

Invisible Borders: Transboundary Pollution in Europe

16.1 Introduction

On April 28, 1986, scientists at a nuclear power plant in Sweden listened in horror as their computers began to beep. The beeps meant that there were high levels of **nuclear radiation** in the air. This form of energy, produced by nuclear power plants, is deadly to living things when present in large amounts. The signals that the Swedish scientists were receiving indicated a radiation leak—a sign that something had gone very wrong in a power plant.

The scientists searched their plant for a leak, but they soon discovered that the radiation was not from the Swedish plant. In fact, the source of the radiation was not even anywhere in Sweden. Instead, winds had carried the radiation to Sweden from the Soviet Union. Eventually the world learned that there had been an accident at a Soviet nuclear power plant called Chernobyl.

The Chernobyl accident is an example of **transboundary pollution**. As you know, **pollution** is damage to the environment that is caused by harmful substances. The word *transboundary* means “across country boundaries.” Transboundary pollution starts in one country and then spreads to other countries.

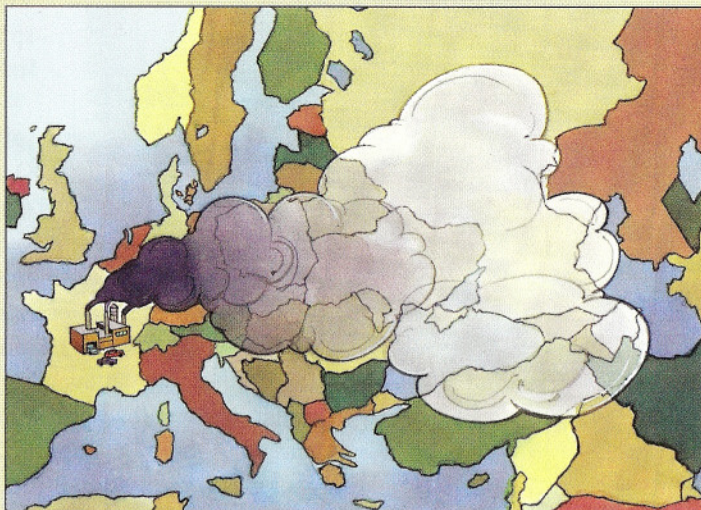
In this chapter, you will learn about several cases of transboundary pollution in Europe. You will find out how different kinds of pollution begin and how that pollution can then easily cross borders between countries. You’ll also learn about people’s efforts to reduce transboundary pollution.

Essential Question

How can one country’s pollution become another country’s problem?

This illustration shows parts of Europe and Russia. It also shows one source of transboundary pollution in this region. Notice how this pollution spreads across borders. Keep this illustration in mind as you try to answer the Essential Question.

Graphic Organizer



16.2 The Geographic Setting

Beginning in the 1700s, Europe went through a great change known as the **Industrial Revolution**. More and more goods were produced by machines instead of by hand. As a result, work moved from homes into factories. This shift created great benefits for many people. It also created big problems for the environment.

From Handmade to Machine-Made Goods Before the Industrial Revolution, people made almost everything they needed using simple hand tools. Most work was done at home or in small workshops. Goods were costly because they took so long to make.

The entire process of producing goods changed with the Industrial Revolution. The change began in the textile industry. The invention of machines to spin cotton and wool into thread and to weave thread into cloth revolutionized the way cloth was made. The new machines produced cloth much faster than people could with hand looms. Over time, people invented machines to produce everything in the modern home, from clocks to computers.

The Industrial Revolution has made life better for people in many ways. Machine-made goods are usually cheaper than those made by hand. As a result, many people today can afford to buy goods that only the rich could buy in the past. However, this revolution has also created big environmental problems. As factories churn out their goods, they also produce pollution.

Water Pollution Then

This 1858 illustration shows the River Thames in England during the Industrial Revolution. The figure in the rowboat is a symbol of death. The artist used it to represent the poisoning of the Thames by pollution.



The Granger Collection

How Pollution Occurs and Spreads

Pollution occurs when dangerous substances, such as certain chemicals, are added to the air, water, or soil. Pollution sometimes has a natural cause. A volcano, for example, may pollute the air with poisonous gases. More often, however, pollution is the result of human activity.

