KEY ISSUE 1

How Do Geographers Describe Where Things Are?

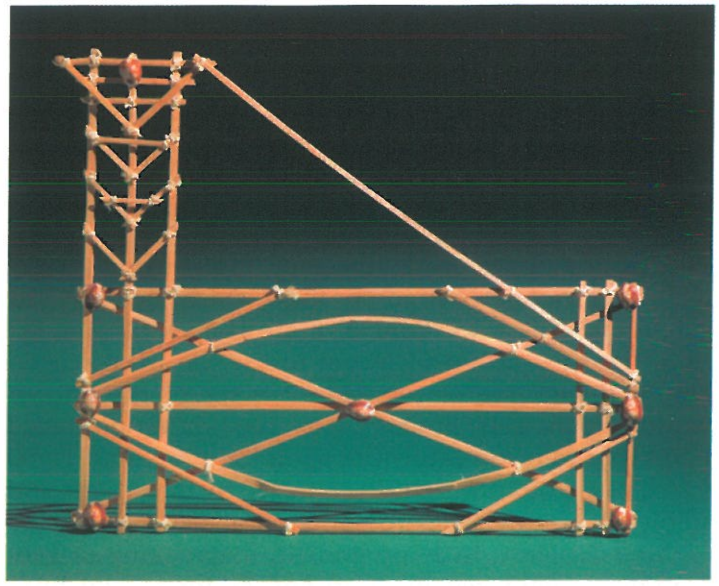
- Maps
- Contemporary Tools

The word *geography*, invented by the ancient Greek scholar Eratosthenes, is based on two Greek words. *Geo* means "Earth," and *graphy* means "to write." Geography is the study of where things are found on Earth's surface and the reasons for the locations. Human geographers ask two simple questions: Where are people and activities found on Earth? Why are they found there?

Thinking geographically is one of the oldest human activities (Figure 1-3). Perhaps the first geographer was a prehistoric human who crossed a river or climbed a hill, observed what was on the other side, returned home to tell about it, and scratched the route in the dirt. Perhaps the second geographer was a friend or relative who followed the dirt drawing to reach the other side.

Maps

Geography's most important tool for thinking spatially about the distribution of features across Earth is a map. A **map** is a two-dimensional or flat-scale model of Earth's surface, or a portion of it. A map is a scale model of the real world, made small enough to work with on a desk or computer. It can be a hasty here's-how-to-get-to-the-party sketch, an elaborate work of art, or a precise computer-generated product. For centuries, geographers have worked to perfect the science of mapmaking, called **cartography**.



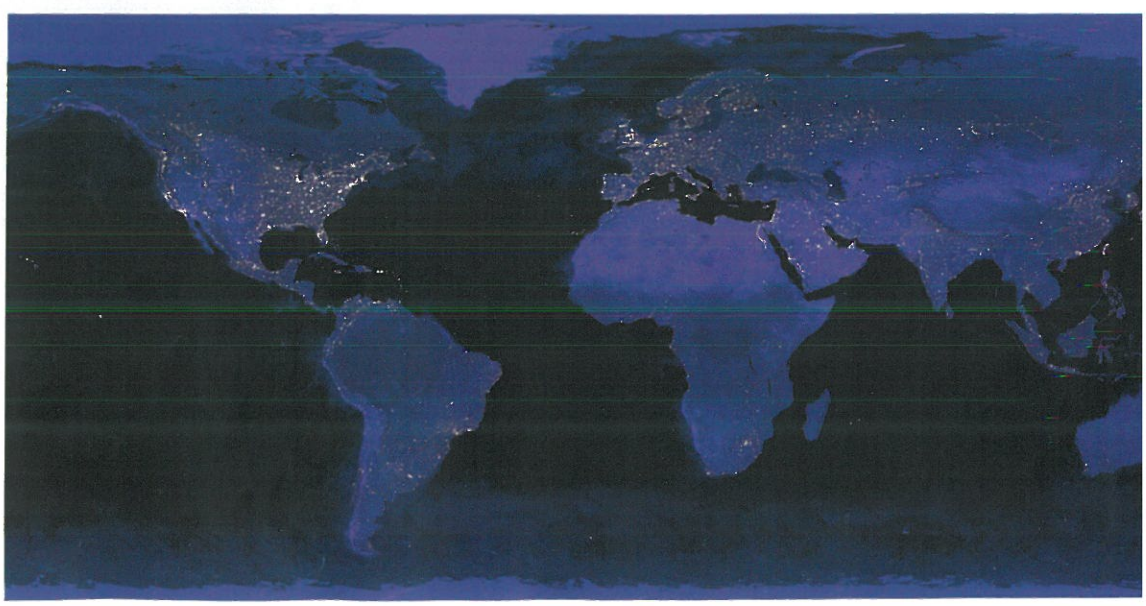
▲ **FIGURE 1-3 POLYNESIAN "STICK CHART"** A "stick chart" is a type of ancient map created by people living in the present-day Marshall Islands in the South Pacific Ocean. Islands were shown with shells, and patterns of swelling of waves were shown with palm strips.

Contemporary cartographers are assisted by computers and satellite imagery.

Geography is immediately distinguished from other disciplines by its reliance on maps to display and analyze information. A map serves two purposes:

- **As a reference tool.** A map helps us to find the shortest route between two places and to avoid getting lost along the way. We consult maps to learn where in the world something is found, especially in relationship to a place we know, such as a town, body of water, or highway. The maps in an atlas or a road map are especially useful for this purpose.
- **As a communications tool.** A map is often the best means for depicting the distribution of human activities or physical features, as well as for thinking about reasons underlying a distribution.

▶ **FIGURE 1-2 SATELLITE IMAGE: NIGHTTIME** The portion of Earth illuminated at night reflects the distribution of electricity. The dark areas are either sparsely inhabited areas, such as deserts and mountains, or areas where people are too poor to have electricity.



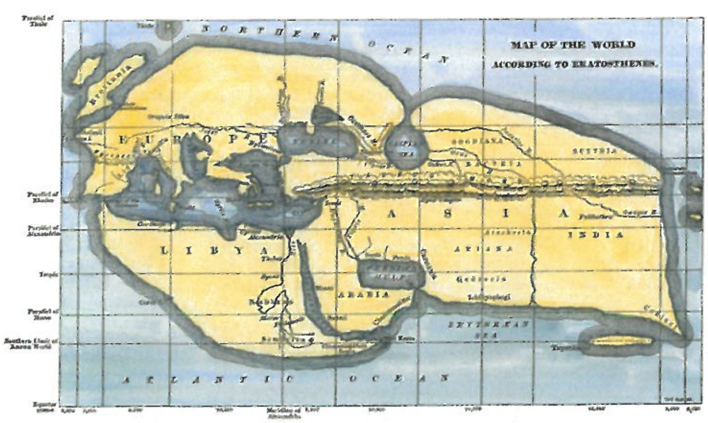
EARLY MAPMAKING

Learning Outcome 1.1.1
Explain differences between early maps and contemporary maps.

