

# 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 is a form of energy produced by nuclear power plants. In large amounts, it is deadly to living things. A radiation leak is a sign that something has gone very wrong in a power plant.

The scientists searched the plant for a leak. But the radiation was not from their plant. It was not even from anywhere in Sweden. Winds had carried it to Sweden from the Soviet Union. Eventually, the world learned why. 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. Then it spreads to other countries.

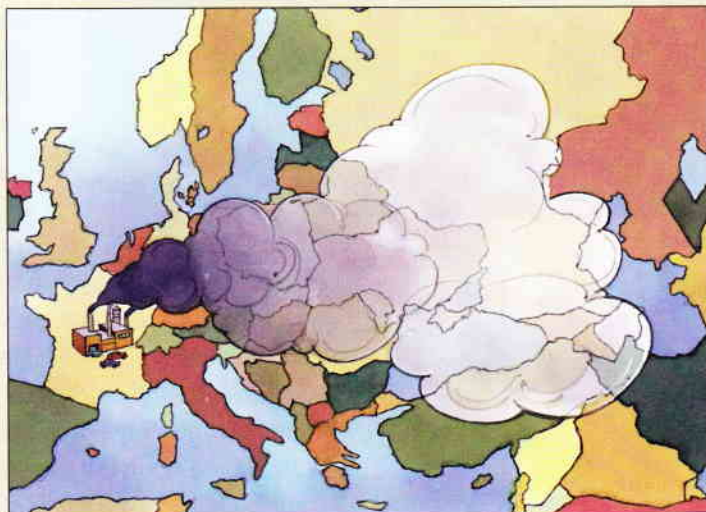
In this chapter, you will learn about several cases of transboundary pollution in Europe. You will find out how different kinds of pollution begin. You’ll see how pollution can easily cross borders between countries. You’ll also learn about efforts to reduce transboundary pollution.

### 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.

All this changed with the Industrial Revolution. The change began with the invention of machines to make cloth. These machines spun cotton into thread. Other machines then wove the thread into cloth. The new machines produced cloth much faster than people could with hand looms. Over time, machines were invented to produce everything in the modern home, from clocks to computers.

The Industrial Revolution has made life better 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. The factories that churn out these goods 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, it is the result of human activity.

People create two kinds of pollution. One is **accidental pollution**. This is pollution that occurs as the result of an accident, such as an oil tanker spilling oil into the sea. An oil spill may kill fish and seabirds.

The other kind is **general pollution**. This is pollution caused by everyday activities such as burning coal to make electricity. Smoke from coal-burning power plants pollutes the air. It 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, animals, and 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.

