population back to 1798, when British economist Thomas Malthus published *An Essay on the Principles of Population*. In this work Malthus warned that the world's population was increasing faster than the food supplies needed to sustain it. His reasoning was that food supplies grew *linearly*, adding acreage and crops incrementally by year, whereas population grew *exponentially*, compounding on the year before. From 1803 to 1826, Malthus issued revised editions of his essay and responded vigorously to a barrage of criticism.

The predictions Malthus made assumed food production is confined spatially—what people can eat within a country depends on what is grown in the country. We now know his assumption does not hold true; countries are not closed systems. Malthus did not foresee how globalization would aid the exchange of agricultural goods across the world. Mercantilism, colonialism, and capitalism brought interaction among the Americas, Europe, Africa, Asia, and the Pacific. Through global interaction, new agricultural methods developed, and commodities and livestock diffused across oceans. In the 1700s, farmers in Ireland grew dependent on a South American crop that was well suited for its rocky soils, the potato. Today, wealthier countries that lack arable land, such as Norway, can import the majority of its foodstuffs, circumventing the limitations of their lands. Each of these examples demonstrates that food production is not confined spatially, as Malthus assumed.

Malthus assumed the growth of food production was linear, but food production has grown exponentially as the acreage under cultivation expands, mechanization of agricultural production diffuses, improved strains of seed are developed, and more fertilizers are used. In the twenty-first century, bioengineering continues to bring new hybrids, genetically modified organisms, and countless herbicides and pesticides that enabled exponential growth in food production.

Nonetheless, Malthus's ideas continue to attract followers. Neo-Malthusians scholars continue to share Malthus's concerns (even if they do not agree with every detail of his argument) and continue to be alarmed at the continuing rise in the world's population. Neo-Malthusians point out that human suffering is now occurring on a scale unimagined even by Malthus. Although many demographers predict the world population will stabilize later in the twenty-first century, neo-Malthusians argue that overpopulation is a real problem that must be addressed now.

Population Growth at World, Regional, National, and Local Scales

Analysis of population growth and change requires attention to scale. In this section, we examine population growth at different scales, but we must be mindful that what happens at one scale can be affected by what is happening at other scales and in other places at the same time.

Keeping in mind that population change in one place can be affected rapidly by what is going on in a neighboring country or at the regional scale, one can gain some insights by looking at population change within the confined territory of a country (or other administrative unit, such as a province or city). To calculate the natural increase in a country's population, simply subtract deaths from births. This is a simple statistic to calculate and comprehend; however, calculating the natural increase misses two other key components in a country's population: immigration, which along with births adds to the total population, and emigration (outmigration), which along with deaths, subtracts from the total population. Using these four components, we can calculate demographic change within a territory.

When we mapped population growth in Figure 2.7, we did not take into account emigration and immigration. Other maps and tables of population growth you see may take into account emigration and immigration. Statistics for each population trait can be calculated globally, by region, by country, or even for smaller locales. When studying population data across scales and across the world, we must constantly remind ourselves of exactly what is being calculated and for where. Otherwise, many of the statistics we read will seemingly be contradictory.

For example, we began this chapter discussing the low and declining TFRs in a number of countries in the world. How can the worldwide population continue to increase when so many countries are experiencing low TFRs and population decline? Despite declining population growth rates and even negative growth rates (growth rates below 0.0) in a number of the world's countries, the global population continues to rise. The worldwide TFR was 2.6 in 2007, above the replacement level of 2.1. The Population Reference Bureau estimates global population will rise to over 9.3 billion by 2050. The low TFRs and low population growth rates enumerated in this chapter are dwarfed by continued additions to the population in countries where growth rates are still relatively high, such as India, Indonesia, Bangladesh, Pakistan, and Nigeria.

One way to easily grasp the growth rate in world population is to compare a population's rate of growth to its **doubling time**. Every rate of growth has a doubling time; for example, if you invest $100 at 10 percent, compounded annually (exponentially), it would take about seven years to double to $200, and then another seven years to become $400, and then another seven years to become $800. When the growth rate is 10 percent, therefore, the doubling time is around seven years.

Two thousand years ago, the world's population was an estimated 250 million. More than 16 centuries passed before this total had doubled to 500 million, the estimated population in 1650. Just 170 years later, in 1820 (when Malthus was still writing), the population had doubled