The earliest maps were reference tools—simple navigation devices designed to show a traveler how to get from Point A to Point B. Eratosthenes (276?–194? B.C.), the first person of record to use the word *geography*, prepared one of the earliest maps of the known world (Figure 1-4). Ptolemy (A.D. 100?–170?) produced maps that were not improved upon for more than 1,000 years, based on information collected by merchants and soldiers who traveled through the Roman Empire.

After Ptolemy, little progress in mapmaking or geographic thought was made in Europe for several hundred years. Maps became less mathematical and more fanciful, showing Earth as a flat disk surrounded by fierce animals and monsters. Geographic inquiry continued, though, outside Europe. Pei Xiu, the "father of Chinese cartography," produced an elaborate map of China in A.D. 267. Building on Ptolemy's long-neglected work, Muhammad al-Idrisi (1100–1165?), a Muslim geographer, prepared a world map and geography text in 1154 (Figure 1-5).

Mapmaking as a reference tool revived during the Age of Exploration and Discovery. Columbus, Magellan, and other explorers who sailed across the oceans in search of trade routes and resources in the fifteenth and sixteenth centuries required accurate maps to reach desired destinations without wrecking their ships. In turn, cartographers took information collected by the explorers to create more accurate maps. German cartographer Martin Waldseemuller (1470?–1520) produced the first map with the label "America"; he wrote on the map (translated from Latin) "from Amerigo the discoverer . . . as if it were the land of Americus, thus 'America'". Abraham Ortelius (1527–1598), a Flemish cartographer, created the first modern atlas (Figure 1-6).



▲ **FIGURE 1-4 WORLD MAP BY ERATOSTHENES, 194? B.C.** This is a nineteenth-century reconstruction of the map produced by Eratosthenes.

▲ **FIGURE 1-5 WORLD MAP BY AL-IDRISI, 1154** Al-Idrisi built on Ptolemy's map, which had been neglected for nearly a millennium.

By the seventeenth century, maps accurately displayed the outline of most continents and the positions of oceans. Bernhardus Varenius (1622–1650) produced *Geographia Generalis*, which stood for more than a century as the standard treatise on systematic geography.

Pause and Reflect 1.1.1
What is one main difference between Eratosthenes's world map (Figure 1-4) and the word map of Ortelius (Figure 1-6)?

CONTEMPORARY MAPPING

Contemporary maps are still created as tools of reference, but human geographers now make use of maps primarily as tools of communication. Maps are geographers' most essential tool for displaying geographic information and for offering geographic explanation. The feature on page 7 includes a contemporary use of maps to demonstrate issues of sustainability and inequality in New Orleans.

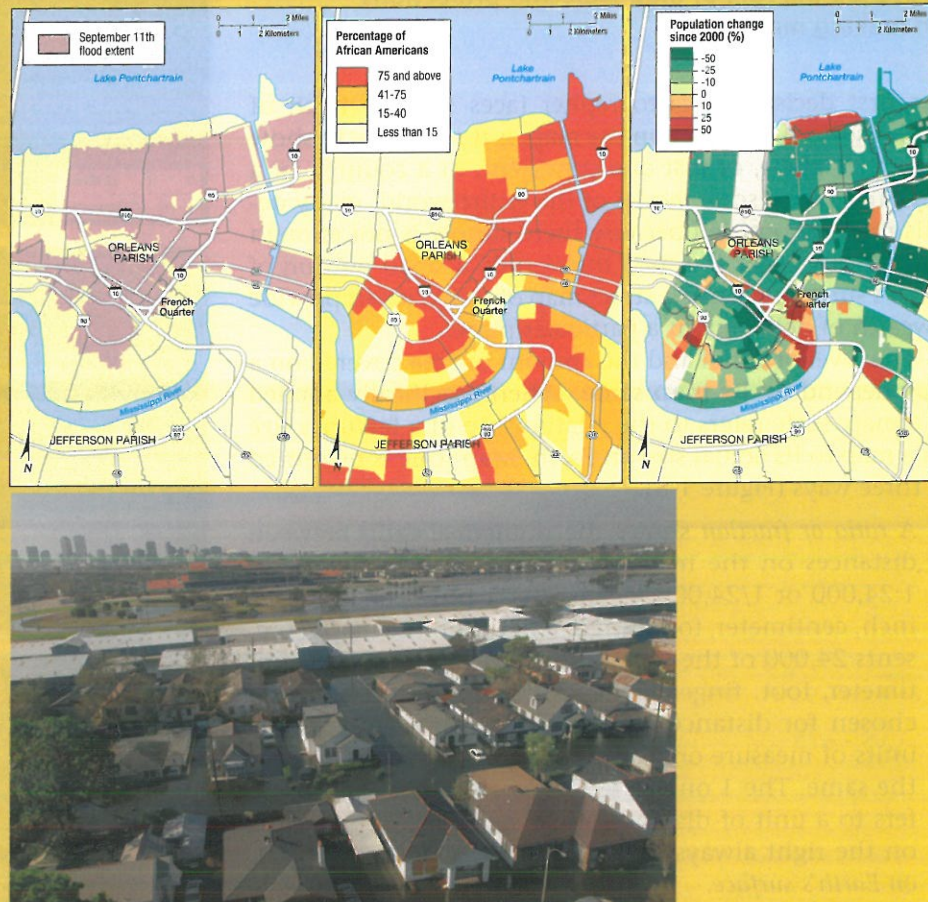
▲ **FIGURE 1-6 WORLD MAP BY ORTELIUS, 1571** This map was one of the first to show the extent of the Western Hemisphere, as well as Antarctica.

SUSTAINABILITY AND INEQUALITY IN OUR GLOBAL VILLAGE

Mapping a Disaster: Hurricane Katrina

Hurricane Katrina, one of the strongest hurricanes ever to hit the United States, struck in 2005. It killed 1,836 people and was the costliest natural disaster in U.S. history, measured in the dollar value of the destruction. The aftermath of Katrina provides a useful introduction to geographic perspectives on contemporary global issues of sustainability and inequality. Is a city like New Orleans—below sea level and protected by aging levees—sustainable in an era of rising sea levels and stronger hurricanes? Why did Katrina affect residents of New Orleans so unequally, with lower-income people much more likely to die or become homeless than more wealthy people?

