining CDR—the epidemiologic transition. Because fertility and, hence, the CBR remain high, population growth accelerates during Phase II. The CBR declines during **Phase III** due to a declining fertility rate, but population growth is still significant. Finally, **Phase IV** is reached, in which modern stability is achieved by a continuing low CDR, but an equally low CBR.

Developed countries have generally completed the demographic transition, so they are in Phase IV. Developing countries, by contrast, are still in Phases II and III. Death rates have declined markedly, and fertility and birthrates are declining, but remain considerably above replacement levels. Therefore, populations in developing countries are still growing rapidly.

Where They Are. Using the concept of the demographic transition, you can plot the current birth and death rates of the major regions of the world to visualize

where they are in the transition (Fig. 5-19). The vertical dividing line drawn through this plot separates the nations (to the right of the line) that are on a fast track to completing the demographic transition or are already there from the nations (to the left of the line) that are in the middle of the demographic transition. Nations to the left of the line (about half the world) are mostly in the fourth decade of rapid population increase. It is as if they are trapped there, with serious consequences.

Why Worry? On the basis of the demographic transition, some argue that we do not need to worry about population. Instead, it will stabilize by itself as developing countries reach Phase IV. Therefore, the argument goes, we need only encourage free enterprise, democratization, globalization, and other factors that will speed economic growth in developing countries. The major flaws in this argument are as follows:

1. The demographic transition occurred in the developed countries over a period of many decades; modernization did not happen overnight.
2. Many of the most populous developing countries are still very far behind the developed countries economically (Fig. 5-4) and are making very slow progress toward modernization. If they must modernize before population growth comes under control, their population growth and its demands for resources and services will undercut the very economic growth that is so necessary—a catch-22 with profound consequences.

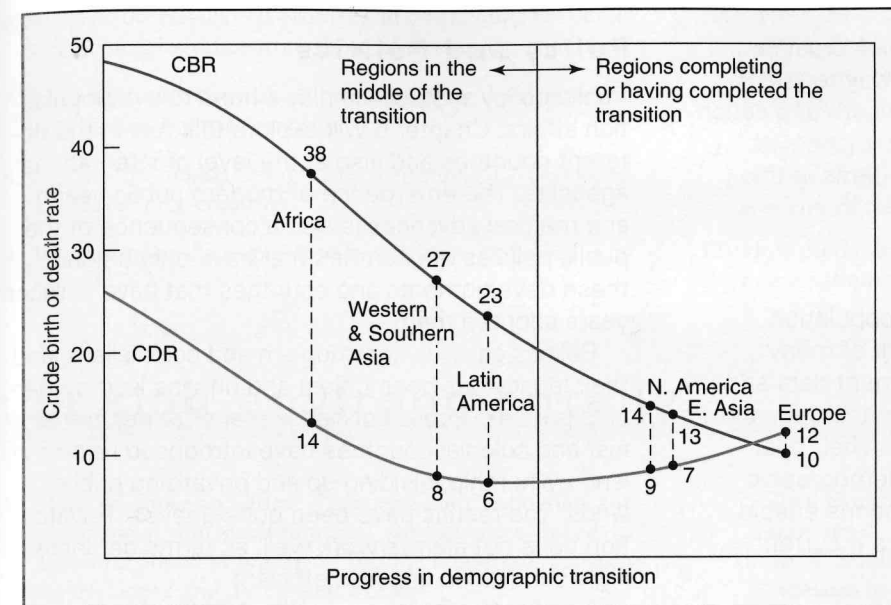


Figure 5-19 World regions in the process of demographic transition. Crude birthrates (CBRs) and crude death rates (CDRs) are shown for major regions of the world. A dividing line separates countries at or well along in the demographic transition from those still in the middle of the transition. (Source: Data from 2003 *World Population Data Sheet* [Washington, DC: Population Reference Bureau, 2003].)

3. Present stresses on the biosphere are largely a consequence of the consumption-oriented lifestyles of the current 965 million people living in the high-income nations. Thus, the severe stresses being caused by the lifestyles of a billion people make any notion of a world with 10 billion people living with the same lifestyle utterly absurd.
4. Finally, and most important, the demographic transition really shows only a *correlation* between development and changing birth and death rates; it does not *prove* that development is necessary for the demo-

graphic transition to occur. Other factors may be much more significant.

In Chapter 6, you will investigate the factors that influence birth and death rates, and you will explore the relative contributions of economic development and family planning for bringing about the fertility transition. In the process, you may begin to picture what sustainable development might look like for the developing world, in particular, and what it will take to get there.

revisiting the themes

Sustainability

A sustainable world is a world whose population is generally stable—it cannot increase steadily, as the world's population currently does. World population may level off at 10 billion or even 9 billion, but will we be exceeding earth's carrying capacity? Three or four billion more people will need to be fed, clothed, housed, and employed, all in an environment that continues to provide essential goods and services. Many agree that this will be possible only if the additional people maintain a modest ecological footprint, much less than that of the developed countries. Because the additional people will be mostly in the developing countries, it will apparently be up to these countries to hold down their demands on resources and their pollution levels. Given their existing poverty and need for economic growth, this sounds like imperialism, and it is.

In a sense, the United States is playing a small role in the process by accepting so many immigrants from developing countries—about 1% of the annual popu-

lation growth in these countries (hardly a significant percentage). More significant is the impact of immigration on the United States itself, which is currently on a trajectory of indefinite growth because of immigration. We could add 100 million to our population in the next 50 years.

Stewardship

Calling on the developing countries to keep down their future demands on the environment is blatantly unjust. Still, there is no way for these countries to meet their future needs by mimicking what we in the developed world are currently doing to resources and the environment. Justice demands (and sustainability requires) that the rich countries reduce their environmental impact. Recall from Chapter 1 that several transitions must take place within the developed world, all of which would reduce our ecological footprint: a resource transition, a technology transition, and a community transition.