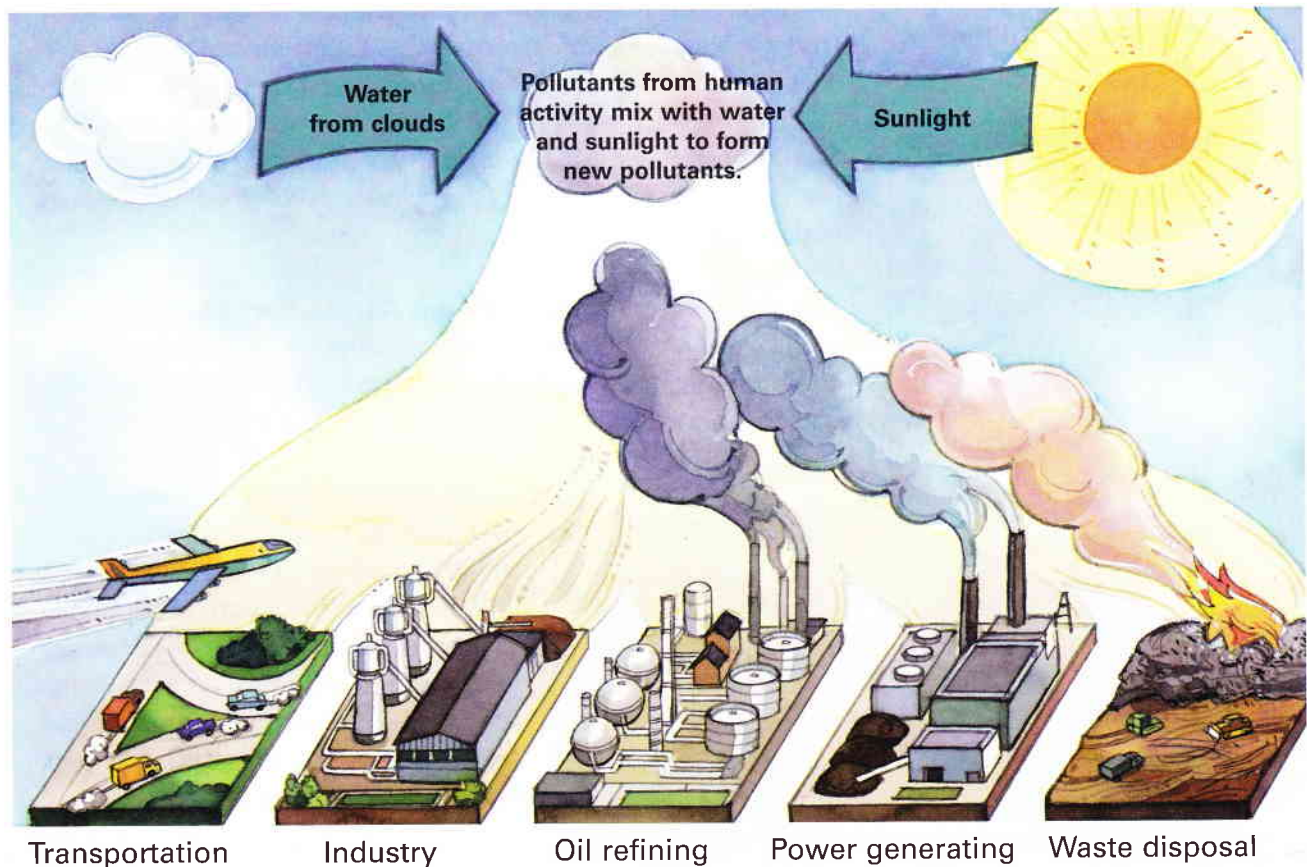
## ► Geoterms

**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. At that time, Ukraine 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. These plants use uranium for fuel. The uranium is mined from the ground, like coal or copper. Then it is put in a special container called a *nuclear reactor*. Inside the reactor, the uranium gives off energy in the form of heat. This heat is used to boil water to create steam. The steam 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.

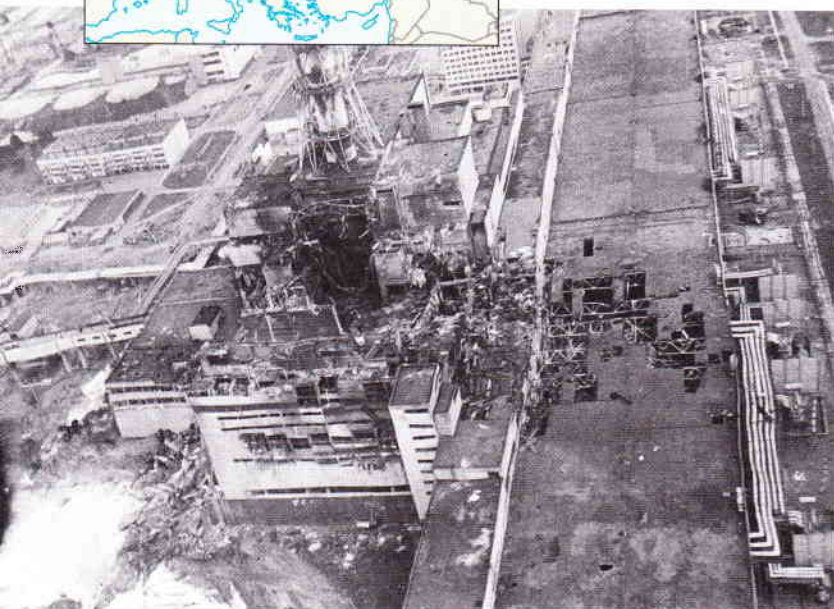
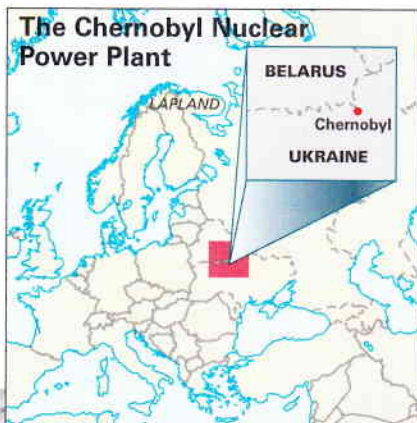
**The Radioactive Cloud Spreads Across Europe** The radioactive cloud did not remain over Chernobyl for long. Winds sent it north toward Sweden and then south toward Central Europe. Radiation also moved east across Asia. It eventually crossed the Pacific Ocean to reach the United States.