Hurricanes such as Katrina form in the Atlantic Ocean during the late summer and autumn and gather strength over the warm waters of the Gulf of Mexico. When a hurricane passes over land, it can generate a powerful storm surge that floods low-lying areas. New Orleans was especially vulnerable because the site of the city is below sea level. To protect it and other low-lying cities from flooding, government agencies had constructed a complex system of levees, dikes, seawalls, canals, and pumps (Figure 1-7, left). Two days after the hurricane hit, the flood-protection levees in New Orleans broke, flooding 80 percent of the city (Figure 1-7, bottom).



▲ **FIGURE 1-7 SUSTAINABILITY AND INEQUALITY IN NEW ORLEANS** (left) Extent of flooding in New Orleans from storm surge after Katrina. (middle) Two-thirds of the population of New Orleans was African American, but the area spared the flooding was less than one-fourth African American. (right) The percentage of homes that have been fixed up and reoccupied since Katrina is lower in the areas that had relatively large African American populations than in other areas. (bottom) Flooded neighborhood in New Orleans nine days after Katrina.

Human geographers are especially concerned with the inequality of the destruction. Katrina's victims were primarily poor, African American, and older individuals (Figure 1-7, center). They lived in the lowest-lying areas, most vulnerable to flooding, and many lacked transportation, money, and information that would have enabled them to evacuate in advance of the storm. In contrast, the wealthy portions of New Orleans, such as tourist attractions like the Vieux Carré (French Quarter), were spared the worst because they were located on slightly higher ground. The slow and incompetent response to the destruction by local, state, and federal emergency teams was attributed by many analysts to the victims' lack of a voice in the political, economic, and social life of New Orleans and other impacted communities.

Inequalities persist several years after the hurricane (Figure 1-7, right). Five years after Katrina, according to the 2010 census, a large percentage of African Americans had still not returned to New Orleans. According to the census, the population of New Orleans declined from 484,674 in 2000 to 343,829 in 2010. African Americans accounted for 84 percent of the decline because most of the houses that remained damaged from the hurricane were in predominantly African American neighborhoods. The percentage of African Americans in New Orleans declined from 67 percent in 2000 to 60 percent in 2010.

MAP SCALE

Learning Outcome 1.1.2
Describe the role of map scale and projections in making maps.

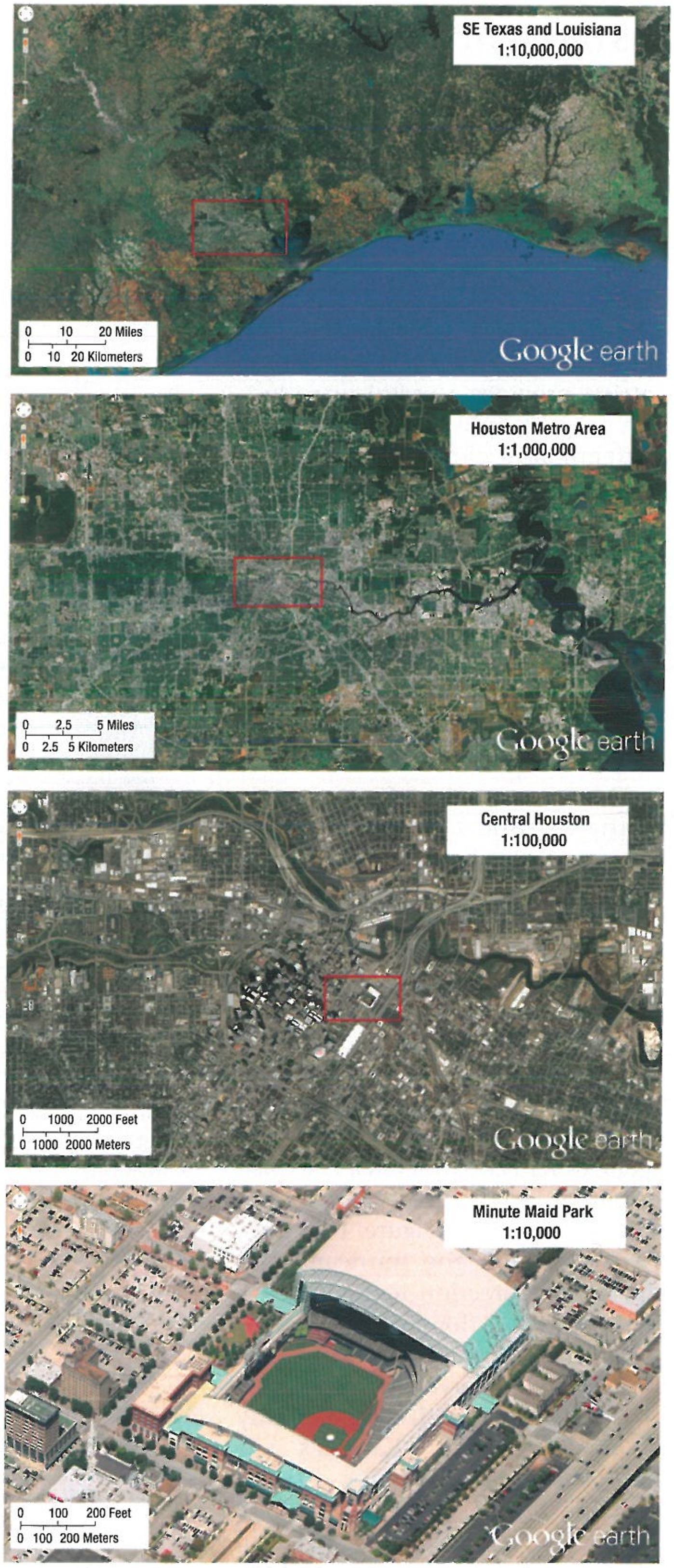
The first decision a cartographer faces is how much of Earth's surface to depict on the map. Is it necessary to show the entire globe, or just one continent, or a country, or a city? To make a scale model of the entire world, many details must be omitted because there simply is not enough space. Conversely, if a map shows only a small portion of Earth's surface, such as a street map of a city, it can provide a wealth of detail about a particular place.

The level of detail and the amount of area covered on a map depend on its **map scale.** When specifically applied to a map, scale refers to the relationship of a feature's size on a map to its actual size on Earth. Map scale is presented in three ways (Figure 1-8).