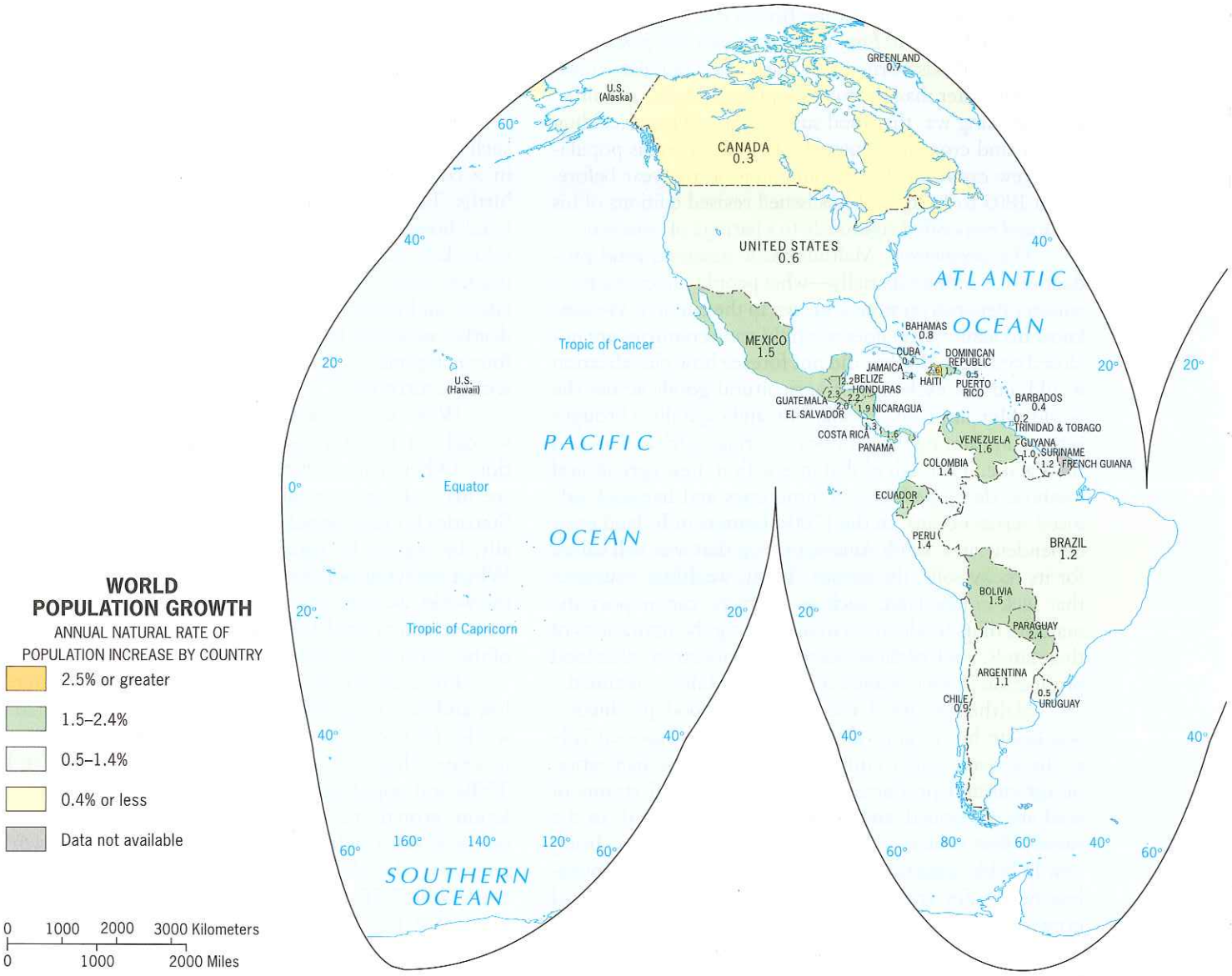
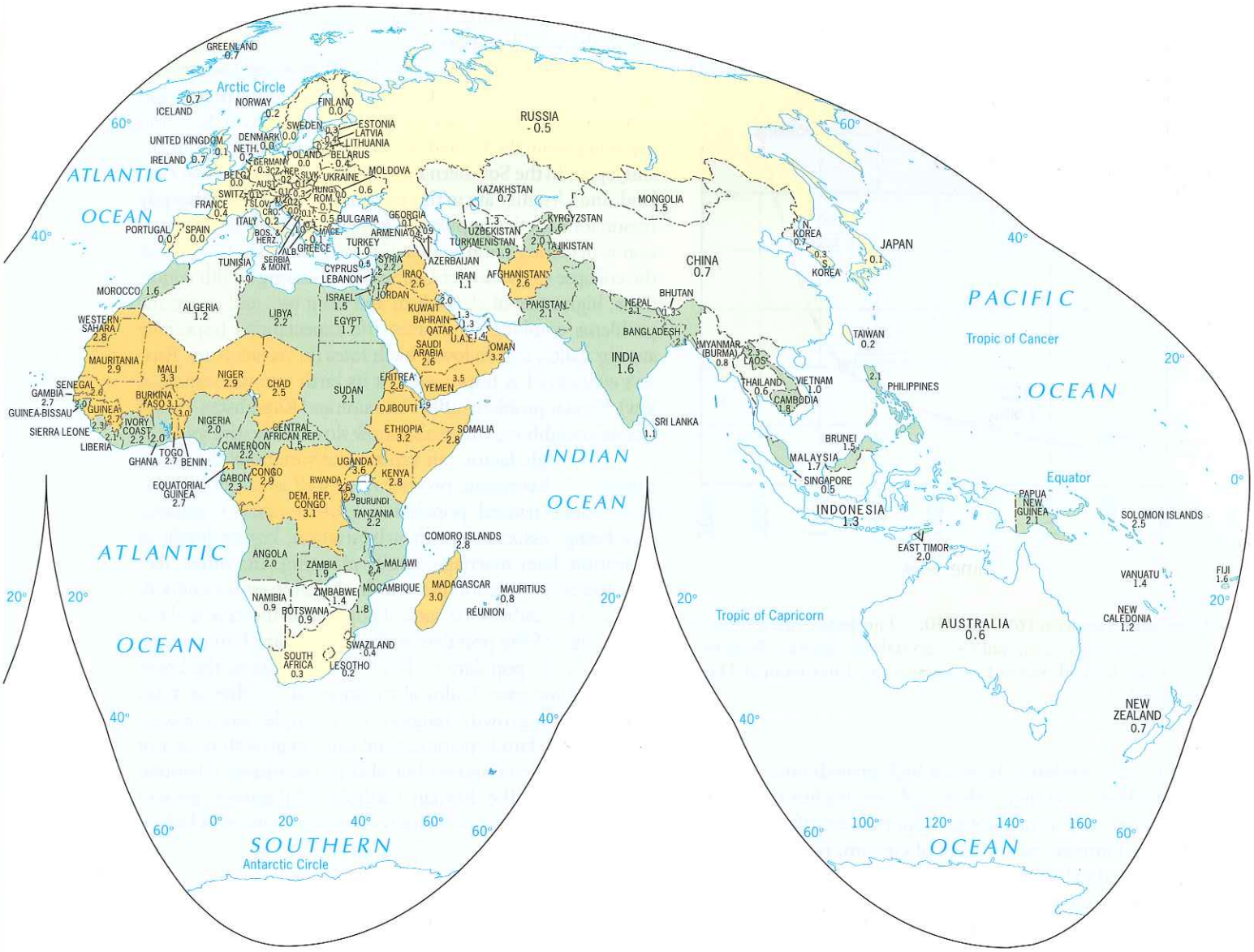


Figure 2.7

World Population Growth. Annual natural rate of population increase by country. *Data from:* United States Census Bureau, International Data Base, 2008.

again, to 1 billion (Fig. 2.8). And barely more than a century after this, in 1930, it reached 2 billion. The doubling time was down to 100 years and dropping fast; the **population explosion** was in full gear. Only 45 years elapsed during the next doubling, to 4 billion (1975). During the mid-1980s, when the rate declined to 1.8 percent, the doubling slowed to 39 years. Today, world population is doubling in 54 years, and the continuing slowdown in the estimated doubling rate is one of the bright spots in the problematic demographic picture.

For demographers and population geographers who study global population growth today, the concept of doubling time is losing much of its punch. With populations falling in many places, fears of global population doubling quickly are definitely subsiding. Many indicators, such as the slowing of the doubling time, suggest that the worst may be over, that the explosive population growth of the twentieth century will be followed by a marked and accelerating slowdown during the twenty-first century. The global growth rate is now down to 1.4 percent, perhaps slightly lower. But today the world's population is about 6.7 billion, yielding an increase in world population that still exceeds 80 million annually. Although this does reflect improvement over the 90 million annual increase the world experienced in the late 1980s, the population growth rate of the globe will have to come down well below 1.0 percent to significantly slow down global population growth.



Population Growth at the Regional and National Scales

The world map of population growth rates (Fig. 2.7), displayed by country, confirms the wide range of natural increases in different geographic regions. These variations have existed as long as records have been kept: countries and regions go through stages of expansion and decline at varying times. In the mid-twentieth century, the population of the former Soviet Union was growing vigorously. Thirty years ago, India's population was growing at nearly 3.0 percent, more than most African countries; then India's growth rate fell below that of Subsaharan Africa. Today, Africa's rate of natural increase still is higher than India's (2.4 percent to 1.7 percent), but now Subsaharan Africa faces the impact of the AIDS epidemic, which is killing millions, orphaning children, reducing life expectancies, and curtailing growth rates.

