6.2 Using Resources Wisely

Key Questions

- ***Why is soil important, and how do we protect it?***
- ***What are the primary sources of water pollution?***
- ***What are the major forms of air pollution?***

Vocabulary

desertification
deforestation
pollutant
biological magnification
smog
acid rain

Taking Notes

Concept Map As you read, create a concept map to organize the information in this lesson.

THINK ABOUT IT Our economy is built on the use of natural resources, so leaving those resources untouched is not an option. Humans need to eat, for example, so we can't just stop cultivating land for farming. But the goods and services provided by healthy ecosystems are essential to life. We can't grow anything in soil that has lost its nutrients due to overfarming. If we don't properly manage agriculture, then, we may one day lose the natural resource on which it depends. So how do we find a balance? How do we obtain what we need from local and global environments without destroying those environments?

Soil Resources

Why is soil important, and how do we protect it?

When you think of natural resources, soil may not be something that comes to mind. But many objects you come into contact with daily rely on soil—from the grain in your breakfast cereal, to the wood in your home, to the pages of this textbook. **Healthy soil supports both agriculture and forestry.** The mineral- and nutrient-rich portion of soil is called topsoil. Good topsoil absorbs and retains moisture yet allows water to drain. It is rich in organic matter and nutrients, but low in salts. Good topsoil is produced by long-term interactions between soil and the plants growing in it.

Topsoil can be a renewable resource if it is managed properly, but it can be damaged or lost if it is mismanaged. Healthy soil can take centuries to form but can be lost very quickly. And the loss of fertile soil can have dire consequences. Years of poorly managed farming in addition to severe drought in the 1930s badly eroded the once-fertile soil of the Great Plains. Thousands upon thousands of people lost their jobs and homes. The area essentially turned to desert, or, as it came to be known, a "dust bowl," as seen in **Figure 6–5.** What causes soil erosion, and how can we prevent it?

FIGURE 6–5 The Dust Bowl A ranch in Boise City, Idaho, is about to be hit by a cloud of dry soil on April 15, 1935.

Soil Erosion The dust bowl of the 1930s was caused, in part, by conversion of prairie land to cropland in ways that left soil vulnerable to erosion. Soil erosion is the removal of soil by water or wind. Soil erosion is often worse when land is plowed and left barren between plantings. When no roots are left to hold soil in place, it is easily washed away. And when soil is badly eroded, organic matter and minerals that make it fertile are often carried away with the soil. In parts of the world with dry climates, a combination of farming, overgrazing, seasonal drought, and climate change can turn farmland into desert. This process is called **desertification,** and it is what happened to the Great Plains in the 1930s. Roughly 40 percent of Earth's land is considered at risk for desertification. **Figure 6–6** shows vulnerable areas in North and South America.

Deforestation, or loss of forests, can also have a negative effect on soil quality. Healthy forests not only provide wood, but also hold soil in place, protect the quality of fresh water supplies, absorb carbon dioxide, and help moderate local climate. Unfortunately, more than half of the world's old-growth forests (forests that had never been cut) have already been lost to deforestation. In some temperate areas, such as the Eastern United States, forests can regrow after cutting. But it takes centuries for succession to produce mature, old-growth forests. In some places, such as in parts of the tropics, forests don't grow back at all after logging. This is why old-growth forests are usually considered nonrenewable resources.

Deforestation can lead to severe erosion, especially on mountainsides. Grazing or plowing after deforestation can permanently change local soils and microclimates in ways that prevent the regrowth of trees. Tropical rain forests, for example, look lush and rich, so you might assume they would grow back after logging. Unfortunately, topsoil in these forests is generally thin, and organic matter decomposes rapidly under high heat and humidity. When tropical rain forests are cleared for timber or for agriculture, their soil is typically useful for just a few years. After that the areas become wastelands, the harsh conditions there preventing regrowth.