- A *ratio or fraction* shows the numerical ratio between distances on the map and Earth's surface. A scale of 1:24,000 or 1/24,000 means that 1 unit (for example, inch, centimeter, foot, finger length) on the map represents 24,000 of the same unit (for example, inch, centimeter, foot, finger length) on the ground. The unit chosen for distance can be anything, as long as the units of measure on both the map and the ground are the same. The 1 on the left side of the ratio always refers to a unit of distance *on the map,* and the number on the right always refers to the *same unit* of distance *on Earth's surface.*
- A *written scale* describes the relationship between map and Earth distances in words. For example, the statement "1 inch equals 1 mile" on a map means that 1 inch on the map represents 1 mile on Earth's surface. Again, the first number always refers to map distance and the second to distance on Earth's surface.
- A *graphic scale* usually consists of a bar line marked to show distance on Earth's surface. To use a bar line, first determine with a ruler the distance on the map in inches or centimeters. Then hold the ruler against the bar line and read the number on the bar line opposite the map distance on the ruler. The number on the bar line is the equivalent distance on Earth's surface.

Maps often display scale in more than one of these three ways.

The appropriate scale for a map depends on the information being portrayed. A map of a downtown area, such as Figure 1-8, bottom, may have a scale of 1:10,000, whereas a map of southeast Texas (Figure 1-8, top) may have a scale of 1:10,000,000. One inch represents about 1/6 mile on the downtown Houston map and about 170 miles on the southeast Texas map.



▲ **FIGURE 1-8 MAP SCALE** The four images show (top) southeast Texas (second), the city of Houston (third), downtown Houston, and (bottom) Minute Maid Park. The map of southeastern Texas has a fractional scale of 1:10,000,000. Expressed as a written statement, 1 inch on the map represents 10 million inches (about 158 miles) on the ground. Look what happens to the scale on the other three maps. As the area covered gets smaller, the maps get more detailed, and 1 inch on the map represents smaller distances.

At the scale of a small portion of Earth's surface, such as a downtown area, a map provides a wealth of details about the place. At the scale of the entire globe, a map must omit many details because of lack of space, but it can effectively communicate processes and trends that affect everyone.

PROJECTION

Earth is very nearly a sphere and is therefore accurately represented with a globe. However, a globe is an extremely limited tool with which to communicate information about Earth's surface. A small globe does not have enough space to display detailed information, whereas a large globe is too bulky and cumbersome to use. And a globe is difficult to write on, photocopy, display on a computer screen, or carry in the glove box of a car. Consequently, most maps—including those in this book—are flat. Three-dimensional maps can be made but are expensive and difficult to reproduce.

Earth's spherical shape poses a challenge for cartographers because drawing Earth on a flat piece of paper unavoidably produces some distortion. Cartographers have invented hundreds of clever methods of producing flat maps, but none has produced perfect results. The scientific method of transferring locations on Earth's surface to a flat map is called **projection** (Figure 1-9).

The problem of distortion is especially severe for maps depicting the entire world. Four types of distortion can result:

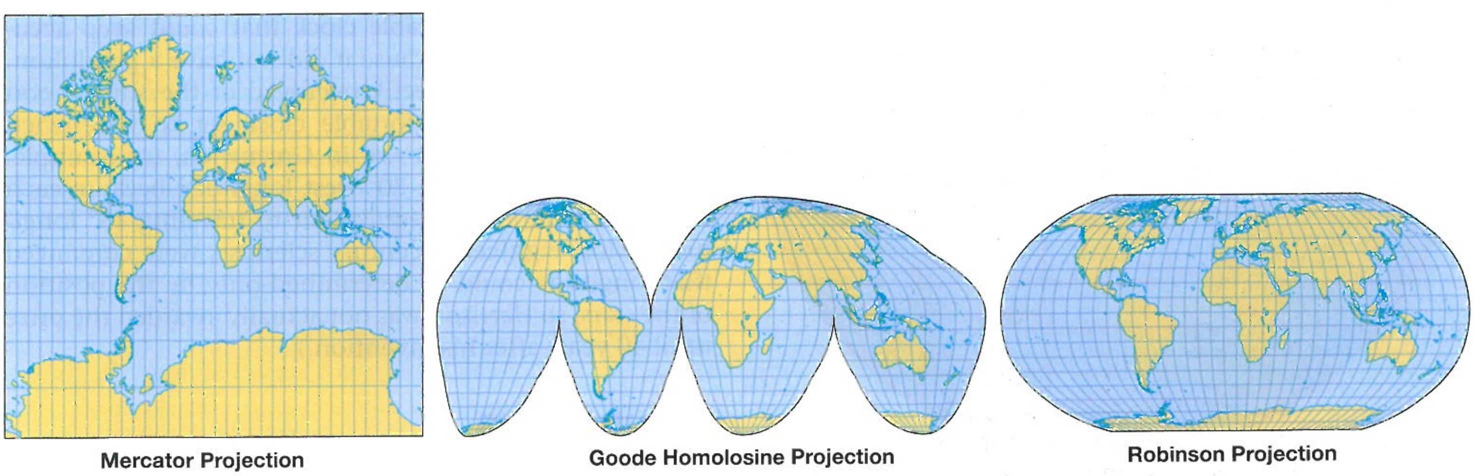
1. The *shape* of an area can be distorted, so that it appears more elongated or squat than in reality.
2. The *distance* between two points may become increased or decreased.
3. The *relative size* of different areas may be altered, so that one area may appear larger than another on a map but is in reality smaller.
4. The *direction* from one place to another can be distorted.

Most of the world maps in this book, such as Figure 1-9 center, are *equal area projections*. The primary benefit of this type of projection is that the relative sizes of the landmasses on the map are the same as in reality. The projection minimizes distortion in the shapes of most landmasses. Areas toward the North and South poles—such as Greenland and Australia—become more distorted, but they are sparsely inhabited, so distorting their shapes usually is not important.

To largely preserve the size and shape of landmasses, however, the projection in Figure 1-9 center forces other distortions:

- The Eastern and Western hemispheres are separated into two pieces, a characteristic known as interruption.
- The meridians (the vertical lines), which in reality converge at the North and South poles, do not converge at all on the map. Also, they do not form right angles with the parallels (the horizontal lines).
- The Robinson projection, in Figure 1-9 right, is useful for displaying information across the oceans. Its major disadvantage is that by allocating space to the oceans, the land areas are much smaller than on interrupted maps of the same size.
- The Mercator projection, in Figure 1-9 left, has several advantages: Shape is distorted very little, direction is consistent, and the map is rectangular. Its greatest disadvantage is that relative size is grossly distorted toward the poles, making high-latitude places look much larger than they actually are.