The map also reveals continuing high growth rates in Muslim countries of North Africa and Southwest Asia. Saudi Arabia has one of the highest growth rates in the world, but some smaller countries in this region are increasing even faster. For some time during the second half of the twentieth century, countries in this region saw their growth rates increase even as those in most of the rest of the world were declining. But more recently several of the fast-growing populations, for example, those of Iran and Morocco, have shown significant declines. Demographers

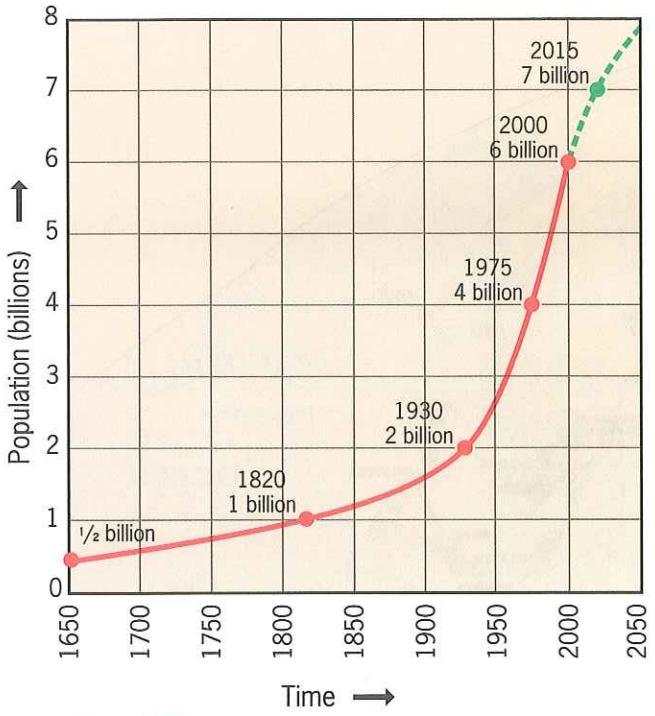


Figure 2.8

Population Growth, 1650 to 2050. The dashed line indicates one estimate of global population growth for the next 50 years. *Data from:* United States Census Bureau, International Data Base, 2007.

point to the correlation between high growth rates and the low standing of women: where cultural traditions restrict educational and professional opportunities for women, and men dominate as a matter of custom, rates of natural increase tend to be high.

South Asia is the most important geographic region in the population growth rate picture. The region includes the country that appears destined to overtake China as the world's most populous: India. Only one country in this region has a growth rate lower than the world average: Sri Lanka. But Sri Lanka's total population is only 20.4 million, whereas the fast-growing countries, Pakistan and Bangladesh, have a combined population exceeding 326 million. India, as the map shows, is still growing well above the world average. The situation in East Asia, the world's most populous region, is different. China's official rate of natural growth has fallen well below 1.0 percent (0.6 in 2008), and Japan's population is no longer growing. Southeast Asia's natural growth rates remain higher, but this region's total population is much lower than either East or South Asia; key countries, such as Indonesia, Thailand, and Vietnam, have declining growth rates.

South America is experiencing significant reductions in natural population growth rates, where those rates were alarmingly high just a generation ago. The region as a whole is still growing at 1.5 percent, but Brazil's population, for example, has declined from 2.9 percent in the mid-1960s to 1.4 percent today. And the populations of Argentina, Chile, and Uruguay are growing at rates well below the world average.

As Figure 2.7 shows, the slowest growing countries—including those with declining rates of natural population increase—lie in the economically wealthier areas of the world extending from the United States and Canada across Europe, and Japan. In the Southern Hemisphere, Australia, New Zealand, and Uruguay are in this category. Wealth is not the only reason for negative population growth rates. Russia's population is declining because of social dislocation in the wake of the collapse of the Soviet Union: deteriorating health conditions, high rates of alcoholism and drug use, and economic problems combine to shorten life expectancies (especially among males) and to lower birth rates (in recent years, Russia's economy has improved, but its birth rate has remained low). Similar problems afflict Ukraine and Kazakhstan, two of Russia's neighbors, which also show slow or negative growth.

No single factor can explain the variations shown on Figure 2.7. Economic prosperity as well as social dislocation reduce natural population growth rates. Economic well-being, associated with urbanization, higher levels of education, later marriage, family planning, and other factors, lowers population growth. In the table in Appendix B, compare the indices for natural population increase and the percentage of the population that is urbanized; in general, the higher the population's level of urbanization, the lower its natural increase. Cultural traditions also influence rates of population growth: religion, for example, has a powerful impact on family planning and thus on growth rates, not only in Islamic countries but also in traditional Christian societies (note the Roman Catholic Philippines' growth rate) and in Hindu-dominated communities (such as India).

Population Growth at the Local Scale

The information provided in Figure 2.7 is based on country-wide statistics. Significant demographic variations also occur *within* countries. In India, for example, some States record population growth rates far above the national average; these States lie mostly in the east of the country (Fig. 2.9). But other States, in the west and southwest region, are growing much more slowly. India is a federation of 28 States and 7 union territories, and the individual States differ greatly both culturally and politically. As in any federation, the will of the federal government cannot be forcibly imposed on the States.

After becoming independent in 1947, India began a population planning program in the 1950s, long before the fear of worldwide overpopulation and a global population bomb spread. In the 1960s, when census numbers revealed the extreme growth rates in parts of the country, the Indian government instituted a national population planning program, encouraging States to join.

Despite the federal effort, rapid population growth continued, especially in the eastern States. Social problems arose in some of the States where governments pursued the campaign vigorously. During the 1970s, the Indian

