Chapter 2
Population

A natural starting point for a book on human geography is to examine where humans live and how these patterns impact places and regions. As we move through busy cities, gridlocked with traffic, a brown haze of smog in the air, concrete in all directions, we may get the feeling that the world has reached a breaking point and cannot support any more people. But then we can visit vast open spaces, from forests and deserts to savannas and steppes, where humans have left a much more minimal imprint on the landscape. Clearly, the distribution of human population is uneven. As we will see, human populations are clustered and thus impact some locations more than others. In addition, rates of population growth vary substantially from place to place, so that the spatial distribution of clusters can shift. Population centers move over time, as people are born in particular places and move to new locations.

Population patterns and growth rates have a profound impact on places, as seen in their spatial relationships with economic and social conditions. As you can imagine, some countries face fast-growing populations, where women have many children and there is a sensation of overpopulation. In parts of the world, governments struggle to grow their economies and provide enough jobs, housing, and food for rapidly expanding populations. Shortages in these areas can sometimes lead to political instability, as peoples’ anger over unmet needs erupts into street protests, coups and revolutions, and crime.

Less obviously, some places are seeing very slow population growth or even negative growth. This can create a completely different set of problems, as governments face conditions where there may not be enough people to work and grow (or even maintain) an economy. Low population growth can lead to a situation where places have too many elderly residents relative to young, active workers.

There is a strong spatial relationship between economic and urban development, gender roles, culture, and differing rates of population growth. As people move away from farms and into cities, economic and social change has a profound impact on population dynamics. As the reader of this book, you are most likely a resident of an affluent country and live in a city or town. Given your life experience, how many children do you plan to have? Why did you choose that number? If you lived in a poor rural setting, your life experience would be very different and would have a significant impact on the number of children you would want. Where you live has a strong relationship with how much you will contribute to population growth.

Population issues also lead to important discussions on spatial interaction. When population growth is high in some places and low in others, forces of migration can come into play. Migration is covered in more detail in chapter 3, but let it suffice that population pressures on economies and environments can push people to leave some places and move to new countries or cities.
Spatial distribution of population

World population numbers

For much of human history, populations grew slowly, but once humans moved from hunting and gathering to agriculture, improved food supplies allowed population growth to speed up. Later, as more consistent food supplies were complemented by improvements in human health through medical innovation and sanitary conditions, population growth rates increased even more as in Tokyo, Japan (figure 2.1). The global human population did not reach one billion until around 1800 (figure 2.2). After that, however, the population growth rate increased quickly. In just 123 years, by 1927, the population reached two billion. Then, in just thirty-three years, by 1960, world population reached three billion. Four billion was reached by 1974, and five billion by 1987. In 1999, there were six billion, and by 2011, there were seven billion people. The human population as of 2017 was over 7.3 billion, and growing at over eighty million people per year.

These growth patterns appear to be following the S-shaped curve (figure 2.2), whereby a population grows slowly during an initial lag period and then sees a rapid increase of exponential growth.

But before getting too worried about the fact that over eighty million people are added to our planet each year, it is important to see how the growth rate is changing over time (figure 2.3). Globally, peak growth was reached between 1965 and 1970. However, since that time, the growth trend has typically sloped downward. So, while the earth’s population is still growing, it is growing less quickly than in the past. Population geographers and others believe that this downward trend will continue, with population reaching 11.2 billion by the year 2100. After that time, projections become more uncertain. The global population could continue to gradually increase, or it could ultimately reach zero growth, where the human population returns to a relatively stable equilibrium. This pattern would represent the later stages of the S-shaped curve, where population growth slows and possibly reaches a more stable plateau.

While the world’s population is over 7.3 billion people, these people are not evenly distributed over the

Figure 2.1. Tokyo, Japan. Understanding human population patterns is a first step in understanding human geography. Photo by aon168, Stock photo ID: 519265849. Shutterstock.
It took 123 years to add 1 billion people to the world between 1804 and 1927.

By 2011 it took just 12 years to add another billion people to our planet.

By 2100 the world population is estimated to reach 11.2 billion.

**Figure 2.2.** World population over time. Human population size remained relatively flat until the past one-hundred years or so. Data sources: United Nations, 1999; United Nations, 2015.

But while world population continues to expand, it is doing so at a much slower rate of growth.

From a peak around 1965-1970, the rate of growth has fallen by over 40%.

**Figure 2.3.** Population growth rate. The human population continues to grow but at a slower rate than in the past. Date source: United Nations, 2015.
planet. As pointed out earlier, humans are clustered, resulting in very distinct levels of population density.