Pause and Reflect 1.1.2
What type of projection would be best for a world map of population density? Why?



▲ **FIGURE 1-9 PROJECTION**
(left) Mercator projection, (center) equal area projection, (right) Robinson projection. Compare the sizes of Greenland and South America on these maps. Which of the two landmasses is actually larger?

GEOGRAPHIC GRID

Learning Outcome 1.1.3

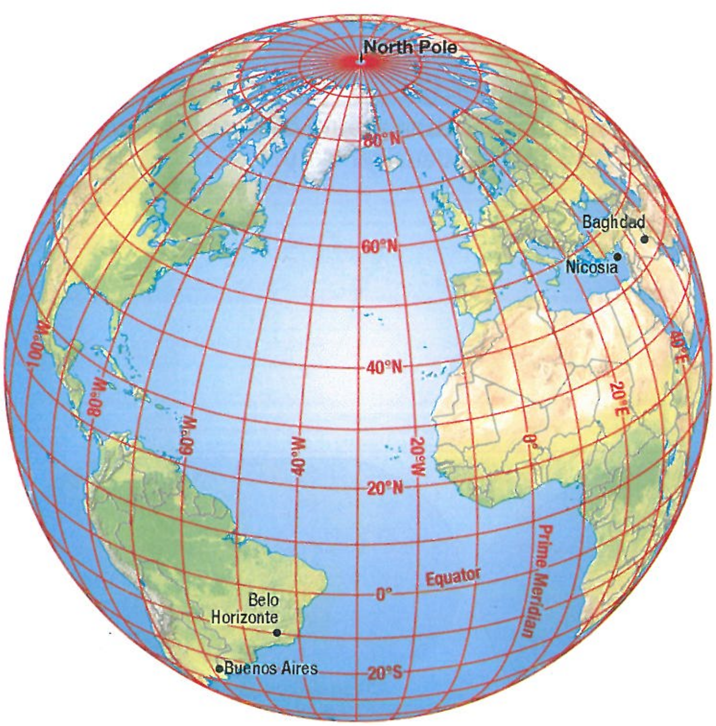
Explain how latitude and longitude are used to locate points on Earth's surface.

The geographic grid is a system of imaginary arcs drawn in a grid pattern on Earth's surface. The location of any place on Earth's surface can be described precisely by meridians and parallels, two sets of imaginary arcs drawn in a grid pattern on Earth's surface (Figure 1-10). The geographic grid plays an important role in telling time:

- A **meridian** is an arc drawn between the North and South poles. The location of each meridian is identified on Earth's surface according to a numbering system known as **longitude.**

The meridian that passes through the Royal Observatory at Greenwich, England, is 0° longitude, also called the **prime meridian.** The meridian on the opposite side of the globe from the prime meridian is 180° longitude. All other meridians have numbers between 0° and 180° east or west, depending on whether they are east or west of the prime meridian. For example, Belo Horizonte, Brazil, is located at 44° west longitude and Baghdad, Iraq, at 44° east longitude.

- A **parallel** is a circle drawn around the globe parallel to the equator and at right angles to the meridians. The numbering system to indicate the location of a parallel is called **latitude.**



▲ **FIGURE 1-10 GEOGRAPHIC GRID** Meridians are arcs that connect the North and South poles. The meridian through Greenwich, England, is the prime meridian, or 0° longitude. Parallels are circles drawn around the globe parallel to the equator. The equator is 0° latitude, and the North Pole is 90° north latitude.

The equator is 0° latitude, the North Pole 90° north latitude, and the South Pole 90° south latitude. Nicosia, Cyprus, is located at 35° north latitude and Buenos Aires, Argentina, at 35° south latitude.

Latitude and longitude are used together to identify locations. For example, Denver, Colorado, is located at 40° north latitude and 105° west longitude.

The mathematical location of a place can be designated more precisely by dividing each degree into 60 minutes (′) and each minute into 60 seconds (″). For example, the official mathematical location of Denver, Colorado, is 39°44′ north latitude and 104°59′ west longitude. The state capitol building in Denver is located at 39°42′2″ north latitude and 104°59′04″ west longitude. GPS systems typically divide degrees into decimal fractions rather than minutes and seconds. The Colorado state capitol, for example, is located at 39.714444° north latitude and 84.984444° west longitude.

Measuring latitude and longitude is a good example of how geography is partly a natural science and partly a study of human behavior. Latitudes are scientifically derived by Earth's shape and its rotation around the Sun. The equator (0° latitude) is the parallel with the largest circumference and is the place where every day has 12 hours of daylight. Even in ancient times, latitude could be accurately measured by the length of daylight and the position of the Sun and stars.

On the other hand, 0° longitude is a human creation. Any meridian could have been selected as 0° longitude because all meridians have the same length and all run between the poles. The 0° longitude runs through Greenwich because England was the world's most powerful country when longitude was first accurately measured and the international agreement was made.

Inability to measure longitude was the greatest obstacle to exploration and discovery for many centuries. Ships ran aground or were lost at sea because no one on board could pinpoint longitude. In 1714, the British Parliament enacted the Longitude Act, which offered a prize equivalent to several million in today's dollars to the person who could first measure longitude accurately.

English clockmaker John Harrison won the prize by inventing the first portable clock that could keep accurate time on a ship—because it did not have a pendulum. When the Sun was directly overhead of the ship—noon local time—Harrison's portable clock set to Greenwich time could say it was 2 P.M. in Greenwich, for example, so the ship would be at 30° west longitude because each hour of difference was equivalent to traveling 15° longitude. (Most eighteenth-century scientists were convinced that longitude could be determined only by the position of the stars, so Harrison was not actually awarded the prize until 40 years after his invention.)

TELLING TIME

Longitude plays an important role in calculating time. Earth as a sphere is divided into 360° of longitude (the degrees from 0° to 180° west longitude plus the degrees from 0° to 180° east longitude).

As Earth rotates daily, these 360 imaginary lines of longitude pass beneath the cascading sunshine. If we let every fifteenth degree of longitude represent one time zone, and divide the 360° by 15°, we get 24 time zones, or one for each hour of the day. By international agreement, **Greenwich Mean Time (GMT)**, or Universal Time (UT), which is the time at the prime meridian (0° longitude), is the master reference time for all points on Earth.