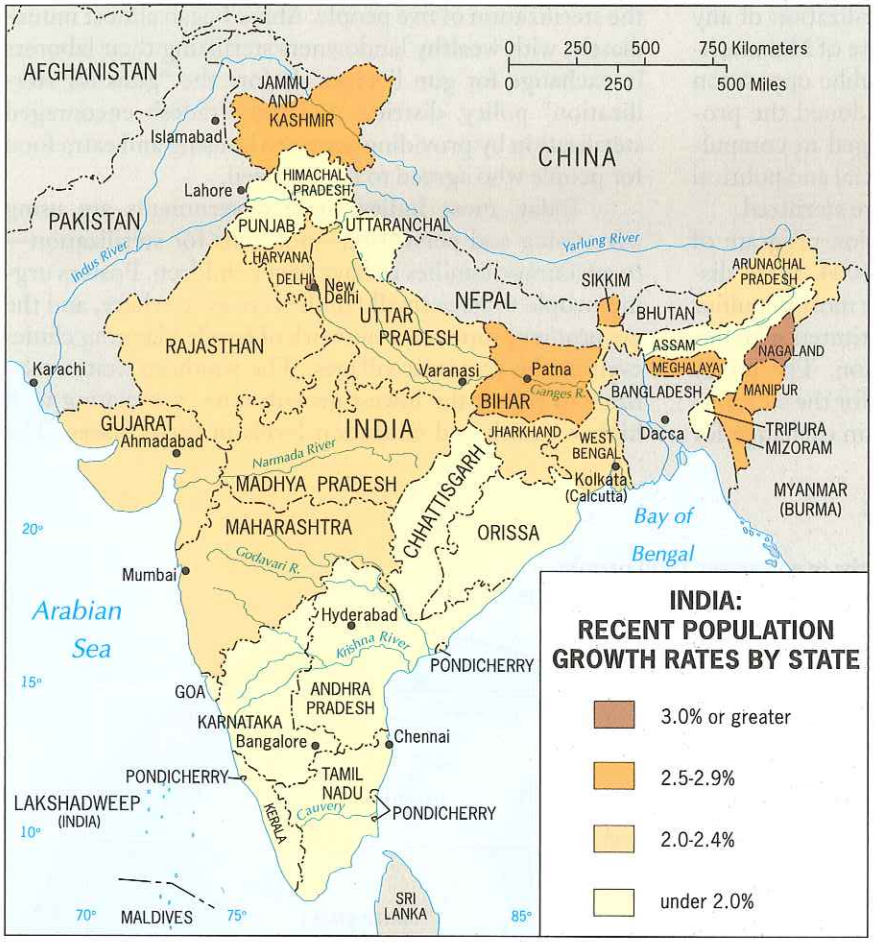


Figure 2.9
Recent Population Growth Rates in India. *Data from:* India Census Bureau, 2001.

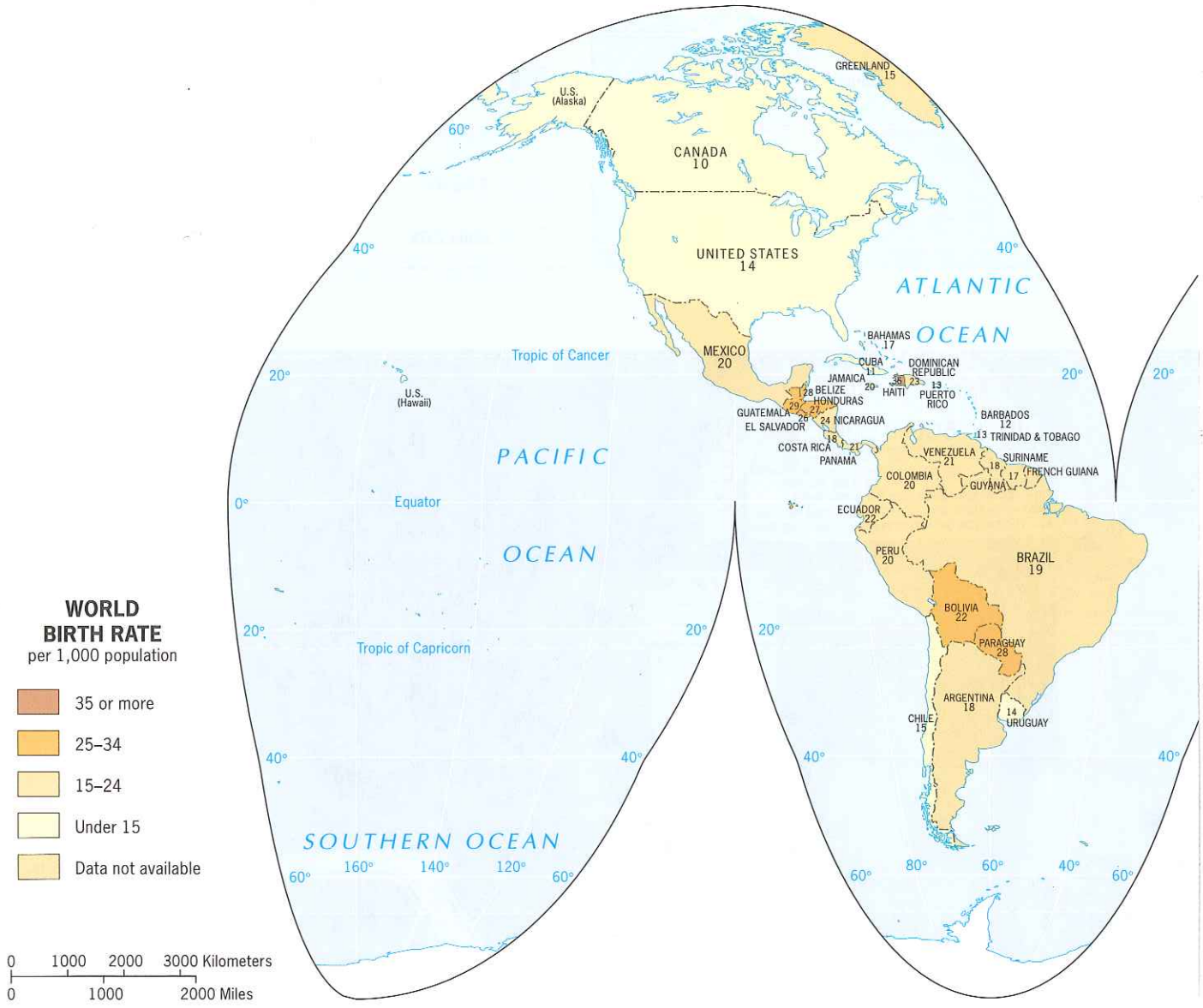
Figure 2.10
Maharashtra, India. Above the entrance to a suite of medical offices is a sign announcing that the "free family planning sterilization operation" closed in 1996.

government began a policy of forced sterilization of any man with three or more children. The State of Maharashtra sterilized 3.7 million people before public opposition led to rioting, and the government abandoned the program (Fig. 2.10). Other States also engaged in compulsory sterilization programs, with heavy social and political costs—eventually, 22.5 million people were sterilized.

The horrors of the forced sterilization program of the 1970s are haunting India again. In 2004, three districts in the State of Uttar Pradesh (India's most populous State with over 170 million people) instituted a policy of exchanging gun licenses for sterilization. The policy allowed for a shotgun license in exchange for the sterilization of two people and a revolver license in exchange for the sterilization of five people. Abuse began almost immediately, with wealthy landowners sterilizing their laborers in exchange for gun licenses. Before the "guns for sterilization" policy, districts in Uttar Pradesh encouraged sterilization by providing access to housing and extra food for people who agreed to be sterilized.

Today, most Indian State governments are using advertising and persuasion—not guns for sterilization—to encourage families to have fewer children. Posters urging people to have small families are everywhere, and the government supports a network of family planning clinics even in the remotest villages. The southern States continue to report the lowest growth rates, correlating with higher wealth and education levels in these States. The

Figure 2.11
Crude Birth Rate. Number of Births in a year per 1000 people.
Data from: United States Census Bureau, International Data Base, 2008.