**Population density**

Population density is used to describe the concentration of people in different parts of the world and can be calculated in several ways (figure 2.5). *Arithmetic density*, the most commonly used measure of population density, is the number of people per unit area, such as people per square mile. Arithmetic density (in countries of one million or more people) ranges from a high of over 7,500 people per square kilometer in Singapore to a low of less than two people per square kilometer in Mongolia (figure 2.4). As a comparison, the United States has about thirty-four people per square kilometer.

Another measure of population density is *physiological density*, which measures the number of people per unit of arable land and is intended to compare the number of people in an area with the amount of land available to feed them. Arable land is defined in a couple of different ways and thus can be confusing when mapping and analyzing physiological density. One definition holds that arable land is land that is suitable for cultivation. It includes land with the proper soils, elevations, slopes, and climates for growing crops. A narrower definition, which is used by the World Bank and the United Nations, holds that it is land used for annual crops, such as corn, wheat, rice, and vegetables, in contrast to permanent crops planted once, such as coffee, fruit, and nuts.

Nevertheless, the idea behind physiological density is that a high value reflects a large population with a limited amount of agricultural land. Singapore, with virtually no agriculture, has an astonishing physiological density of over 945,000 people per square kilometer of arable land. At the other extreme lies Australia, with a physiological density of only about fifty people per square kilometer of arable land. Obviously, the strategies for feeding the people of Singapore are different than those for feeding the people of Australia: either they grow food domestically, they import it, or they do some combination of the two.

A third measurement is *agricultural density*, the number of rural residents per unit of arable land, which indicates how many people are involved with agricultural production. This measure helps illuminate which countries are efficient at growing food and which are not. For instance, Egypt’s agricultural density is over 1,800, whereas it is 39 for the United States. This means

![Figure 2.4. Singapore, which is essentially urban, has one of the highest population densities in the world. Mongolia, a sparsely populated country, has one of the lowest population densities in the world. Singapore photo by Martin Ho Smart. Stock photo ID: 559395556. Shutterstock. Mongolia photo by Jan Peeters. Stock photo ID: 225794263. Shutterstock.](image-url)
that there are forty-six times more people in rural areas of Egypt relative to arable land compared to the United States. Presumably, these people are involved directly or indirectly in the agricultural economy. A lower proportion of Americans in rural areas relative to arable land implies that they are much more efficient than the Egyptians in agricultural production, possibly because of the availability of agricultural technology such as farm machinery, agricultural chemicals, and precision agricultural mapping and monitoring with geographic information systems.

When physiological and agricultural densities are high, pressure to expand arable land into new areas may increase. This expansion can cause negative environmental impacts as natural landscapes are converted to agricultural uses, displacing wild plant and animal life. One way to reduce this pressure is to import food. For example, Egypt was the world’s largest importer of wheat in 2016. If a country such as Egypt, with high physiological and agricultural densities, has a weak economy and is unable to earn foreign currency through exports, then it will be difficult to import food, and hunger can ensue. With Egypt’s economy weakened from political instability and violence in recent years, foreign currency shortages and a declining exchange rate have strained the country’s ability to import food (figure 2.6). Prices have increased for consumers, forcing the state to spend more on subsidizing bread. In contrast, countries with high physiological and agricultural densities and relatively strong economies, such as South Korea and Japan, can import food more easily and face virtually no risk of hunger.

**Population clusters**

As can be seen, the spatial distribution of people around the world varies greatly. Some places have high densities, known as population clusters, whereas others
have very low densities. Population clusters are found in several key locations (figure 2.7). East Asia, South Asia, and Europe form the largest population clusters, with other localized clusters found in parts of the Americas, Africa, and Southeast Asia. In East Asia, China alone has over 1.3 billion people, making it the largest country in the world in terms of population size. The region also includes large populations in South and North Korea as well as Japan. South Asia is dominated by India, with a population of just under

The East Asian population cluster is dominated by China, which has the world’s largest population: Over 1.3 billion.

South Asia is dominated by the second largest country, India. Its population is over 1.2 billion.

The European cluster sweeps from the Iberian Peninsula eastward into Russia and Turkey.

Figure 2.6. Waiting to buy bread in Aswan, Egypt. Egyptians rely heavily on imported wheat for their bread. With a weakened economy, prices rise, and many people struggle to purchase this staple food. Photo by Olga Vasilyeva. Stock photo ID: 418291645. Shutterstock.