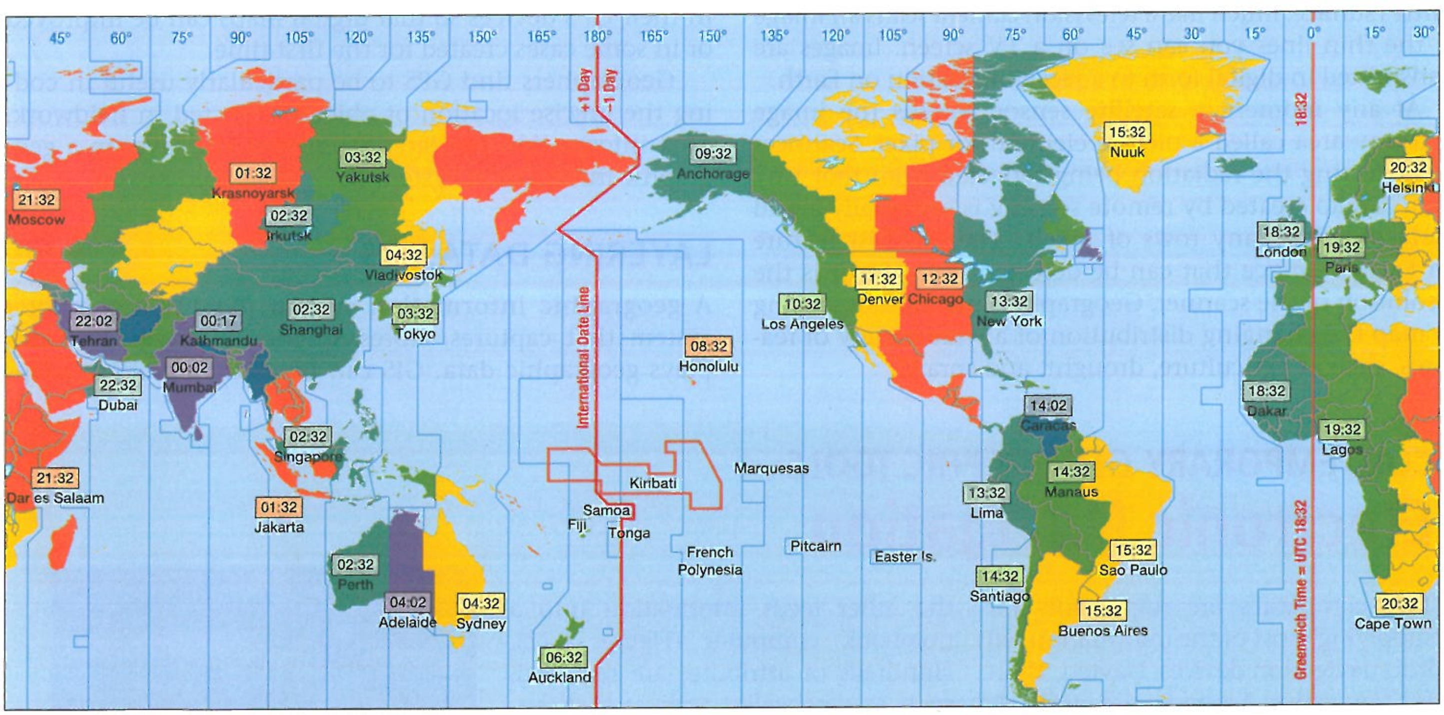
Each 15° band of longitude is assigned to a standard time zone (Figure 1-11). The eastern United States, which is near 75° west longitude, is therefore 5 hours earlier than GMT (the 75° difference between the prime meridian and 75° west longitude, divided by 15° per hour, equals 5 hours). Thus when the time in New York City in the winter is 1:32 P.M. (or 13:32 hours, using a 24-hour clock), it is 6:32 P.M. (or 18:32 hours) GMT. During the summer, many places in the world, including most of North America, move the clocks ahead one hour; so in the summer when it is 6:32 P.M. GMT, the time in New York City is 2:32 P.M.

When you cross the **International Date Line**, which, for the most part, follows 180° longitude, you move the clock back 24 hours, or one entire day, if you are heading eastward toward America. You turn the clock ahead 24 hours if you are heading westward toward Asia. To see the need for the International Date Line, try counting the hours around the world from the time zone in which you live. As you go from west to east, you add 1 hour for each time zone. When you return to your starting point, you will reach the absurd conclusion that it is 24 hours later in your locality than it really is. Therefore—if it is 6:32 A.M. *Monday* in Auckland, when you get to Honolulu, it will be 8:32 A.M. *Sunday* because the International Date Line lies between Auckland and Honolulu.

The International Date Line for the most part follows 180° longitude. However, several islands in the Pacific Ocean belonging to the countries of Kiribati and Samoa, as well as to New Zealand's Tokelau territory, moved the International Date Line several thousand kilometers to the east. Samoa and Tokelau moved it in 2011 so that they could be on the same day as Australia and New Zealand, their major trading partners. Kiribati moved it in 1997 so that it would be the first country to see each day's sunrise. Kiribati hoped that this feature would attract tourists to celebrate the start of the new millennium on January 1, 2000 (or January 1, 2001, when sticklers pointed out the new millennium really began). But it did not.

Pause and Reflect 1.1.3

Compare the stick chart in Figure 1-3 with the geographic grid in Figure 1-10. What are their similarities and differences?



▲ FIGURE 1-11 TIME ZONES

The United States and Canada share four standard time zones:

- Eastern, near 75° west, is 5 hours earlier than GMT.
- Central, near 90° west, is 6 hours earlier than GMT.
- Mountain, near 105° west, is 7 hours earlier than GMT.
- Pacific, near 120° west, is 8 hours earlier than GMT.

The United States has two additional standard time zones:

- Alaska, near 135° west, is 9 hours earlier than GMT.
- Hawaii-Aleutian, near 150° west, is 10 hours earlier than GMT.

Canada has two additional standard time zones:

- Atlantic, near 60° west, is 4 hours earlier than GMT.
- Newfoundland is 3½ hours earlier than GMT; the residents of Newfoundland assert that their island, which lies between 53° and 59° west longitude, would face dark winter afternoons if it were in the Atlantic Time Zone and dark winter mornings if it were 3 hours earlier than GMT.

Contemporary Tools

Learning Outcome 1.1.4
Identify contemporary analytic tools, including remote sensing, GPS, and GIS.