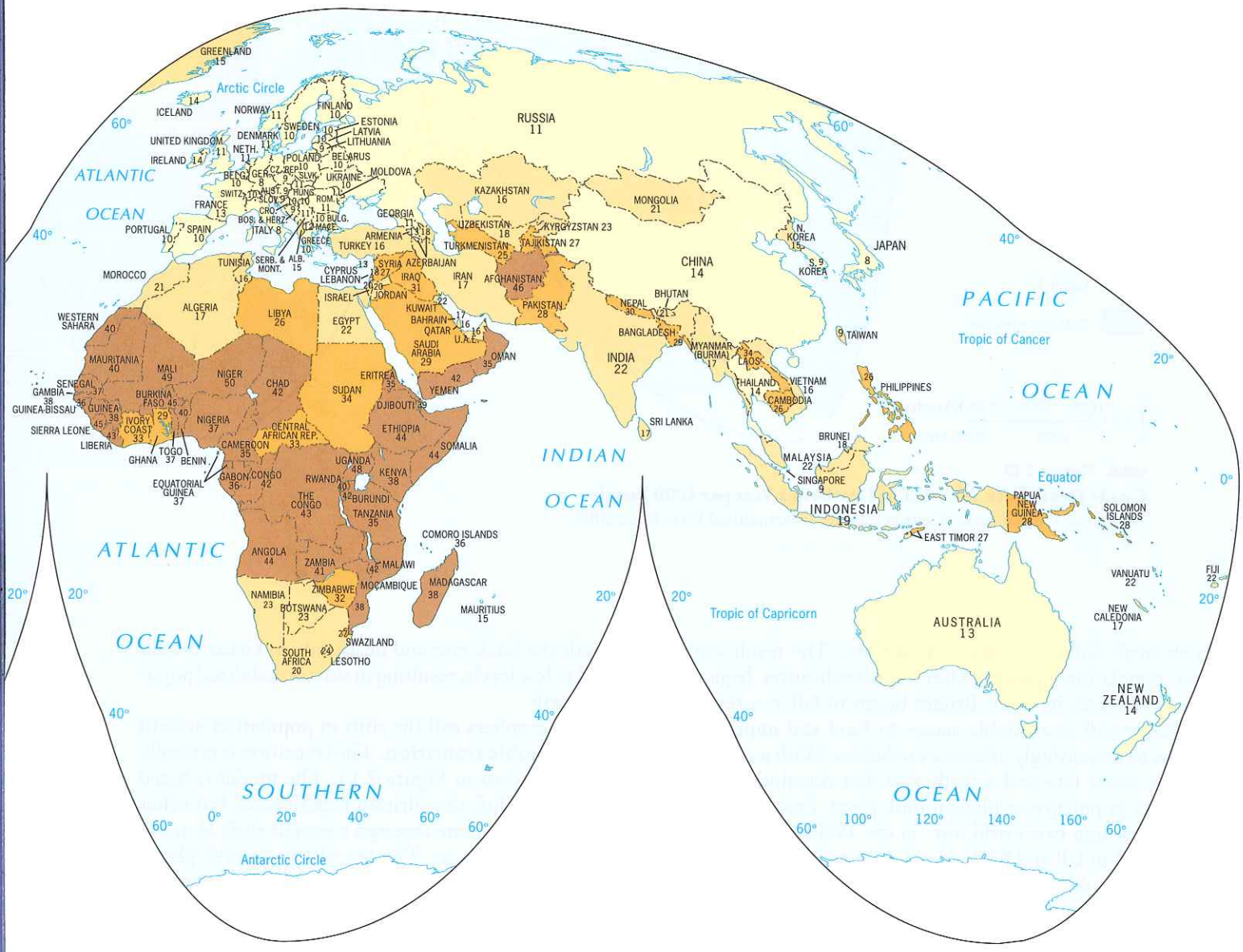
eastern and northern States, the poorer regions of India, continue to report the highest growth rates.

Our world map of growth rates is a global overview, a mere introduction to the complexities of the geography of population. The example of India demonstrates that what we see at the scale of a world map does not give us the complete story of what is happening within each country or region of the world.

The Demographic Transition

The high population growth rates now occurring in many poorer countries are not necessarily permanent. In Europe, population growth changed several times in the last three centuries. Demographers used data on baptisms and funerals from churches in Great Britain to study changes in birth and death rates of the population. They expected the rate of **natural increase** of the population—the difference between the number of births and the number of deaths—to vary over different periods of time. Demographers calculated the **crude birth rate** (CBR), the number of live births per year per thousand people in the population (Fig. 2.11), and the **crude death rate** (CDR), the number of deaths per year per thousand people (Fig. 2.12).

The church data revealed that before the Industrial Revolution began in Great Britain in the 1750s, the country experienced high birth rates and high death rates,