People create two kinds of pollution. One kind is **accidental pollution**, or pollution that occurs as the result of an accident. For example, when an oil tanker spills oil into the sea, the spill can pollute vast areas of ocean and coastline, killing fish and seabirds.

The other kind of pollution is **general pollution**, which is caused by everyday activities. One example of general pollution is the smoke that comes from burning coal to produce elec-

tricity. The smoke from coal-burning power plants pollutes the air and also contributes to **acid rain**. This is rain that has been turned slightly acid, like vinegar, by pollution in the air. Acid rain can harm plants, fish and other animals, and even buildings.

Pollution is an even bigger problem when it spreads. Wind currents can quickly spread pollution into the atmosphere. Water currents can spread it almost as rapidly through a river system. A **river system** includes a river and all the streams that flow into it. Pollution in one country can quickly become another country's problem.

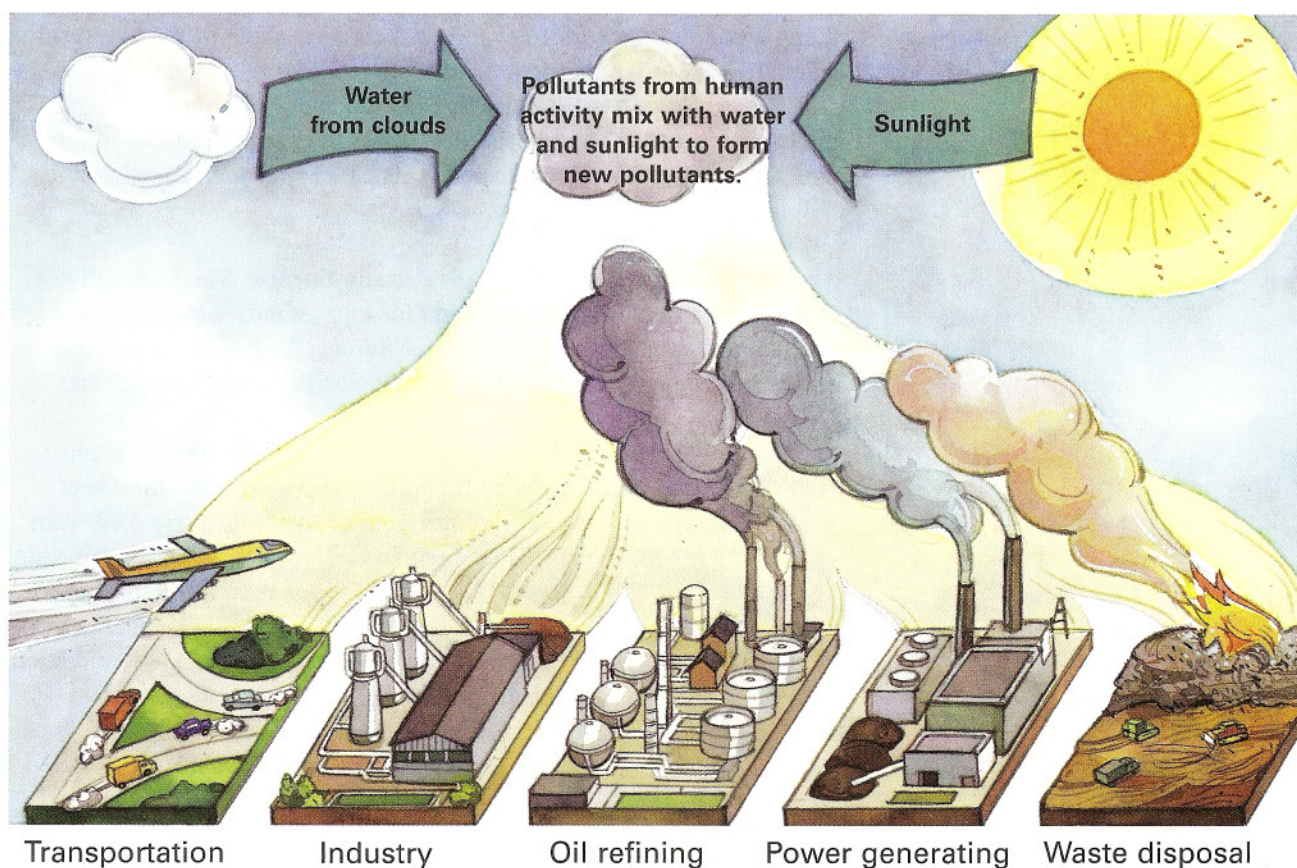
► Geoterms

acid rain rain that can damage the environment because it contains acid from factory smoke and car exhaust. Acid rain can damage plants, fish, animals, and even buildings.