Having largely completed the formidable task of accurately mapping Earth's surface, geographers have turned to **geographic information science (GIScience)**, which involves the development and analysis of data about Earth acquired through satellite and other electronic information technologies. GIScience helps geographers to create more accurate and complex maps and to measure changes over time in the characteristics of places.

GIScience is made possible by satellites in orbit above Earth sending information to electronic devices on Earth to record and interpret information. Satellite-based information allows us to know the precise location of something on Earth and data about that place.

COLLECTING DATA: REMOTE SENSING

The acquisition of data about Earth's surface from a satellite orbiting Earth or from other long-distance methods is known as **remote sensing.** Remote-sensing satellites scan Earth's surface, much like a television camera scans an image in the thin lines you can see on a TV screen. Images are transmitted in digital form to a receiving station on Earth.

At any moment a satellite sensor records the image of a tiny area called a picture element, or pixel. Scanners are detecting the radiation being reflected from that tiny area. A map created by remote sensing is essentially a grid that contains many rows of pixels. The smallest feature on Earth's surface that can be detected by a sensor is the resolution of the scanner. Geographers use remote sensing to map the changing distribution of a wide variety of features, such as agriculture, drought, and sprawl.

PINPOINTING LOCATIONS: GPS

The system that accurately determines the precise position of something on Earth is the **Global Positioning System (GPS).** The GPS in the United States includes three elements:

- Satellites placed in predetermined orbits by the U.S. military (24 in operation and 3 in reserve).
- Tracking stations to monitor and control the satellites.
- A receiver that can locate at least 4 satellites, figure out the distance to each, and use this information to pinpoint its own location.

GPS is most commonly used for navigation, as discussed in the Contemporary Geographic Tools box. Pilots of aircraft and ships stay on course with GPS. On land, GPS detects a vehicle's current position, the motorist programs the desired destination into a GPS device, and the device provides instructions on how to reach the destination. GPS can also be used to find the precise location of a vehicle, enabling a motorist to summon help in an emergency or monitoring the progress of a delivery truck or position of a city bus. Cell phones equipped with GPS allow individuals to share their whereabouts with others.

GPS devices enable private individuals to contribute to the production of accurate digital maps, through web sites such as Google's OpenStreetMap.org. Travelers can enter information about streets, buildings, and bodies of water in their GPS devices so that digital maps can be improved or in some cases created for the first time.

Geographers find GPS to be particularly useful in coding the precise location of objects collected in fieldwork. That information can later be entered as a layer in a geographic information system (GIS), discussed next.

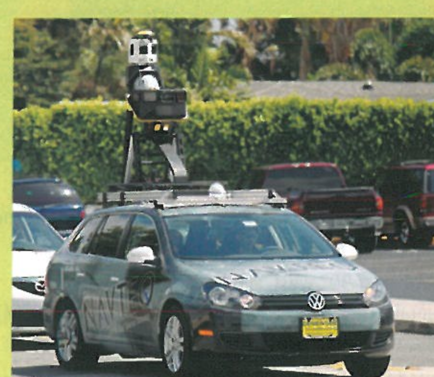
LAYERING DATA: GIS

A **geographic information system (GIS)** is a computer system that captures, stores, queries, analyzes, and displays geographic data. GIS can be used to produce maps

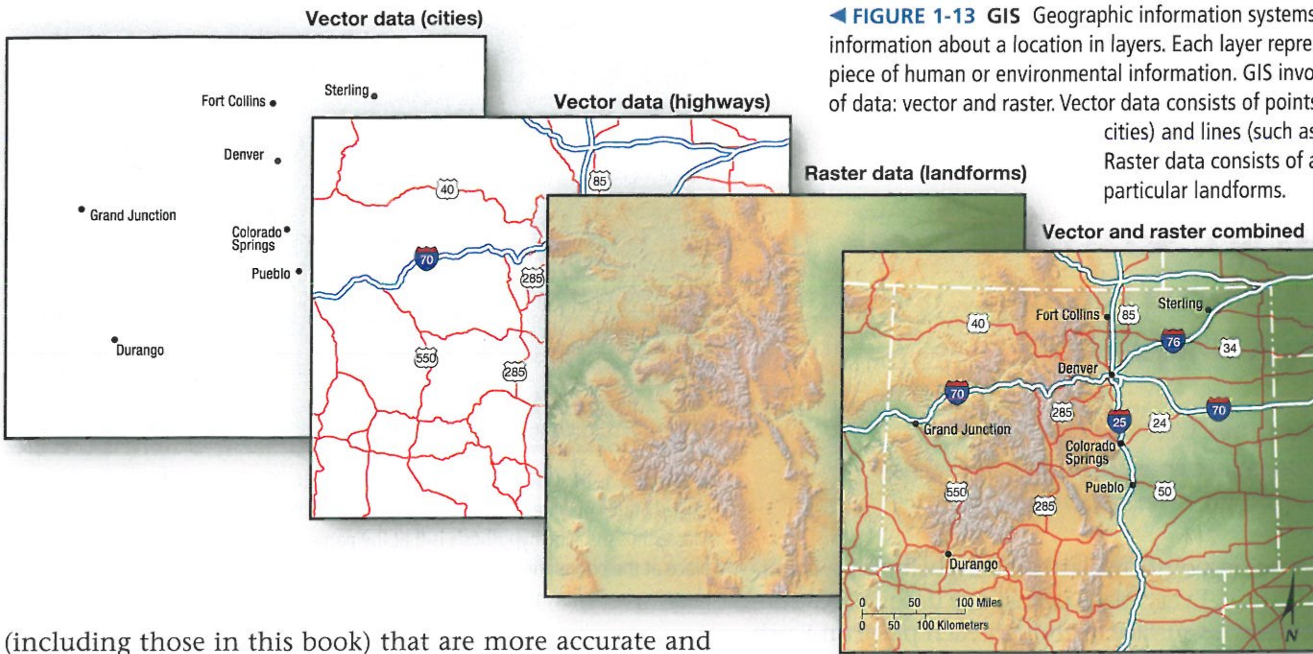
CONTEMPORARY GEOGRAPHIC TOOLS
Electronic Navigation

Two companies are responsible for supplying most of the information fed into navigation devices: Navteq, short for Navigation Technologies, and Tele Atlas, originally known as Etak. Tele Atlas, based in the Netherlands was founded in 1984, and Navteq, based in the United States, was founded a year later. Navteq and Tele Atlas get their information from what they call "ground truthing." Hundreds of field researchers drive around, building the database. One person drives, while the other feeds information into a notebook computer (Figure 1-12). Hundreds of attributes are recorded, such as crosswalks, turn restrictions, and name changes. Thus, electronic navigation systems ultimately depend on human observation.