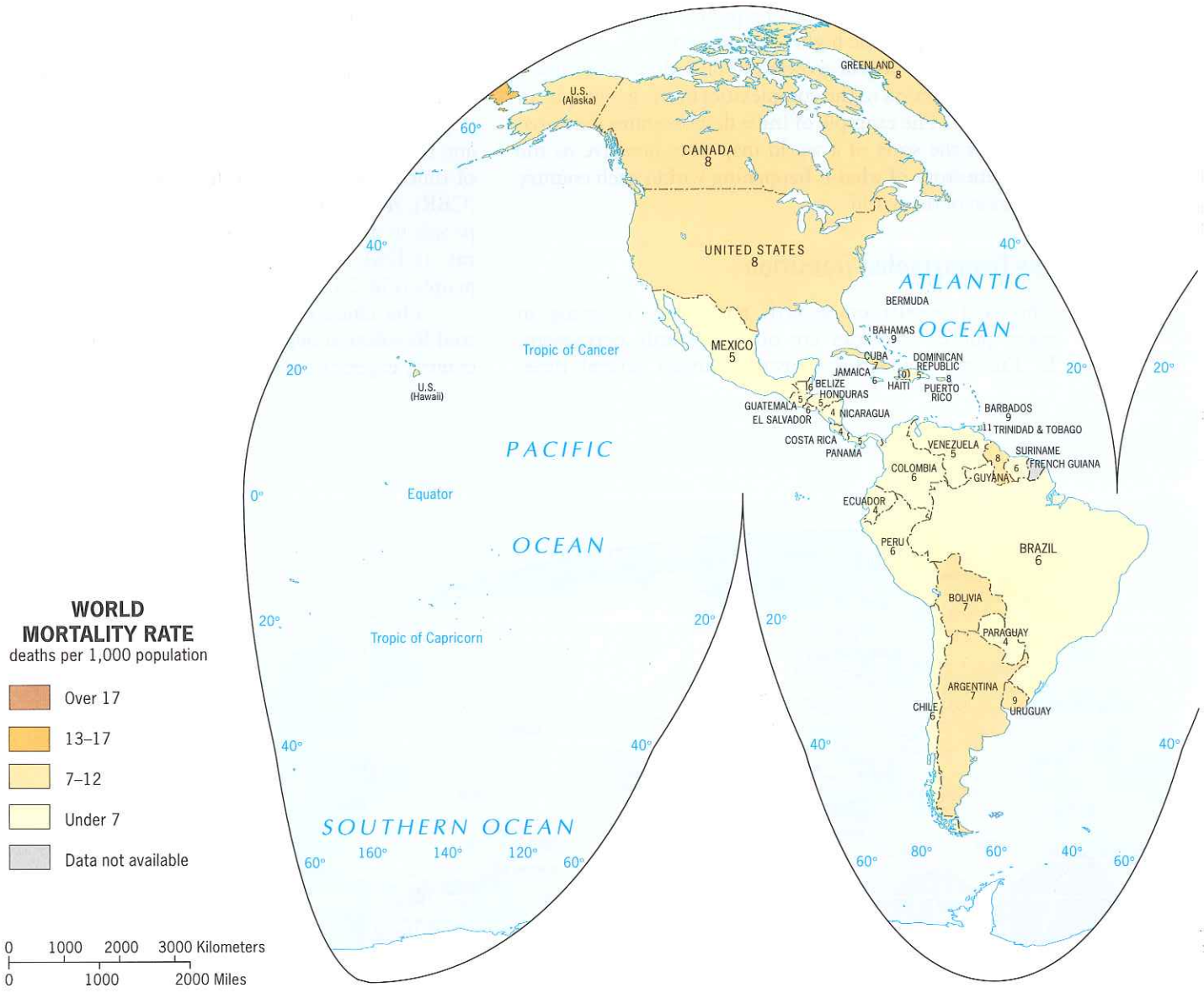
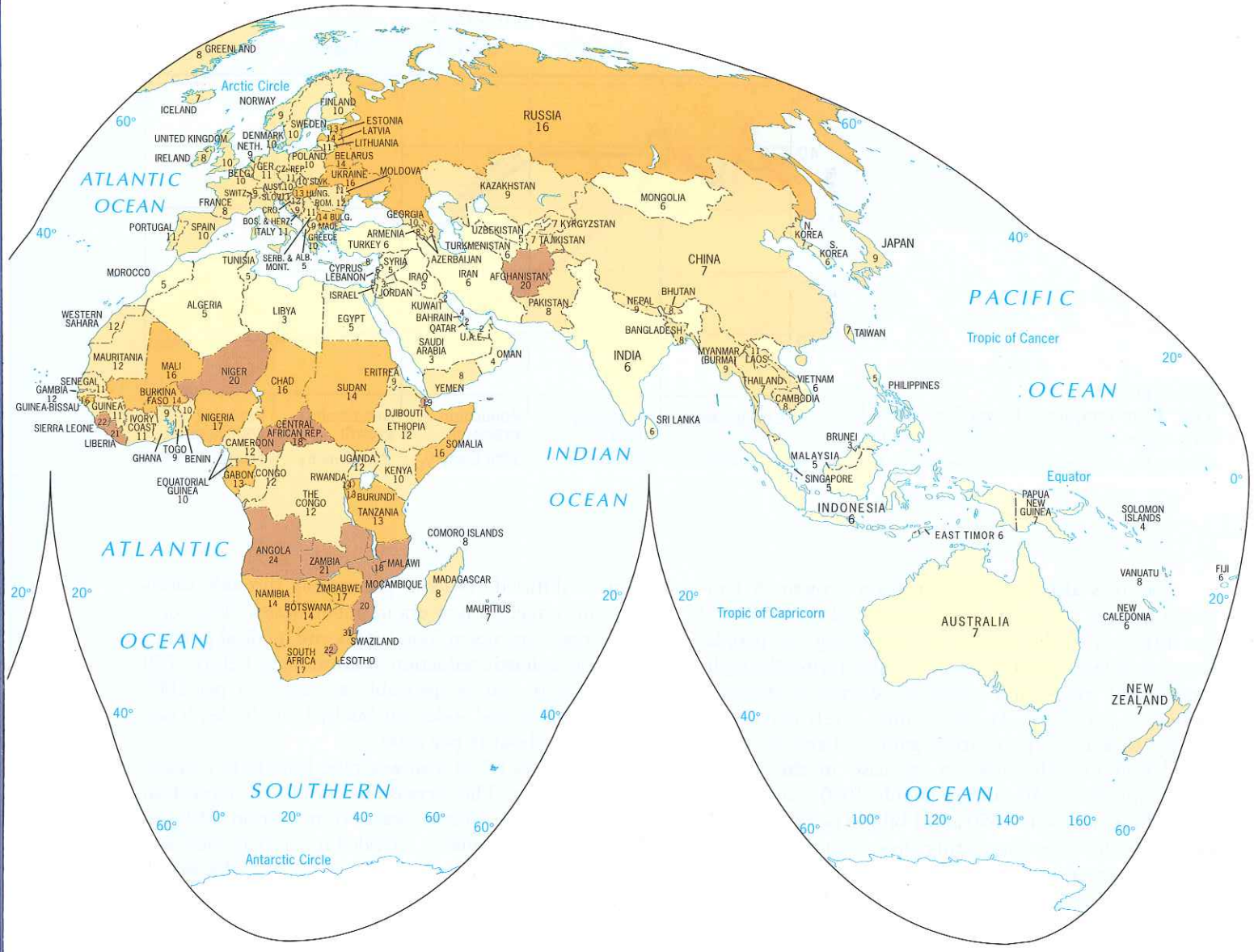


Figure 2.12
Crude Death Rate. Number of Deaths in a Year per 1000 People.
Data from: United States Census Bureau, International Data Base, 2008.

with small differences between the two. The result was low population growth. After industrialization began, the death rates in Great Britain began to fall as a result of better and more stable access to food and improved access to increasingly effective medicines. With a rapidly falling death rate and a birth rate that remained high, Britain's population explosion took place. From the late 1800s through two world wars in the 1900s, death rates continued to fall and birth rates began to fall, but stayed higher than death rates, resulting in continued population growth but at a slower rate. Finally, in recent history, both the birth rate and death rate in Great Britain declined to low levels, resulting in slow or stabilized population growth.

Demographers call the shift in population growth the **demographic transition**. The transition is typically modeled as shown in Figure 2.13. The model is based on the kind of shift that Britain experienced, but other places either have gone through a similar shift or are in the process of doing so. The initial low-growth phase, which in all places endured for most of human history, is marked by high birth rates and equally high death rates.



In this phase, epidemics and plagues keep the death rates high among all sectors of the population—in some cases so high that they exceed birth rates. For Great Britain and the rest of Europe, death rates exceeded birth rates during the bubonic plague (the Black Death) of the 1300s, which hit in waves beginning in Crimea on the Black Sea, diffusing through trade to Sicily and other Mediterranean islands, and moving through contagious diffusion and the travel of rats (which hosted the vector, the flea, that spread the plague) north from the Mediterranean.