nuclear radiation a form of energy that comes from nuclear reactions. Radiation has no smell or taste, but it can be very harmful to living things. Materials polluted with nuclear radiation are said to be radioactive.

river system a river and all the streams that flow into it. The streams that flow into a river are called *tributaries*.

transboundary pollution pollution that starts in one country and crosses boundaries into other countries. Generally, transboundary pollution is carried by wind or water.



Air Pollution Has Many Causes

There are many sources of air pollution. Most air pollution is caused by the burning of fossil fuels. Fossil fuels include coal, oil, and natural gas. Burning fossil fuels releases energy for heating, running motors, and making electricity. It also releases harmful chemicals into the air.

16.3 The Chernobyl Radiation Accident

At 1:24 A.M. on April 25, 1986, an explosion rocked the Chernobyl nuclear power plant. A fireball of radioactive dust rose three miles into the air. Soon the radioactive cloud rode the winds to places thousands of miles away. A terrible accident at a single power plant became a matter of concern for the entire world.

Human Error Creates a Deadly Radiation Leak The Chernobyl nuclear plant lies near the city of Kiev in Ukraine, which at that time was part of the Soviet Union. Ukraine later became independent, after the breakup of the Soviet Union into 15 separate countries.

Chernobyl was one of hundreds of nuclear power plants operating in about 30 countries around the world. These plants use uranium for fuel. The uranium is mined from the ground, like coal or copper, and then put in a special container called a *nuclear reactor*. Inside the reactor, the uranium gives off energy in the form of heat, which is used to boil water. The boiling water creates steam, which in turn powers a turbine to produce electricity.

During the Chernobyl accident, one of the reactors got too hot to control. This accident did not just “happen.” It occurred when workers doing a routine check failed to follow their own safety rules. As a result, an explosion blasted through the reactor.

The explosion started a fire that quickly raged out of control. But the biggest problem was not the fire. It was the huge cloud that formed over Chernobyl after the explosion. This cloud was made up of deadly radioactive dust.

The Radioactive Cloud Spreads Across Europe The radioactive cloud did not remain over Chernobyl for long. Winds sent it north toward Sweden and then south toward Central Europe. Radiation also moved east across Asia. It eventually crossed the Pacific Ocean to reach the United States.

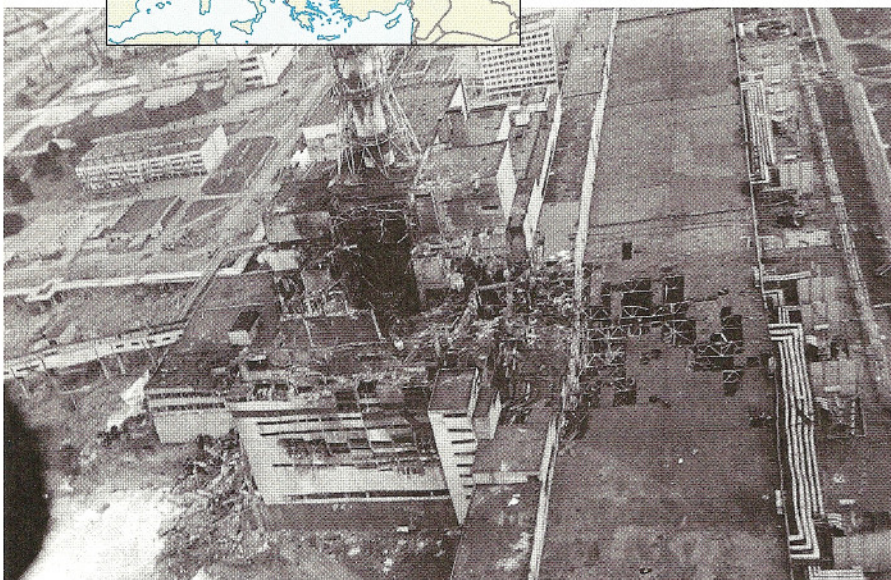
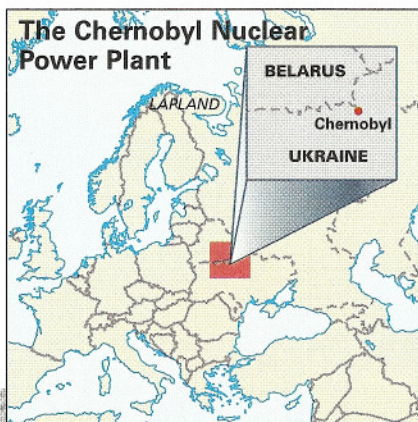
The countries closest to the Chernobyl disaster suffered the most. Hardest hit was Belarus, which borders Ukraine to the north. About