In Your Notebook *Describe the relationship between agriculture and soil quality.*

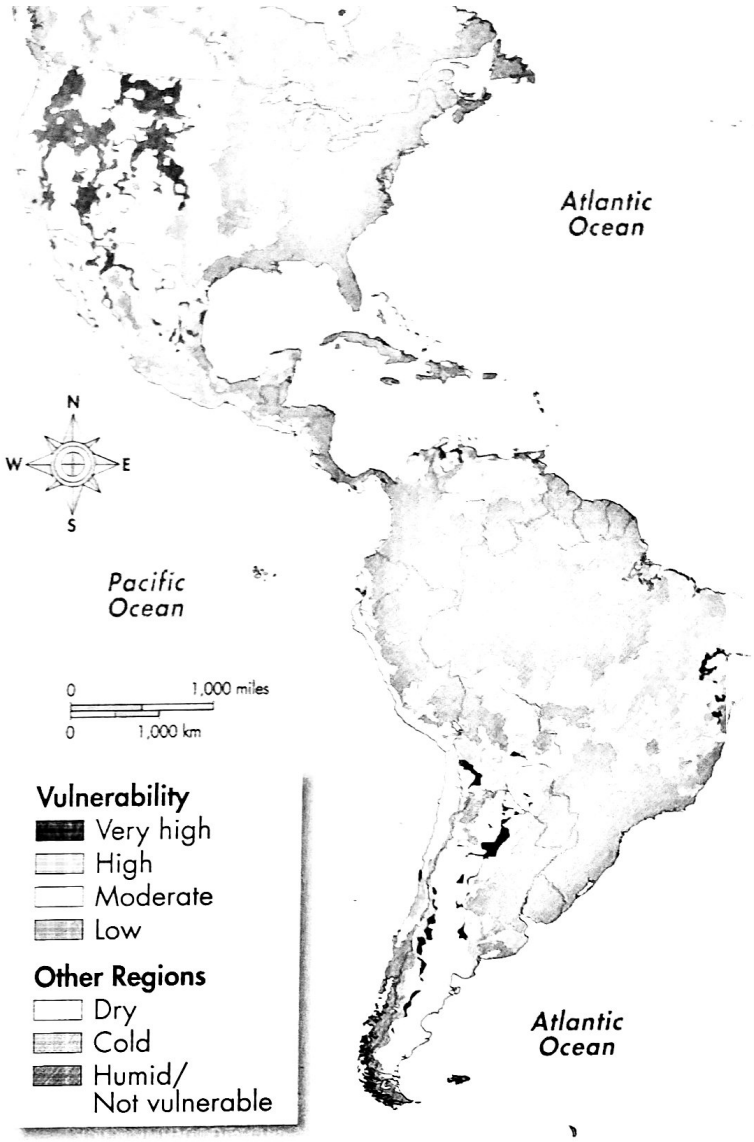


FIGURE 6–6 Desertification Risk The U.S. Department of Agriculture assigns desertification risk categories based on soil type and climate. **Interpret Visuals** ***Find your approximate location on the map. What category of desertification risk is your area in?***

MYSTERY CLUE

Forests of palm trees with strong, tall trunks and edible seeds once covered most of Easter Island. Why would the islanders have cut down these forests? What effect would deforestation have had?

FIGURE 6–7 Contour Plowing Planting crops parallel to the land's natural contours can help reduce soil erosion.

Soil Use and Sustainability **It is possible to minimize soil erosion through careful management of both agriculture and forestry.** Soil is most vulnerable to erosion when it is completely bare. Leaving stems and roots of the previous year's crop in the soil can help hold soil in place between plantings. And because different plants take different nutrients from the soil, crop rotation—planting different crops at different seasons or in different years—can help prevent both erosion and nutrient loss.

Altering the shape of the land is another way to limit erosion. The practice of contour plowing, shown in **Figure 6–7**, involves planting fields of crops across, instead of down, the slope of the land. This can reduce water runoff and therefore erosion. Similarly, terracing—shaping the land to create level "steps"—helps hold water and soil.

What are options for sustainable forestry? Selectively harvesting mature trees can promote the growth of younger trees and preserve the forest ecosystem, including its soil. In the southeastern United States, conditions enable foresters to plant, harvest, and replant tree farms. A well-managed tree farm both protects the soil and makes the trees themselves a renewable resource.

Freshwater Resources

What are the primary sources of water pollution?

Humans depend on fresh water and freshwater ecosystems for goods and services, including drinking water, industry, transportation, energy, and waste disposal. Some of the most productive American farmland relies heavily on irrigation, in which fresh water is brought in from other sources.