Once the plague hit a region, it was likely to return within a few years time, creating another wave of human suffering. Estimates of plague deaths vary between one-quarter and one-half of the population, with the highest death rates recorded in the West (where trade among regions was the greatest) and the lowest in the East (where cooler climates and less connected populations delayed diffusion). Across Europe, many cities and towns were left decimated. Historians estimate the population of Great Britain fell from nearly 4 million when the plague began to just over 2 million when it ended.

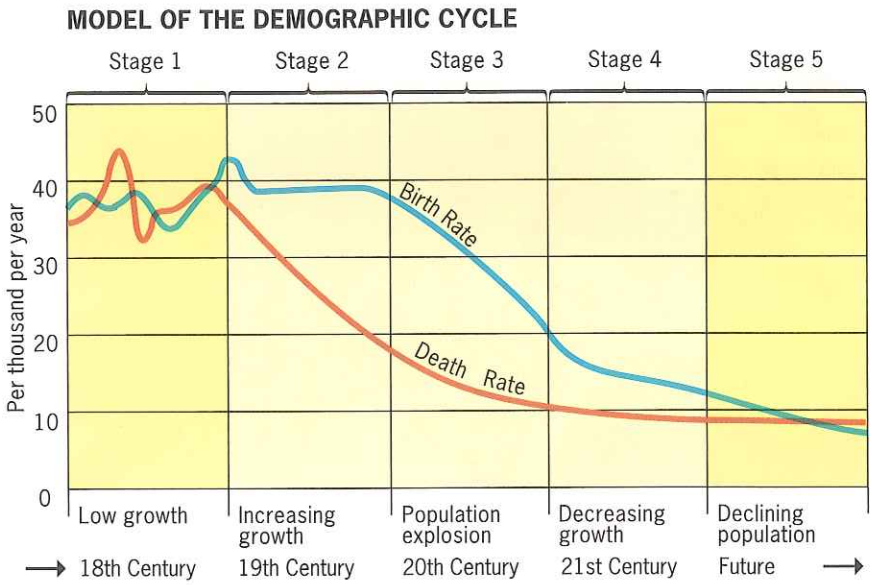


Figure 2.13
The Demographic Transition Model. Five stages of the demographic transition.

Famines also limited population growth. A famine in Europe just prior to the plague likely facilitated the diffusion of the disease by weakening the people. Records of famines in India and China during the eighteenth and nineteenth centuries document millions of people perishing. At other times, destructive wars largely wiped out population gains. Charts of world population growth show an increase in the world's population from 250 million people 2000 years ago to 500 million people in 1650 and 1 billion people in 1820. However, the lines connecting these points in time do not trend steadily upward. Rather, they turn up and down frequently, reflecting the impacts of disease, crop failures, and wars.

The beginning of the Industrial Revolution ushered in a period of accelerating population growth in Europe. Before the workers could move from farms to factories, a revolution in agriculture had to occur. The eighteenth century marked the Second Agricultural Revolution, so named because the first occurred thousands of years earlier (see Chapter 11). During the Second Agricultural Revolution, farmers improved seed selection, practiced new methods of crop rotation, selectively bred livestock to increase production and quality, employed new technology such as the seed drill, expanded storage capacities, and consolidated landholdings for greater efficiencies. With more efficient farming methods, the number of people needed in farming decreased and the food supply increased, thereby supporting a higher population overall.

In the 1800s, as the Industrial Revolution diffused through continental Europe, other advances also helped lower the death rates. Sanitation facilities made the towns and cities safer from epidemics, and modern medical practices diffused. Disease prevention through vaccination introduced a new era in public health. The combined improvements in food supply and medical practice resulted in a drastic reduction in death rates. Before 1750 death rates in Europe probably averaged 35 per 1000 (birth rates averaged under 40), but by 1850 the death rate was down to about 16 per 1000.

Birth rates fell at a slower rate, leading to a population explosion. The increase in the rate of population growth in Europe spurred waves of migration. Millions of people left the squalid, crowded industrial cities (and farms as well) to emigrate to other parts of the world. They were not the first to make this journey. Adventurers, explorers, merchants, and colonists had gone before them. In a major wave of colonization from 1500 through the 1700s, European migrants decimated native populations through conquest, slavery, and the introduction of diseases against which the local people had no natural immunity.

When a second wave of European colonization began in Africa and Asia during the late 1800s, the Europeans brought with them their newfound methods of sanitation and medical techniques, and these had the opposite effect. By the mid-1900s, declining death rates in Africa, India, and South America brought rapid population increases to these regions. At this point, new alarms and cautions of worldwide overpopulation rang.

Although the global alarms continued to ring, they subsided for populations in Europe and North America when population growth rates began to decline in the first half of the 1900s. The cause was a significant decline in birth rates. Populations continued to grow,

but at a much slower rate. Many countries in Latin America and Asia experienced falling birth rates later in the twentieth century, which helped slow the global population growth rate.

Why have birth rates declined? Throughout the 1900s, lower birth rates arrived first in countries with greater urbanization, wealth, and medical advances. As more and more people moved to cities, both the economics and the culture of large families changed. Instead of lending a hand on the family farm, children in urban areas were a drain on the family finances. At the same time, new opportunities—especially for women—were often not compatible with large families. Hence, women often delayed marriage and childbearing. Medical advances lowered infant and child mortality rates, lessening the sense that multiple children were necessary to sustain a family. In recent history, the diffusion of contraceptives, the accessibility to abortions, and conscious decisions by many women to have fewer children or to start having children at a later age have all lowered birth rates within a country.

In some parts of the world, countries are now experiencing exceptionally low TFRs. Low birth rates along with low death rates put the countries in a position of negligible, or even negative, population growth. Birth rates are lowest in the countries where women are the most educated and most involved in the labor force.

Future Population Growth

It may be unwise to assume that the demographic cycles of all countries will follow the sequence that occurred in industrializing Europe or to believe that the still-significant population growth currently taking place in Bangladesh, Mexico, and numerous other countries will simply subside. Nonetheless, many agencies monitoring global population suggest that most (if not all) countries' populations will stop growing at some time during the twenty-first century, reaching a so-called **stationary population level** (SPL). This would mean that the world's population would stabilize and that the major problems to be faced would involve the aged rather than the young. In 2004, the United Nations predicted that world population would stabilize at 9 billion in 300 years.

Such predictions require frequent revision, however, and anticipated dates for population stabilization are often moved back. Only a few years ago, the United Nations predicted world population would stabilize at 10 billion in 200 years. The United Nations changed its predictions based on lower fertility rates in many countries. All agencies reporting population predictions have to revise their predictions periodically. In the late 1980s, for example, the World Bank predicted that the United States would reach SPL in 2035 with 276 million inhabitants. Brazil's population would stabilize at 353 million in 2070, Mexico's at 254 million in 2075, and China's at 1.4 billion in 2090. India, destined to become the world's most populous country, would reach SPL at 1.6 billion in 2150.