70 percent of the radioactive dust from Chernobyl fell on Belarus, contaminating its soil and water. As a result, the people of Belarus eat, drink, and breathe radiation every day. This exposure to radiation has led to higher rates of cancer in Belarus than in other countries.

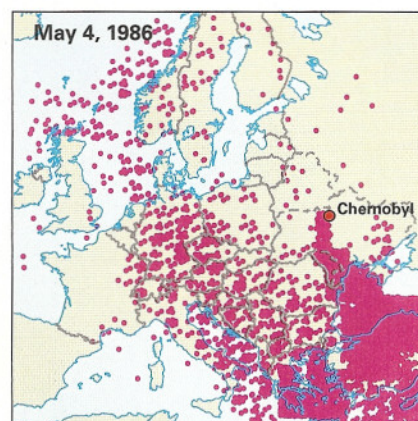
The people of Lapland also suffered as a result of the accidental pollution from Chernobyl. Lapland is an area in the far north of Europe, including part of Sweden. Many people in Lapland fish or raise herds of reindeer for a living. After the Chernobyl accident, radiation polluted their fishing grounds and reindeer herds, killing large numbers of fish and reindeer. Those that survived were not safe to eat.

A Deadly Explosion at Chernobyl

The explosion at the Chernobyl nuclear power plant left a pile of rubble on the ground. It also spread radioactive pollution over a wide area. Children who were exposed to this radiation have a higher than normal risk of getting cancer.



Radiation Spread from Chernobyl



Efforts to Reduce Radioactive Pollution At first, the Soviet government denied that there had been an accident. But Swedish scientists sounded alarms about the rising radiation levels. Finally, the Soviets made an announcement on television.

An accident has taken place at the Chernobyl power station, and one of the reactors was damaged. Measures are being taken to eliminate the consequences of the accident. Those affected by it are being given assistance.

The Soviet government sent an army of engineers into Chernobyl. Over the next few weeks, they built a huge concrete box around the damaged reactor. This giant tomb will have to remain in place until the reactor is no longer dangerously radioactive—a process that will take hundreds of years.

In addition to securing the reactor, the Soviet government relocated people living closest to the plant to safer areas. About 135,000 people had to leave their homes, in many cases without prior warning. Rescue workers would suddenly appear at their homes, looking like spacemen in their protective clothes, and hurry residents onto buses. Workers also destroyed contaminated crops, food, and animals. Despite these efforts, an estimated 8,000 people have died in Ukraine from health problems caused by radiation.

Chernobyl was the world's worst nuclear accident. Since then, world leaders have paid greater attention to improving safety at nuclear power plants. Changes in reactors make them less likely to overheat and make it easier to shut the reactors down in an emergency. These efforts reduce the chances that accidents at power plants will cause major radiation pollution in the future.

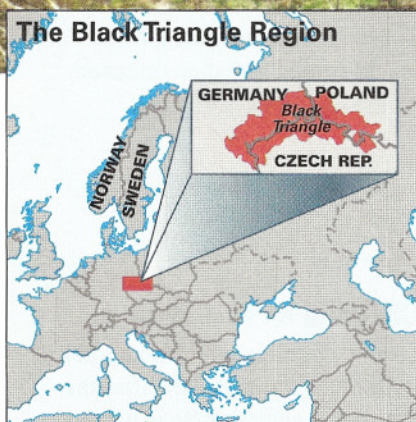
A Deadly Cloud

These maps show how quickly winds spread radiation released by the Chernobyl explosion.