A reflection of the growing importance of navigation technology, Navteq and Tele Atlas were both acquired in 2008 by larger communications companies (Nokia and Tom Tom, respectively).



▲ **FIGURE 1-12 GPS** Navteq researchers at work in Florida.



◄ **FIGURE 1-13 GIS** Geographic information systems store information about a location in layers. Each layer represents a different piece of human or environmental information. GIS involves two types of data: vector and raster. Vector data consists of points (such as for cities) and lines (such as for highways). Raster data consists of areas, such as particular landforms.

(including those in this book) that are more accurate and attractive than those drawn by hand.

The position of any object on Earth can be measured and recorded with mathematical precision and then stored in a computer. A map can be created by asking the computer to retrieve a number of stored objects and combine them to form an image. In the past, when cartographers drew maps with pen and paper, a careless moment could result in an object being placed in the wrong location, and a slip of the hand could ruin hours of work. GIS is more efficient than pen and ink for making a map: Objects can be added or removed, colors brightened or toned down, and mistakes corrected (as long as humans find them!) without having to tear up the paper and start from scratch.

Each type of information can be stored in a layer. For example, separate layers could be created for boundaries of countries, bodies of water, roads, and names of places. A simple map might display only a single layer by itself, but most maps combine several layers (Figure 1-13), and GIS permits construction of much more complex maps than can be drawn by hand.

Layers can be compared to show relationships among different kinds of information. For example, to protect hillsides from development, a geographer may wish to compare a layer of recently built houses with a layer of steep slopes. GIS enables geographers to calculate whether relationships between objects on a map are significant or merely coincidental. For example, maps showing where cancer rates are relatively high and low (such as those in Figure 1-25) can be combined with layers showing the location of people with various incomes and ethnicities, the location of different types of factories, and the location of mountains and valleys.

MIXING DATA: MASHUPS

Computer users have the ability to do their own GIS because mapping services provide access to the application programming interface (API), which is the language that links a database such as an address list with software such as mapping. The API for mapping software, available at such sites as www.google.com/apis/maps, enables a computer programmer to create a mashup that places data on a map.

The term *mashup* refers to the practice of overlaying data from one source on top of one of the mapping services; the term comes from the hip-hop practice of mixing two or more songs. A mashup map can show the locations of businesses and activities near a particular street or within a neighborhood in a city. The requested information could be all restaurants within 1 kilometer (0.6 mile) of an address or, to be even more specific, all pizza parlors. Mapping software can show the precise locations of commercial airplanes currently in the air, the gas stations with the lowest prices, and current traffic tie-ups on highways and bridges.

Pause and Reflect 1.1.4

State a question you have about the area where you live. Now describe a mashup that you could create using GIS that would answer your question.

CHECK-IN: KEY ISSUE 1

How Do Geographers Describe Where Things Are?

- ✓ **Maps are tools of reference and increasingly tools of communication. Reading a map requires recognizing its scale and projection.**
- ✓ **Contemporary mapping utilizes electronic technologies, such as remote sensing, GPS, and GIS.**

KEY ISSUE 2

Why Is Each Point on Earth Unique?

- Place: A Unique Location
- Region: A Unique Area

Learning Outcome 1.2.1
Identify geographic characteristics of places, including toponym, site, and situation.

A **place** is a specific point on Earth distinguished by a particular characteristic. Every place occupies a unique location, or position, on Earth's surface. Although each place on Earth is in some respects unique, in other respects it is similar to other places. The interplay between the uniqueness of each place and the similarities among places lies at the heart of geographic inquiry into why things are found where they are.

Place: A Unique Location

Humans possess a strong sense of place—that is, a feeling for the features that contribute to the distinctiveness of a particular spot on Earth—perhaps a hometown, vacation destination, or part of a country. Describing the features of a place is an essential building block for geographers to explain similarities, differences, and changes across Earth. Geographers think about where particular places are located and the combination of features that make each place on Earth distinct.

Geographers describe a feature's place on Earth by identifying its **location**, the position that something occupies on Earth's surface. In doing so, they consider three ways to identify location: place name, site, and situation.

PLACE NAMES

Because all inhabited places on Earth's surface—and many uninhabited places—have been named, the most straightforward way to describe a particular location is often by referring to its place name. A **toponym** is the name given to a place on Earth.

A place may be named for a person, perhaps its founder or a famous person with no connection to the community, such as George Washington. Some settlers select place names associated with religion, such as St. Louis and St. Paul, whereas other names derive from ancient history, such as Athens, Attica, and Rome, or from earlier occupants of the place (Figure 1-14).

A place name may also indicate the origin of its settlers. Place names commonly have British origins in North America and Australia, Portuguese origins in Brazil, Spanish origins elsewhere in Latin America, and Dutch origins in South Africa. Some place names derive from features of the physical environment. Trees, valleys, bodies of water, and other natural features appear in the place names of most languages.

▲ **FIGURE 1-14 LONGEST U.S. PLACE NAME** The longest place name in the United States may be Lake Chargoggagoggmanchauggagoggchaubunagungamaugg, Massachusetts. One hypothesis is that the name is Algonquian language for "fishing place at the boundaries—neutral meeting grounds." Others believe that the original meaning is unknown, and the current meaning and spelling are recent inventions.

The Board of Geographical Names, operated by the U.S. Geological Survey, was established in the late nineteenth century to be the final arbiter of names on U.S. maps. In recent years the board has been especially concerned with removing offensive place names, such as those with racial or ethnic connotations.

SITE

The second way that geographers describe the location of a place is by **site**, which is the physical character of a place. Important site characteristics include climate, water sources, topography, soil, vegetation, latitude, and elevation. The combination of physical features gives each place a distinctive character.

Site factors have always been essential in selecting locations for settlements, although people have disagreed on the attributes of a good site, depending on cultural values. Some have preferred a hilltop site for easy defense from attack. Others have located settlements near convenient river-crossing points to facilitate communication with people in other places.

Humans have the ability to modify the characteristics of a site. Central Boston is more than twice as large today as it was during colonial times (Figure 1-15). Colonial Boston was a peninsula connected to the mainland by a very narrow neck. During the nineteenth century, a dozen major projects filled in most of the bays, coves, and marshes. A major twentieth-century landfill project created Logan Airport. Several landfill projects continue into the twenty-first century. The central areas of New York and Tokyo have also been expanded through centuries of landfilling in nearby bodies of water, substantially changing these sites.