Today these figures are unrealistic. China's population passed the 1.2 billion mark in 1994, and India's reached 1 billion in 1998. If we were to project an optimistic decline in growth rates for both countries, China's population would "stabilize" at 1.5 billion in 2070 and India's at 1.8 billion in the same year. But population increase is a cyclical phenomenon, and overall declines mask lags and spurts as well as regional disparities.

thinking geographically

Examine Appendix B at the end of the book. Study the growth rate column. Which countries have the highest growth rates? Determine what stage of the demographic transition these countries are in, and hypothesize what may lead them to the next stage.

WHY DOES POPULATION COMPOSITION MATTER?

Maps showing the regional distribution and density of populations tell us about the number of people in countries or regions, but they cannot reveal two other aspects of those populations: the number of men and women and their ages. These aspects of population, the **population composition**, are importants because a populous country where half the population is very young has quite different problems from a populous country where a large proportion of the population is elderly. When geographers study populations, therefore, they are concerned not only with spatial distribution and growth rates but also with population composition.

The composition is the structure of a population in terms of age, sex, and other properties such as marital status and education. Age and sex are key indicators of population composition, and demographers and geographers use **population pyramids** to represent these traits visually.

The population pyramid displays the percentages of each age group in the total population (normally five-year groups) by a horizontal bar whose length represents its share. Males in the group are to the left of the center line, females to the right.

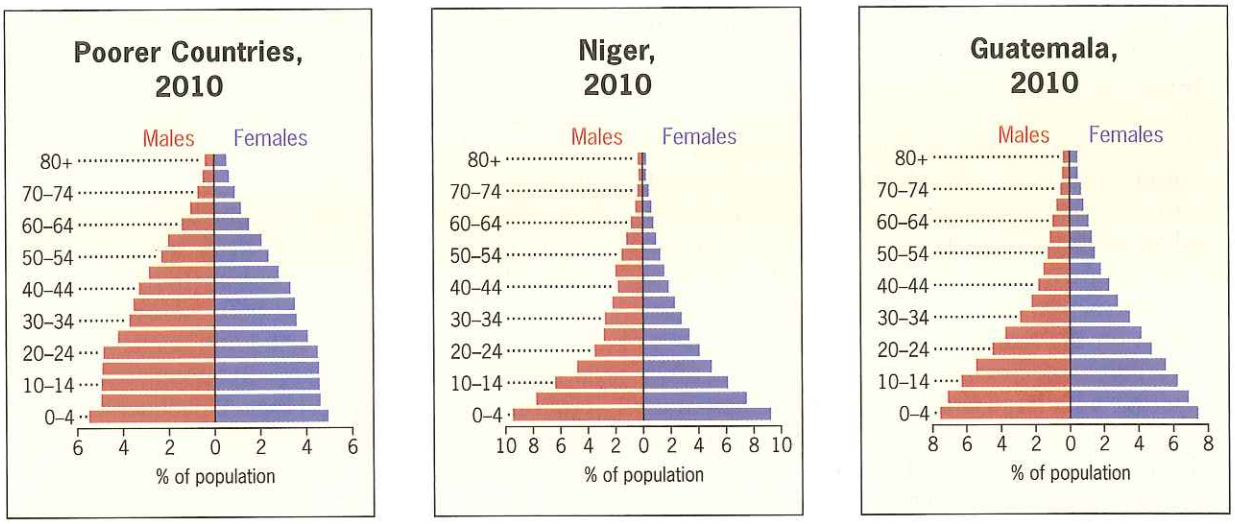


Figure 2.14
Age-Sex Population Pyramids for Countries with High Population Growth Rates.
Data from: United Nations, World Population Prospects: The 2006 Revision.

A population pyramid can instantly convey the demographic situation in a country. In the poorer countries, where birth and death rates generally remain high, the pyramid looks like an evergreen tree, with wide branches at the base and short ones near the top (Fig. 2.14). The youngest age groups have the largest share of the population; in the composite pyramid shown here, the three groups up to age 14 account for more than 30 percent of it. Older people, in the three highest age groups, represent only about 4 percent of the total. Slight variations of this pyramidal shape mark the population structure of such countries as Pakistan, Yemen, Guatemala, The Congo, and Laos. From age group 15 to 19 upward, each group is smaller than the one below it.

In countries with economic wealth, pyramid shapes change. Families become smaller, children fewer. A composite population pyramid for wealthier countries looks like a slightly lopsided vase, with the largest components of the population not at the bottom but in the middle. The middle-age bulge is moving upward, reflecting the aging of the population (Fig. 2.15) and

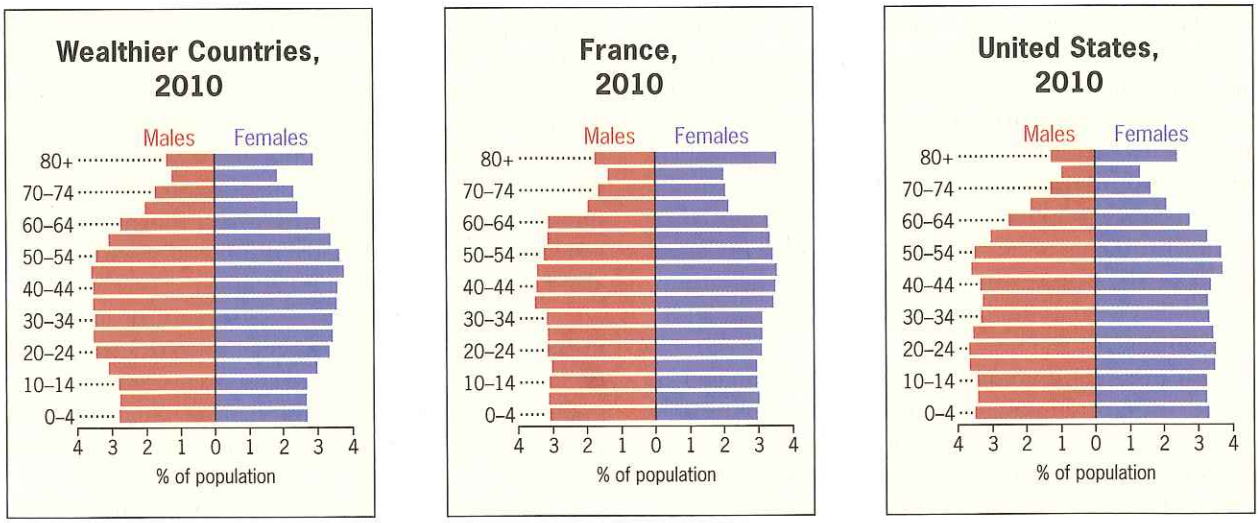


Figure 2.15
Age-Sex Population Pyramids for Countries with Low Population Growth Rates.
Data from: United Nations, World Population Prospects: The 2006 Revision.