Figure 2.7. Major world population clusters in Europe, South Asia, and East Asia. Sign in to your ArcGIS Online account and explore this map at http://arcg.is/2lDz8WW. Data sources: World Population Estimated Density 2015, Esri.
1.3 billion, the second largest in the world. Bangladesh, Pakistan, and Sri Lanka also have substantial populations in South Asia. Dense populations can be found in Europe as well, stretching from the Iberian Peninsula (Portugal and Spain) into the western portions of Russia and northwest Turkey. In the United States, dense populations can be found along the northeast seaboard, stretching from Boston to Washington, DC. Smaller population clusters can be found throughout the world in the form of large urban agglomerations, the result of ongoing urbanization of human society.

The distribution of population can be partially explained by the natural environment. As humans migrated out of Africa millions of years ago and spread to the far reaches of the earth’s surface, some environments proved more suitable than others for supporting large populations. Temperate climates (those that are not too hot or too cold, too wet or too dry) tend to form soils well suited for agriculture, a prerequisite for large populations. Environments with more extreme climates, such as deserts and subarctic regions, are suited only for small populations, which tend to be nomadic. Larger human populations also tend to be located at lower elevations. Exceptions to this rule are the mountain valleys of tropical regions, such as Central America, which have milder climates and better soils than the lowland tropics. Other environmental characteristics, such as natural resources or waterways for trade, can influence population distributions. For instance, arid locations with large mineral deposits or tropical rainforests with timber resources can attract people to small local clusters. Likewise, populations can cluster along coastal and river locations that facilitate trade with other areas.

While the natural environment has been an important force shaping where human populations clustered for much of human history, it is no longer the most important determinant. The differing rates of fertility, mortality, and migration that determine world population distributions now depend on a wider range of cultural, environmental, political, technological, and economic forces. For instance, since food can be easily imported from far away, the importance of agricultural potential in the growth of population clusters is diminished. Also, population growth in trade centers can be just as fast along human-built routes such as railroads and highways as along natural rivers and harbors. Airports can now replace natural seaports. With fewer restrictions tied to the natural environment in terms of food production and trade, population clusters can form in many more locations than in the past.

There are several good examples of places where populations are growing despite the natural environment, not because of it. Phoenix, Arizona, with its arid landscape and over 100 days per year when temperatures reach 100 degrees or higher, is now a thriving metropolis. The same goes for Las Vegas, Nevada (figure 2.8). In both cases, economic development and technology have allowed for populations to grow in places with difficult natural environments. Air conditioning and complex systems to deliver food and water from far away allow these places to grow in ways that were unthinkable in the past (figure 2.9).

On the opposite end of the temperature spectrum is the growing population of Astana, Kazakhstan. It lies in the flat, open steppe of Central Asia, where temperatures never rise above freezing for over 100 days per year. Its barren and remote location made it the ideal
site for Soviet gulag prison camps when it was part of the Soviet Union. With Kazakhstan’s post-Soviet independence, its capital city was relocated to Astana for political reasons, given that city’s central location in the country. Again, modern transportation and food-delivery systems mean that populations can thrive in large numbers despite the inhospitable environment.

As population clusters shift within countries, such as in movement to a new capital city or into territories previously viewed as undesirable, the population centroid changes location. This point represents the center of the country weighted by the location of the population. Imagine a flat map of the US, with weights representing people stacked up for every city, town, and rural area. The population centroid would be the point where the map would balance perfectly. Figure 2.10 shows how the US population has shifted westward and slightly southward since 1790. This shift is in response to westward agricultural settlement, development of the industrial economy of the Great Lakes region, migration to the West Coast with the railways, and later growth of the Sun Belt states.

Go to ArcGIS Online to complete exercise 2.1: “Spatial distribution of population.”

Figure 2.9. Astana, Kazakhstan. Like Las Vegas, this city has a growing population in an inhospitable climate. Coincidentally, both Las Vegas and Astana have fanciful urban landscapes that reject not only their natural environments but also historical and cultural traditions. Photo by ppl. Stock photo ID: 216420808. Shutterstock.

Figure 2.10. Population centroid of the United States. The centroid has shifted over time in response to population growth west and south from the original colonies. Data source: US Census.
The components of population
As seen so far in this chapter, the spatial distribution of population varies substantially from place to place. Environmental and economic forces play an important role in these patterns, as people cluster in areas with land suitable for agriculture or along important trade routes. But these forces tell only part of the story. As you can imagine, birth and death rates greatly vary from place to place as well. In some countries, women have many children, while in others, women have very few. Likewise, death rates can be high in some places and low in others. Naturally, the relationship between birth and death rates plays a role in population distributions. When more people are born than die, populations increase, while populations decrease when death rates are greater than birth rates. The reasons for the variation in birth and death rates include additional economic and political forces as well as cultural attitudes and beliefs.