While fresh water is usually considered a renewable resource, some sources of fresh water are not renewable. The Ogallala aquifer, for example, spans eight states from South Dakota to Texas. The aquifer took more than a million years to collect and is not replenished by rainfall today. So much water is being pumped out of the Ogallala that it is expected to run dry in 20 to 40 years. In many places, freshwater supplies are limited. Only 3 percent of Earth's water is fresh water—and most of that is locked in ice at the poles. Since we can't infinitely expand our use of a finite resource, we must protect the ecosystems that collect and purify fresh water.

Water Pollution Freshwater sources can be affected by different kinds of pollution. A **pollutant** is a harmful material that can enter the biosphere. Sometimes pollutants enter water supplies from a single source—a factory or an oil spill, for example. This is called point source pollution. Often, however, pollutants enter water supplies from many smaller sources—the grease and oil washed off streets by rain or the chemicals released into the air by factories and automobiles. These pollutants are called nonpoint sources.

Pollutants may enter both surface water and underground water supplies that we access with wells. Once contaminants are present, they can be extremely difficult to get rid of. **The primary sources of water pollution are industrial and agricultural chemicals, residential sewage, and nonpoint sources.**

▶ ***Industrial and Agricultural Chemicals*** One industrial pollutant is a class of organic chemicals called PCBs that were widely used in industry until the 1970s. After several large-scale contamination events, PCBs were banned. However, because PCBs often enter mud and sand beneath bodies of water, they can be difficult, if not impossible, to eliminate. Parts of the Great Lakes and some coastal areas, for example, are still polluted with PCBs. Other harmful industrial pollutants are heavy metals like cadmium, lead, mercury, and zinc.

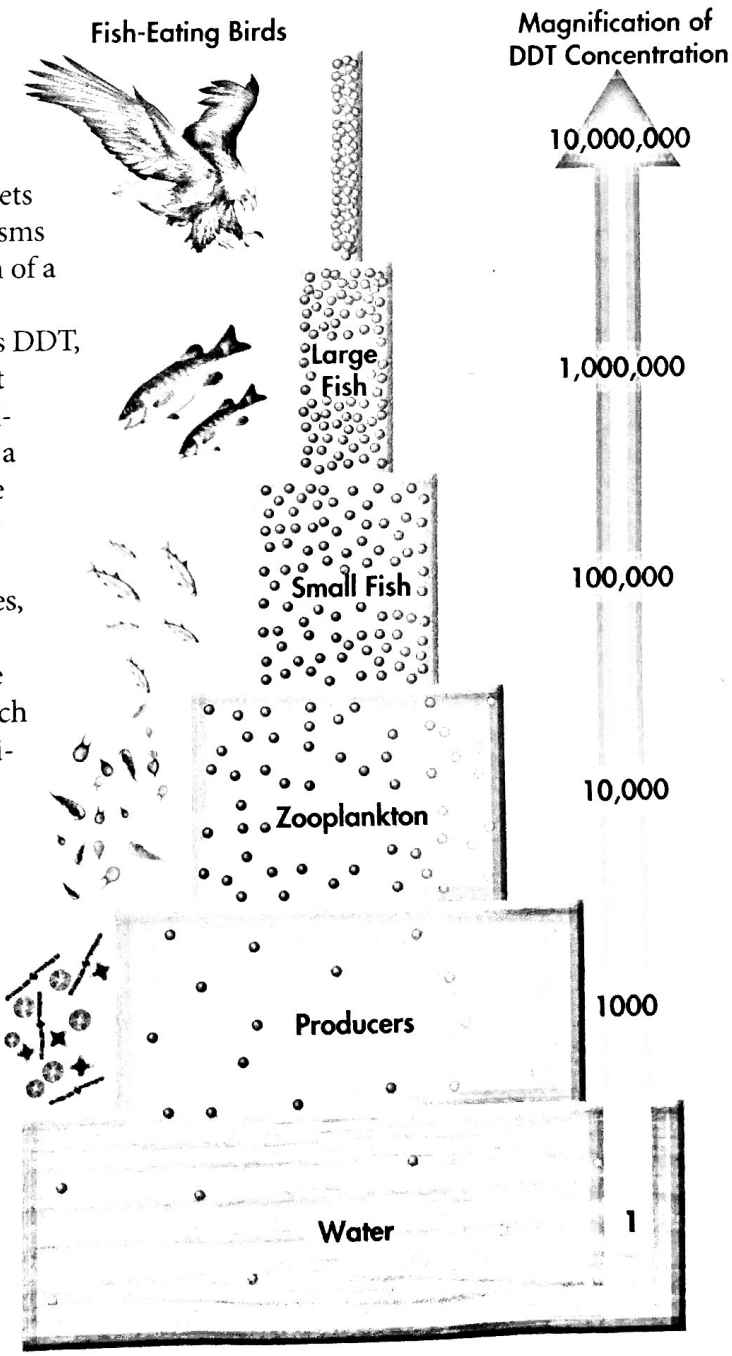
Large-scale monoculture has increased the use of pesticides and insecticides. These chemicals can enter the water supply in the form of runoff after heavy rains, or they can seep directly into groundwater. Pesticides can be very dangerous pollutants. DDT, which is both cheap and long lasting, effectively controls agricultural pests and disease-carrying mosquitoes. But when DDT gets into a water supply, it has disastrous effects on the organisms that directly and indirectly rely on that water—a function of a phenomenon called biological magnification.