Checking for Radiation

This inspector is checking a train in Germany for radiation after the Chernobyl accident. He is using a Geiger counter. This device clicks when it measures radiation nearby. The more radiation there is, the faster a Geiger counter clicks.





A Region of Dying Trees

A “black triangle” of factories and power plants spreads across Central Europe. Air pollution in this region is killing forests and fish.

16.4 The “Black Triangle” and Acid Rain

Tourists flock to Europe each year to visit its famous stone monuments. Some of these monuments, such as ancient Greek temples and Roman bridges, are more than 2,000 years old. They have survived wars, floods, and fires. But they may not survive modern pollution. Acid rain is slowly eating away at these precious relics.

Soot from Factories Creates Acid Rain As you read, acid rain is caused by pollution of the air. People cause most air pollution by burning things. A century ago, when many people burned coal to heat their homes, thick clouds of soot hung over many cities. Today exhaust from factories and cars are the main sources of air pollution and, in turn, acid rain.

Air pollution is a problem in many places, but some areas create more pollution than others. One major source of air pollution, and acid rain, is the “triangle” where Germany, Poland, and the Czech Republic meet. Many factories and power plants are located here, and most of them burn lignite, a soft brown coal, as their main fuel. Because soot from the burning coal blackens the air, this area is often called the “Black Triangle.”

When lignite burns, it gives off two chemicals, sulfur dioxide and nitrogen oxides. When these two chemicals react with water, they form acids. Acids have a sour taste. You can taste acid in lemon juice or vinegar. Acids are also corrosive, which means they will slowly eat away at something until it is destroyed.

Acid rain results from sulfur dioxide and nitrogen oxides mixing with water in the air. When acid rain or snow falls on lakes, it can turn the lake water acidic. In some lakes, high acid levels have killed fish. Acid rain can also harm forests, weakening trees by eating away at their leaves or needles.

The Sudety Mountains are on the border between Poland and the Czech Republic, just east of the Black Triangle. That means they are **downwind**, or in the direction the wind is blowing, of some of the worst pollution in Europe. If you go there, you will see many sick trees without leaves.

Air Pollution Brings Acid Rain to Other Countries Ever since people began burning coal as a fuel, acid rain has been a problem. But in the past the problem was more severe in cities, where most factories were located and large numbers of people lived.

Beginning in the 1950s, however, acid rain was no longer mostly an **urban** problem. Around that time, coal-burning factories and power plants began constructing very high chimneys. The smoke coming out of these chimneys was carried away by high winds. These new, taller chimneys improved the air quality in industrial cities, but led to the spread of air pollution over much wider areas.

Today air pollution from the Black Triangle results in acid rain and snow falling on many countries. In Sweden and Finland, a great majority of the pollution that causes acid rain originates in other countries, especially Germany and Poland. Naturally, these countries are very concerned about reducing acid rain and the air pollution that causes it. They recognize that such an undertaking, however, involves the cooperative effort of many countries.

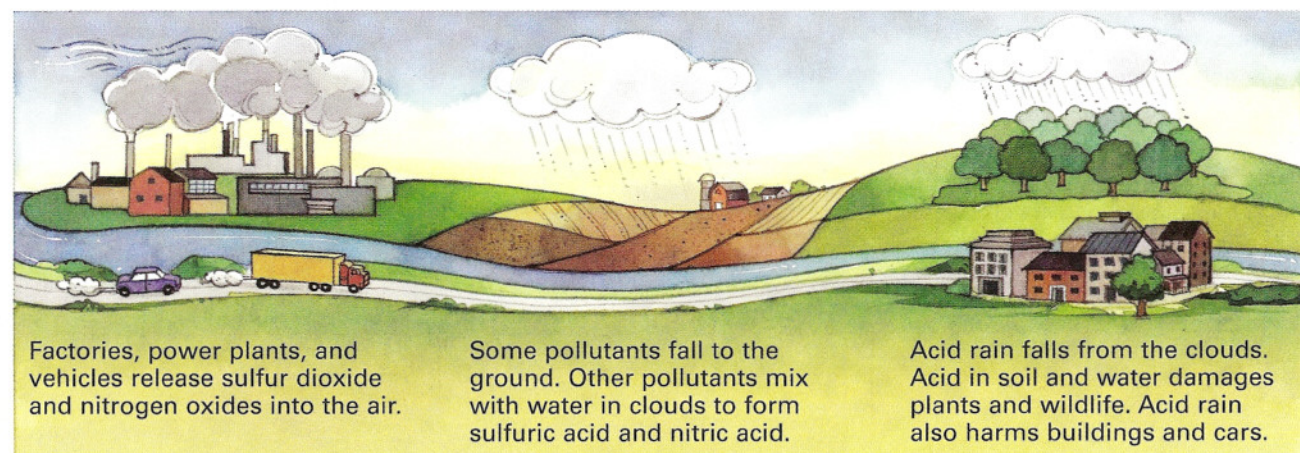
Efforts to Reduce Acid Rain The countries of Europe are trying to reduce acid rain in many ways. One approach is to offer rewards to companies that reduce pollution. Some governments propose doing this by allowing companies that pollute less to pay lower taxes.