Population growth or decline in a specific place can be calculated with a simple demographic equation:
Population change = Births − Deaths + Immigration − Emigration

This intuitive equation simply states that the population of a place changes as babies are born, people die, immigrants move in, and emigrants move out.

This chapter deals with the birth and death portion of the equation, and chapter 3 covers immigration and emigration.

Births
The crude birth rate (CBR) is the number of births per 1,000 people in a given year. The lowest CBR in 2015 was in Monaco with 6.65 births per 1,000, and the highest was in Niger with 45.45 (table 2.1). The CBR for the United States falls within the lower third of national rankings, at 12.49 births per 1,000. This measure is useful for calculating how quickly countries’

<table>
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<th>COUNTRY</th>
<th>CRUDE BIRTH RATE 2015</th>
<th>TOTAL FERTILITY RATE 2015</th>
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<tr>
<td>MONACO</td>
<td>6.65</td>
<td>1.52</td>
</tr>
<tr>
<td>NIGER</td>
<td>45.45</td>
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<td>SINGAPORE</td>
<td>8.27</td>
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<tr>
<td>UNITED STATES</td>
<td>12.49</td>
<td>1.87</td>
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</tbody>
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Table 2.1. Measurements of fertility vary greatly from place to place. Some countries face rapidly growing populations while in others births are not sufficient to replace previous generations. Data source: World Bank.
populations are growing, but its weakness is that it can be affected by the proportion of women in the population (those who may give birth) and by the age structure of the population (the proportion of young people to old people). These factors are discussed in more detail later in the chapter.

A somewhat more intuitive way of understanding population change, and one that accounts for differences in age structures and the proportion of sexes, is the total fertility rate (TFR) (table 2.1, figure 2.11). The TFR represents the average total number of children a woman will have during her lifetime. TFRs vary significantly. In Singapore, women in 2015 were having an average of just 0.81 children—less than one child per woman! The United States’ 2015 TFR fell in a moderate range of 1.87 children per woman. At the high end, Niger’s TFR was 6.76. As seen in the map, clusters of low TFRs can be found in Europe, and clusters of high TFRs are seen in sub-Saharan Africa.

Replacement fertility is the TFR necessary for a population to replace itself from one generation to the next without growing or shrinking. Replacement fertility of 2.0 would be the theoretical value, since 2.0 children would replace their two parents, resulting in no net gain or loss in population. However, because some women will die prior to reaching their reproductive years, replacement fertility is slightly over 2.0. In general, a TFR of 2.1 is used for replacement fertility. However, in developing countries with high mortality rates for infants and young adults, the rate can be a few decimal points higher. If a country has a TFR above replacement fertility, its long-term trend is toward an expanding population. Conversely, if a country’s TFR is below replacement fertility, its long-term trend is toward a shrinking population.

Look at figures 2.11 and 2.12. The countries represented in white have TFRs close to 2.1 and are in the ballpark range of replacement fertility.

**Figure 2.11.** Total fertility rate, 2015. Explore this map at http://arcg.is/2lDAgd5. Data source: World Bank.
Those in the highest category have very high TFRs and should have rapidly growing populations. Most interesting, though, is the lowest category, those with TFRs substantially below 2.1. All those countries are facing the prospect of shrinking populations, since women are having fewer children than required for replacement. It is very rare for a species to voluntarily reproduce below the replacement level, but humans appear to be doing exactly that in many parts of the world.

The rate of births in a country results from a complex mixture of variables. Obviously, access to contraception is an important variable, but other factors include the spatial relationship of where a woman lives, economic conditions, political and social stability, gender equality, education, and levels of urbanization. These are discussed in more detail later in the chapter.

Deaths
Just as populations grow when babies are born, they shrink when people die. For this reason, the second essential component of population to understand is death and the different measurements used for quantifying it.

The *crude death rate* (CDR) is the number of deaths per 1,000 people in a given year (figure 2.13). As with the CBR, there is great spatial variation in the CDR. At the low end, Qatar had a 2015 rate of 1.53 deaths per 1,000, while Lesotho had a rate of 14.89. The United States falls close to the top third, with 8.15 deaths per 1,000.

When looking at figure 2.13, you can see that the CDR can lead to some surprising results. As you may