Biological magnification occurs if a pollutant, such as DDT, mercury, or a PCB, is picked up by an organism and is not broken down or eliminated from its body. Instead, the pollutant collects in body tissues. Primary producers pick up a pollutant from the environment. Herbivores that eat those producers concentrate and store the compound. Pollutant concentrations in herbivores may be more than ten times the levels in producers. When carnivores eat the herbivores, the compound is still further concentrated. Thus, pollutant concentration increases at higher trophic levels. In the highest trophic levels, pollutant concentrations may reach 10 million times their original concentration in the environment, as shown in **Figure 6–8.**

These high concentrations can cause serious problems for wildlife and humans. Widespread DDT use in the 1950s threatened fish-eating birds like pelicans, osprey, falcons, and bald eagles. It caused females to lay eggs with thin, fragile shells, reducing hatching rates and causing a drop in bird populations. Since DDT was banned in the 1970s, bird populations have recovered. Still a concern is mercury, which accumulates in the bodies of certain marine fish such as tuna and swordfish.

In Your Notebook *In your own words, explain the process of biological magnification.*

FIGURE 6–8 Biological Magnification In the process of biological magnification, the concentration of a pollutant like DDT—represented by the orange dots—is multiplied as it passes up the food chain from producers to consumers. **Calculate** ***By what number is the concentration of DDT multiplied at each successive trophic level?*** MATH



► ***Residential Sewage*** Have you ever stopped to think what happens after you flush your toilet? Those wastes don't disappear! They become residential sewage. Sewage isn't poisonous, but it does contain lots of nitrogen and phosphorus. Reasonable amounts of these nutrients can be processed by and absorbed into healthy ecosystems. But large amounts of sewage can stimulate blooms of bacteria and algae that rob water of oxygen. Oxygen-poor areas called "dead zones" can appear in both fresh and salt water. Raw sewage also contains microorganisms that can spread disease.

Water Quality and Sustainability One key to sustainable water use is to protect the natural systems involved in the water cycle. For example, as water flows slowly through a wetland, densely growing plants absorb some excess nutrients and filter out certain pollutants. Similarly, forests and other vegetation help purify water that seeps into the ground or runs off into rivers and lakes. Protecting these ecosystems is a critical part of watershed conservation. A watershed includes all the land whose groundwater, streams, and rivers drain into the same place—such as a large lake or river. The idea behind watershed conservation is simple: Cleaning up the pollution in a local area can't do much good if the water running into it is polluted. You must consider the entire watershed to achieve long-lasting results.