Another approach is to promote new technologies that result in less pollution. For example, many factories and power plants that burn coal have begun installing devices called *smokestack scrubbers*. These scrubbers chemically remove the sulfur dioxide from the gases leaving the smokestack; as a result, less pollution enters the air. Another technology that reduces air pollution is the catalytic converter that is required equipment on most cars manufactured today. The converter works in a similar way to the smokestack scrubber to reduce the emissions of nitrogen oxides from exhaust pipes. Other pollution-reducing technologies have been created that are specific to certain appliances and businesses.

A third approach to reducing acid rain is to decrease the use of coal as a fuel for power plants and factories. Scientists today are looking for new ways to harness the power of the wind, water, and sun. Using wind, water, and sun to generate electricity does not pollute the air or cause acid rain. You will learn more about these alternative energy sources in Chapter 24.

The Impact of Acid Rain

Acid rain is rain that pollution has turned acidic. When acid rain falls on forests, leaves and needles turn brown. Acid rain also dissolves nutrients in the soil. The nutrients then wash away before plants can use them.



Factories, power plants, and vehicles release sulfur dioxide and nitrogen oxides into the air.

Some pollutants fall to the ground. Other pollutants mix with water in clouds to form sulfuric acid and nitric acid.

Acid rain falls from the clouds. Acid in soil and water damages plants and wildlife. Acid rain also harms buildings and cars.

16.5 The Tisza-Danube Cyanide Spill

On January 30, 2000, a large amount of cyanide spilled into a river in Central Europe. Cyanide is a **toxic chemical** that is used in mining and other industries. This accidental spill triggered the worst environmental disaster in Europe since Chernobyl. In fact, many people called the spill the “water Chernobyl.” Central European countries are still seeing the effects of this disaster.

The Tisza-Danube River System



A Burst Dam Releases Deadly Chemicals The accident took place at a mining operation in Romania, one of 13 Central European countries in the Danube river system. The mining company used cyanide to separate gold from less valuable rock. The cyanide was then stored in a pond formed behind a small dam.

On the night of the spill, a driving rain swelled the pond, causing the water to reach a dangerous level. Suddenly, the dam burst. About 100,000 cubic meters of water laced with cyanide spilled out of the pond and into a river. This surge of **toxic waste** was enough to fill about 30 Olympic-size swimming pools.

Cyanide Flows into the Danube River System The cyanide spilled first into the Szamos River in Romania.

The Szamos carried the toxic waste across Hungary, where it entered the Tisza River. The Tisza then emptied into the Danube River, which carried the toxic spill across Serbia and Montenegro and Bulgaria. Finally, the cyanide emptied into the Black Sea.

The first sign of this transboundary pollution was dead fish. The cyanide killed some 200 tons of fish as it washed down the Tisza River. Otters living in all three rivers died by the hundreds after eating the poisoned fish, and the rivers' bird population, especially fish-eating species, was also affected.