Countries close to the disaster suffered the most. The hardest hit was Belarus, which borders Ukraine to the north. About 70 percent of the radioactive dust from Chernobyl fell on Belarus. The dust contaminated soil and water. As a result, the people of Belarus eat, drink, and breathe radiation every day. This has led to higher rates of cancer among Belarusians.

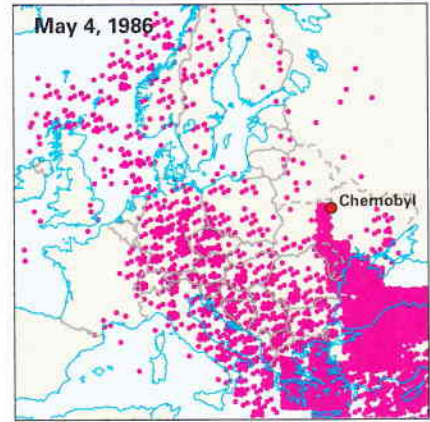
The people of Lapland also suffered. Lapland is an area in the far north of Europe, including part of Sweden. Many people here fish for a living. Others raise herds of reindeer. After the Chernobyl accident, radiation polluted their fishing grounds and reindeer herds. Many animals died. Those that survived 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 raised alarms about rising radiation levels. Finally, an announcement was made on Soviet 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 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. That will not be for hundreds of years.

The Soviet government moved people living closest to the plant to safer areas. About 135,000 people had to leave their homes. Often they had no warning. Rescue workers suddenly appeared, looking like spacemen in their protective clothes. The workers hurried 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, great attention has been paid to improving safety at nuclear power plants. Reactors have been changed to make them less likely to overheat. Other improvements make it easier to shut reactors down in emergencies. These efforts reduce the chances that accidents at power plants will cause major radiation pollution.

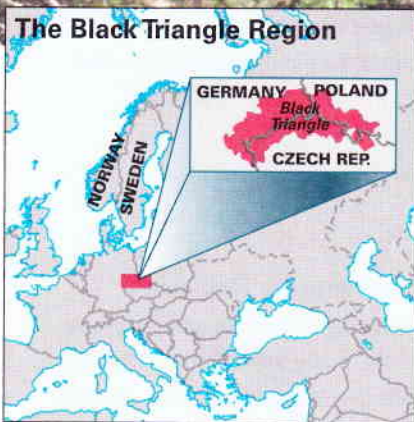
### A Deadly Cloud

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 2000 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 earlier, 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.

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 in this area. 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. One is sulfur dioxide. The other is nitrogen oxides. When these two chemicals react with water, they form acids. Acids have a sour taste. You can taste acid in sour lemon juice or vinegar. Acids are also corrosive. This means that 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 falls on lakes, it can make the water acidic. In some lakes, high acid levels have killed fish. Acid rain can also harm forests. It weakens trees by eating away at their leaves or needles.