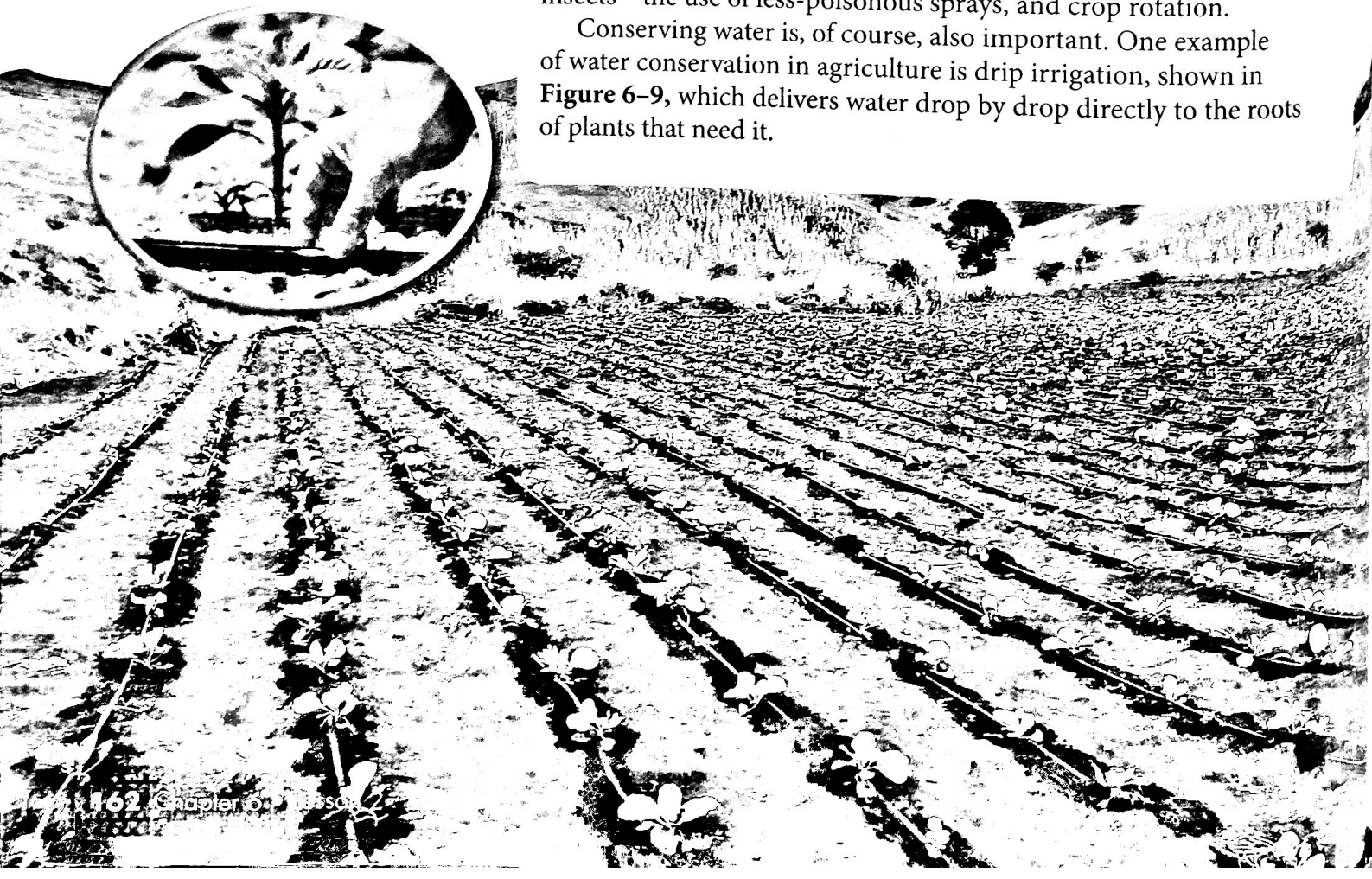
Pollution control can have direct and positive effects on the water quality in a watershed. Sewage treatment can lower levels of sewage-associated bacteria and help prevent dead zones in bodies of water receiving the runoff. In some situations, agriculture can use integrated pest management (IPM) instead of pesticides. IPM techniques include biological control—using predators and parasites to regulate for pest insects—the use of less-poisonous sprays, and crop rotation.

Conserving water is, of course, also important. One example of water conservation in agriculture is drip irrigation, shown in **Figure 6–9,** which delivers water drop by drop directly to the roots of plants that need it.

BUILD Vocabulary

RELATED WORD FORMS The verb *purify* is related to the noun *pure*. *To purify* means "to make pure or clean." Wetlands purify water by removing pollutants.

FIGURE 6–9 Drip Irrigation These cabbages are supplied water directly to their roots through drip irrigation. Tiny holes in water hoses (inset) allow farmers to deliver water only where it's needed.



Atmospheric Resources

What are the major forms of air pollution?

The atmosphere is a common resource whose quality has direct effects on health. After all, the atmosphere provides the oxygen we breathe! In addition, ozone, a form of oxygen that is found naturally in the upper atmosphere, absorbs harmful ultraviolet radiation from sunlight before it reaches Earth's surface. It is the ozone layer that protects our skin from damage that can cause cancer.