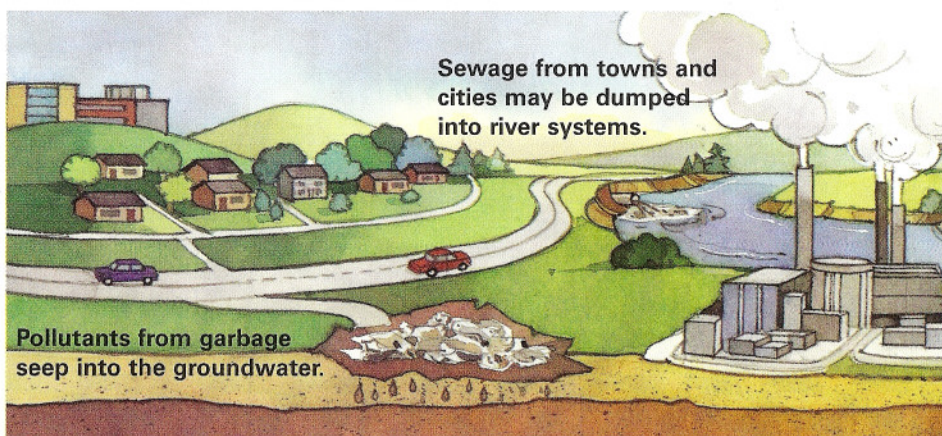
The toxic spill also affected the water supply of some 2.5 million people along the Danube river system. Fearing the pollution, towns along the Tisza and Danube shut down their water systems. People near the rivers flew black banners and posted warning signs for people to stay away from the water. Many tourists canceled their trips to the area, fearing the contamination.

Poisoned from Source to Sea

The Tisza-Danube river system was poisoned in 2000. The source of the poison was a cyanide spill in Romania. Rivers carried the poison all the way to Black Sea.

Sources of Water Pollution

Water pollution comes from both urban and rural areas. Factories and farms create waste that pollutes water. Garbage and sewage from towns and cities add to the problem. Acid rain pollutes water as well.



Efforts to Reduce Water Pollution As deadly as the cyanide was, its effects did not last long, since cyanide breaks down in sunlight. By the time the spill reached the Danube, it was no longer toxic to fish. Even so, scientists do not know how long it will take for the river to recover completely. Most agree that it could take many years.

The spill did have one positive outcome. It focused people's attention on pollution in the waterways that make up the Danube river system. Mining accidents are only one source of pollution. The runoff from farms adds chemicals and fertilizers to the river water, and transport boats pollute it with oil and lead. Factories also pollute the rivers, and many towns dump untreated **sewage** into these waterways as well.

The United Nations Environment Program and the European Union, as well as other environmental organizations, have all committed to helping solve the Danube's environmental problems. In addition, the International Commission for the Protection of the Danube River was established in 1998. The members of the commission represent the 13 countries that share the Danube river system. They are working together to find ways to reduce transboundary pollution in this region.

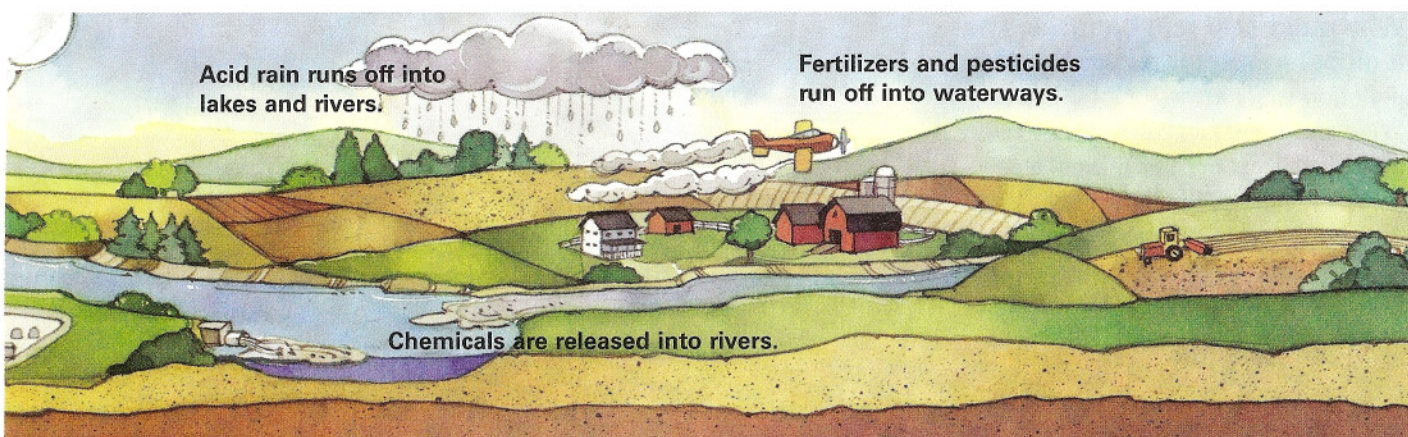
On June 29, 2004, the commission held its first "Danube Day." On that day, millions of people gathered along the banks of the Danube. They came together to celebrate the river's past and to think about its future. Each country held different events, but they all began with this simple truth: "Everybody lives downstream."