The Sudety Mountains are on the border between Poland and the Czech Republic. They are just east of the Black Triangle. That means that 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, 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. Since most factories were located in cities, however, acid rain was mainly an **urban** problem.

In the 1950s, coal-burning factories and power plants began building very high chimneys. The smoke coming out of these chimneys was carried away by high winds. This change improved the air in industrial cities. But it led to the spread of air pollution over much wider areas.

Today air pollution from the Black Triangle brings acid rain to many countries. In Sweden and Finland, a great majority of the pollution that causes acid rain comes from other countries, especially Germany and Poland.

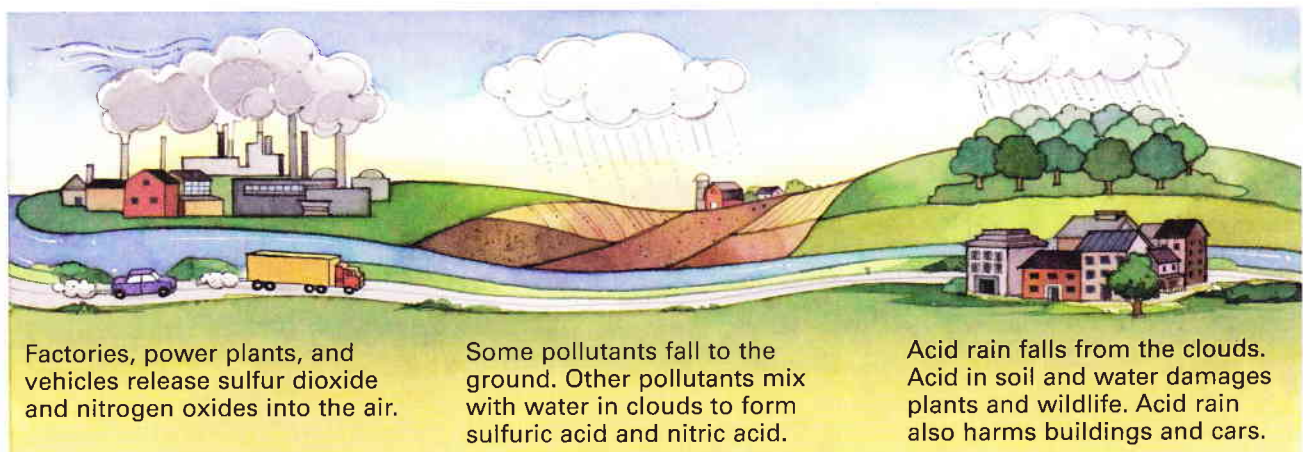
**Efforts to Reduce Acid Rain** The countries of Europe are trying to reduce acid rain in many ways. One approach is to reward companies that reduce pollution. Some governments propose to do this by letting companies that pollute less pay lower taxes.

Another approach is to promote new technologies that result in less pollution. Many factories and power plants that burn coal now use smokestack scrubbers. These scrubbers take harmful substances out of the smoke as it goes up the chimney. As a result, far less pollution enters the air.

A third approach is to reduce 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 the 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**

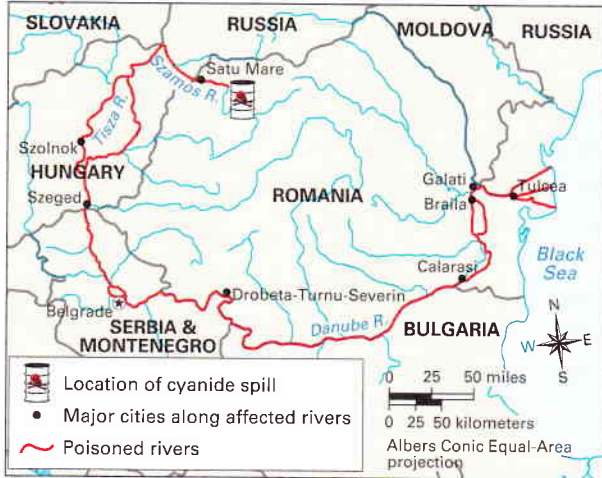
Acid rain is rain that pollution has turned acidic. When acid rain falls on forests, leaves and needles turn brown. Acid rain also dissolves nutrients in the soil. The nutrients then wash away before plants can use them.