The atmosphere provides many other services. For example, the atmosphere's greenhouse gases, including carbon dioxide, methane, and water vapor, regulate global temperature. As you've learned, without the greenhouse effect, Earth's average temperature would be about 30° Celsius cooler than it is today.

The atmosphere is never "used up." So, classifying it as a renewable or nonrenewable resource is not as important as understanding how human activities affect the quality of the atmosphere. For most of Earth's history, the quality of the atmosphere has been naturally maintained by biogeochemical cycles. However, if we disrupt those cycles, or if we overload the atmosphere with pollutants, the effects on its quality can last a very long time.

Air Pollution What happens when the quality of Earth's atmosphere is reduced? For one thing, respiratory illnesses such as asthma are made worse and skin diseases tend to increase. Globally, climate patterns may be affected. What causes poor air quality? Industrial processes and the burning of fossil fuels can release pollutants of several kinds. **Common forms of air pollution include smog, acid rain, greenhouse gases, and particulates.**

▶ *Smog* If you live in a large city, you've probably seen **smog,** a gray-brown haze formed by chemical reactions among pollutants released into the air by industrial processes and automobile exhaust. Ozone is one product of these reactions. While ozone high up in the atmosphere helps protect life on Earth from ultraviolet radiation, at ground level, ozone and other pollutants threaten the health of people, especially those with respiratory conditions. Many athletes participating in the 2008 Summer Olympics in Beijing, China, expressed concern over how the intense smog, seen in **Figure 6–10,** would affect their performance and health.

In Your Notebook *Compare and contrast the atmosphere as a resource with fresh water as a resource.*

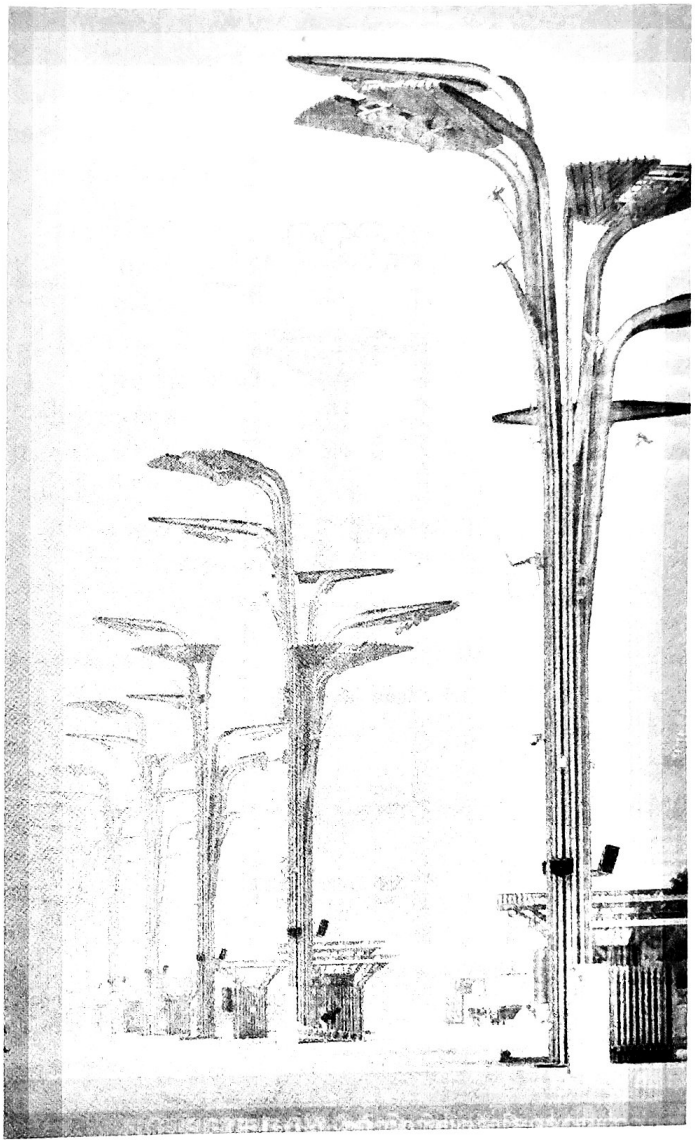


FIGURE 6–10 Smog Despite closing factories and restricting vehicle access to the city, Beijing remained under a blanket of dense smog just days before the 2008 Summer Olympics. **Apply Concepts** ***What component of smog is beneficial when part of the atmosphere, but harmful when at ground level?***