16.6 Beginning to Think Globally

In this chapter, you read about transboundary pollution in Europe. Pollution has many causes. Sometimes pollution occurs naturally, but more often, people cause pollution. Radioactive pollution, like that released from the Chernobyl power plant, is usually the result of an accident. Acid rain, which comes from air pollution, is an example of general pollution.

You also saw how easily pollution can be spread by wind and water. The Tisza-Danube cyanide spill showed how an accident in one country can affect an entire river system.

Transboundary pollution is not only a problem in Europe. Wind currents can carry pollution across oceans and continents. As a result, one country's pollution can create problems in countries halfway around the world. Consider this idea as you look at the map of global wind patterns in the next section.



16.7 Global Connections

The map at the bottom of this page shows the locations of two different levels of acid rain around the world. One category is “acid rain detected,” which means that acid rain has already been discovered to be a serious problem in these areas. The other category is “acid rain potential,” which means that in these places acid rain is not yet a problem, but may be in the future. The diagram of wind currents on the facing page illustrates how winds can carry the chemicals that cause acid rain over vast distances.

Why do North America and Europe have the highest acid rain levels? North America and Europe are highly industrialized, which means they have more factories, cars, and other polluting machines than other parts of the world. As you have learned, the pollution created in industrialized areas is the cause of acid rain.

What changes in Asia are raising the acid rain potential there?

China, India, and other countries in Asia are developing at a rapid rate. These countries are building more and more factories and power plants, and the number of cars is rising quickly as well. One likely result of rapid industrialization is an equally rapid increase in air pollution and, therefore, in acid rain.

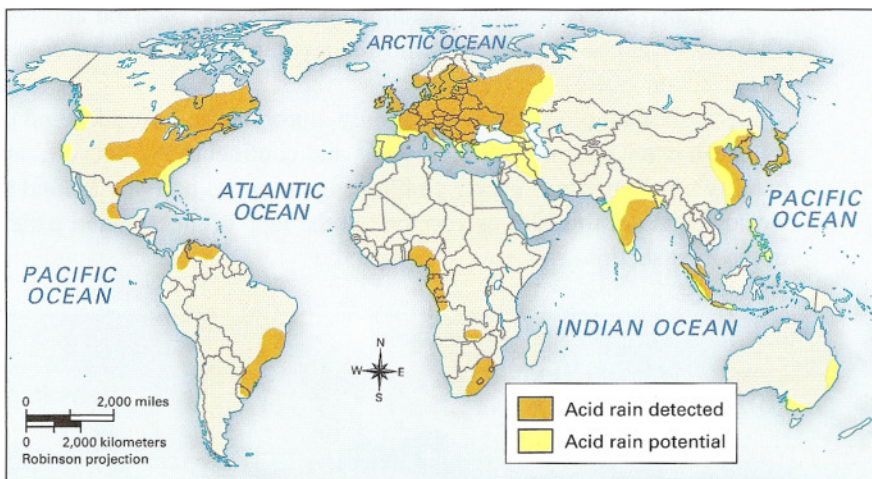
Why must acid rain be tackled as a global problem? As you have seen, pollution is not always a local issue. Wind and water can carry toxic waste great distances. For this reason, a country that creates pollution may not have to live with all of its effects. Only by working together will countries be able to tackle problems that may begin halfway around the world.



Pollution Patrol Plane

This airplane is used to study air pollution. The pods on the end of its wings contain scientific instruments. These devices detect chemicals in the air.

Acid Rain Around the World



Source: Charles Novosad, ed., *Nystrom Desk Atlas*, Chicago: Nystrom, 1994.

Most pollution falls close to the industrial areas where it is created.

Farther away, rain and snow wash pollution from the sky.

Upper-level winds carry small amount of pollution far distances, even across oceans.

Surface winds

Upper-level winds

The Spread of Pollution from North America

Most air pollution falls close to where it is produced. But winds high above Earth, or upper-level winds, can also carry pollution over great distances.