## 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.”

### The Tisza-Danube River System



**A Burst Dam Releases Deadly Chemicals** The accident took place at a mining operation in Romania. Romania is 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, it was raining hard. Water from the storm raised the level of the pond to the danger point. Suddenly, the dam burst. About 100,000 cubic meters of water laced with cyanide spilled out of the pond. This is enough **toxic waste** to fill about 30 Olympic-size swimming pools.

### 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.

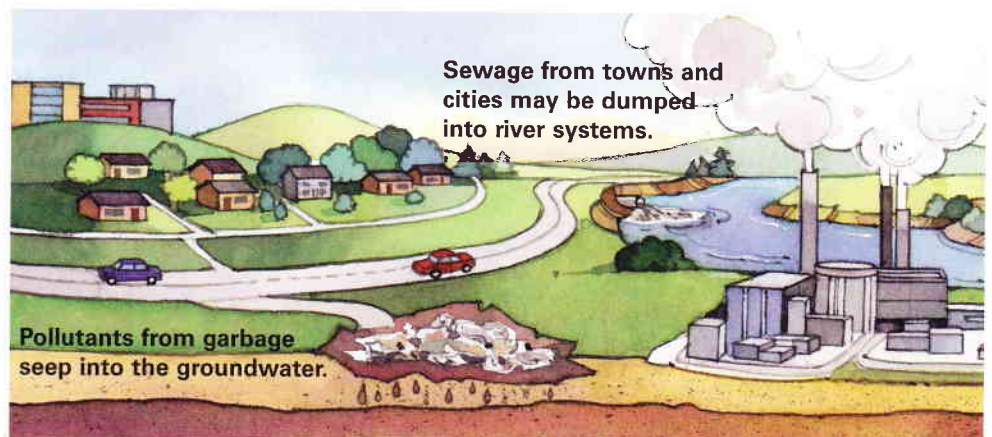
**Cyanide Flows into the Danube River System** The cyanide spilled first into the Szamos River in Romania. As the Szamos flowed across Hungary, it entered the Tisza River. The Tisza then emptied into the Danube River. The Danube carried the toxic spill across Serbia and Montenegro and Bulgaria. Finally, the toxic waste 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 died by the hundreds after eating the poisoned fish.

Fearing 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.

### 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. 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 good 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. Many towns dump untreated **sewage** into these waterways. Farms and factories also pollute rivers with fertilizers and chemicals.

In 1998, the International Commission for the Protection of the Danube River was established. 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.

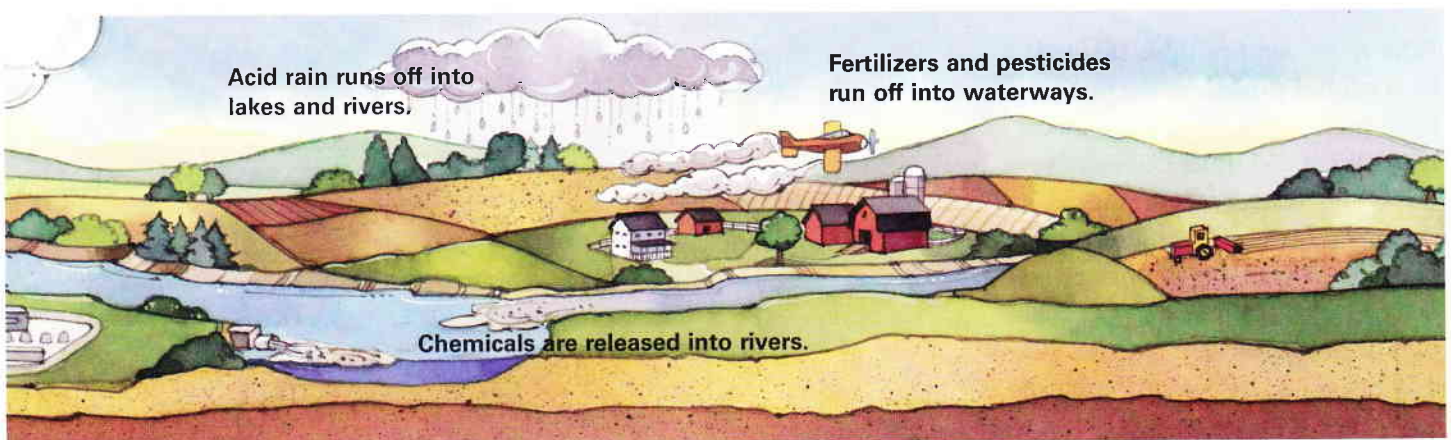
On June 29, 2004, the commission held its first "Danube Day." On that day, millions of people gathered along the banks of the Danube. They came together to celebrate the river's past and to think about its future. Different events were held in each country. But they all began with this simple truth: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

## 16.6 Beginning to Think Globally

In this chapter, you have read about transboundary pollution in Europe. Pollution has many causes. Sometimes it 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 is the result of more general air 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. Because of this, one country's pollution can create problems in countries halfway around the world. Think about this as you look at global wind patterns in the next section.



## 16.7 Global Connections

The map at the bottom of this page shows levels of acid rain around the world. They range from “acid rain detected” to “acid rain potential.”

*Detected* means already found. These are places where acid rain is already a serious problem. *Potential* means possible. These are places where acid rain is not yet a problem but may be in the future. Also notice the diagram of wind currents. It shows 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 were the leaders of the Industrial Revolution. They have more cars and factories than other parts of the world. As you have learned, pollution from factories and cars are the two main causes 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. More and more factories and power plants are being built. The number of cars in these countries is rising rapidly as well. The result is likely to be an equally rapid increase in air pollution.

### Why must acid rain be tackled as a global problem?

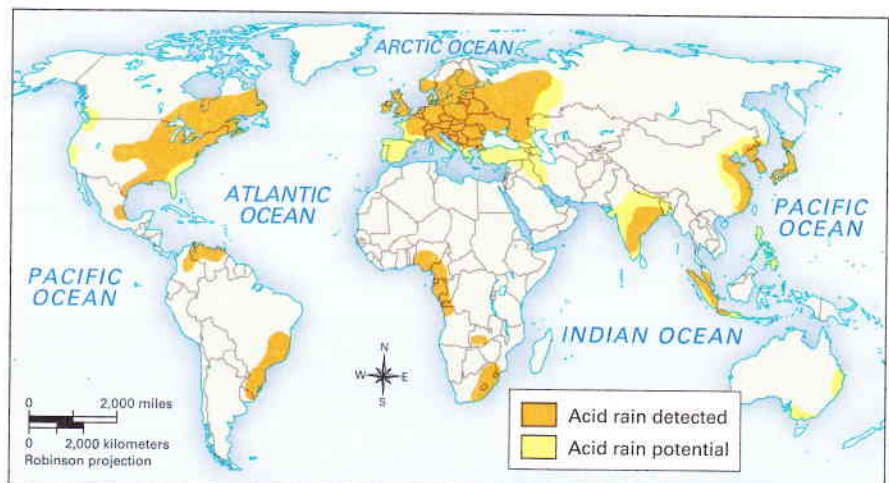
As you have seen, pollution is not always a local issue. Wind and water can carry toxic waste long distances. For this reason, a country that creates pollution may not have to live with all of its effects. Only by working together will countries be able to tackle problems that may begin halfway around 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.

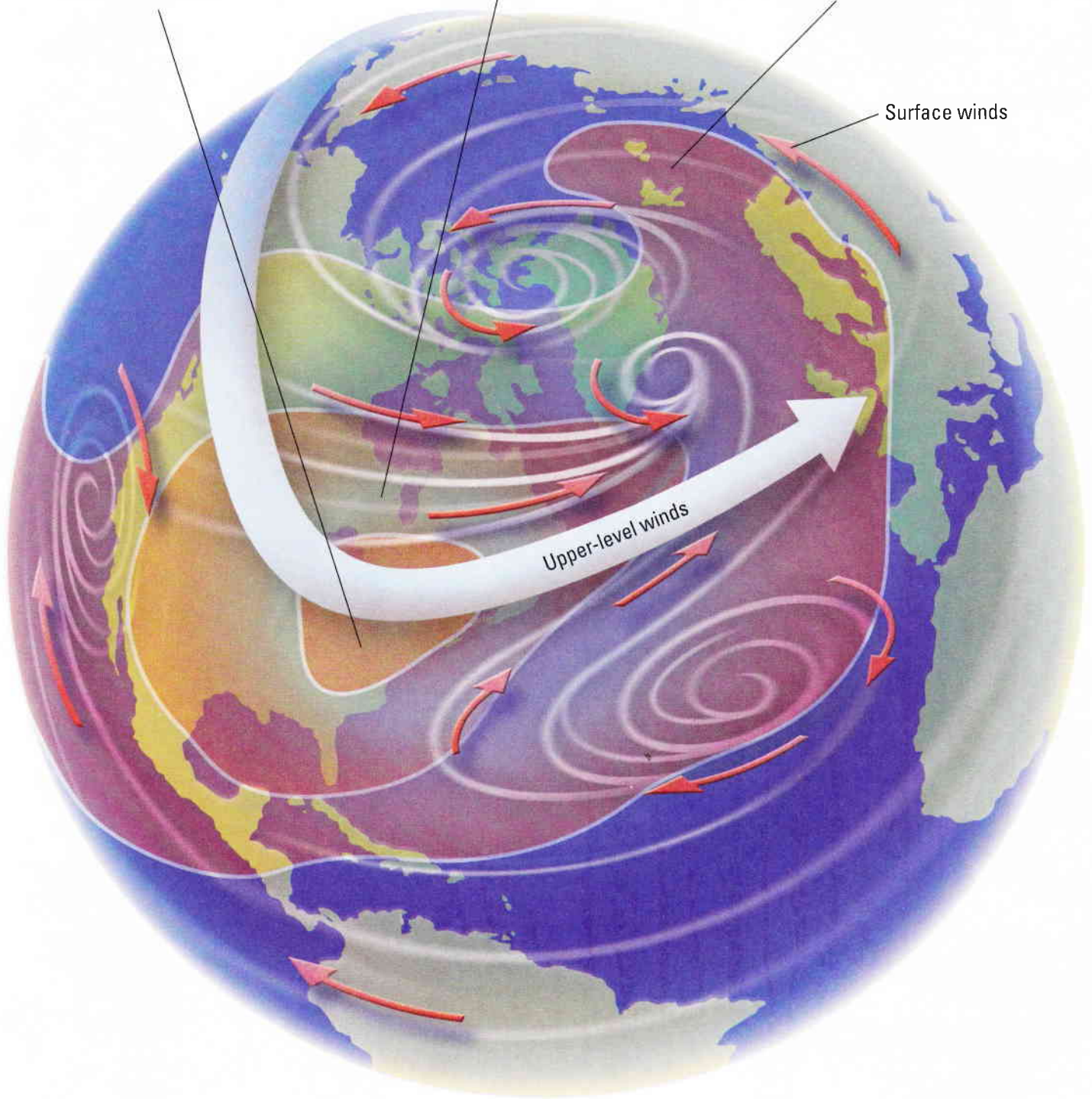
Most pollution falls close to the industrial areas where it is created.

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.