

If you think acid rain sounds terrible, it is! Acid rain is bad news. Fortunately there is good news: we can do something about it. Just what is acid rain?

What Is Acid Rain?

Acid rain is the general term for rain, snow, or fog that carries pollutants in the air that fall to Earth as precipitation. Its scientific name is *acid deposition*, and it refers to any form of precipitation containing high levels of sulfuric and nitric acids. Although small amounts of acid rain are caused by volcanic eruptions or rotting plants, acid rain is mainly the result of human activity. Acid rain is caused specifically by the burning of fossil fuels, such as coal, which are used to produce energy in power plants, factories, and homes. It is also caused by burning gasoline, used to power cars and trucks.



This tree shows signs of damage from acid rain.

Acid rain was first recognized in the 1800s in England. During the Industrial Revolution, English factories were powered by coal, which released sulfur into the atmosphere. In fact, one of the country's most distinctive features, "London fog," was actually a form of acid rain.

As the world grew more industrialized, coal became the fossil fuel most often used to run factories. As the use of coal increased, so did the acid rain. By the 1970s scientists began to recognize acid rain as a significant pollution problem. Throughout the world, scientists began to make the connection between the excess amounts of sulfur and nitrogen being released into the atmosphere and the highly acidic precipitation that was damaging soil, water, and air.

The Science of Acid Rain

Burning fossil fuels releases sulfur dioxide and nitrogen oxide into the air. In the atmosphere, these chemical compounds react with water, oxygen, and other materials to form sulfuric and nitric acids. This acidic combination is blown by the wind and then falls to Earth as rain, snow, fog, or other precipitation. There it seeps into the soil, flows into rivers and lakes, and enters the ecosystem.

Acid rain changes the natural pH, or acid level, of precipitation. The pH scale measures the acidic level of a solution on a scale of 0 to 14. A lower number indicates a high level of acid, and a higher number indicates a low level of acid, or

what is called an alkaline solution. For example on the highly acidic side, the pH of lemon juice is 2 and table vinegar is 3. On the alkaline side, the pH of milk is 6.6, and that of milk of magnesia (a substance used to calm upset stomachs) is 10.5. When the pH level of precipitation goes below 5.6, it is considered acid rain.

Acid Rain's Effects

When acid rain enters Earth's water system, it makes lakes, rivers, and streams more acidic. At critical levels acid rain robs the water of sufficient oxygen, causing fish and other water-based animals and plants to die. Because the fish are eaten by birds and other wildlife, the pollutants then enter the food chain, killing more animals. Humans who eat contaminated animals have a buildup of toxins from acid rain in their bodies, too.

Acid rain also destroys trees and forests, entering the soil and creating toxic levels of pollutants that kill the plants. It leeches, or removes, important nutrients out of the soil so that trees are deprived of the nourishment they need. It kills off leaves and needles, so the trees cannot absorb water and nutrients. The trees weaken and become more susceptible to disease and predatory insects. All of these factors cause forests to die.

Acid rain, created by human activity, destroys another human product: buildings. The acidic nature of the precipitation destroys limestone in particular. It eats away at any limestone structure, including buildings, churches, bridges, homes, and statues.

A Public Outcry

The effects of acid rain first became evident on a worldwide level in the 1970s. People from all over the world, especially in Europe, started to express concern. In Central Europe people realized that acid rain was destroying forests. In fact the damage was so bad that a new word was created: the German word *Waldsterben*, meaning "forest death." In Sweden nearly 25 percent of the country's 90,000 lakes were affected. More than 4,000 lakes were so damaged that they have never recovered. In England most of the toads in the southern half of the country died. Scientists determined that they were killed by acid rain.

In response, governments around the world began to set pollution guidelines. The guidelines created limits for the amount of sulfur and nitrogen emissions. The guidelines were put in place in the 1970s, and by the 1990s they had proven to be very effective in some areas. For example, in Britain most manufacturers changed from coal to gas to run their factories. The results were impressive: from 1980 to 1990, the level of acid rain pollution from sulfur was reduced by 80 percent in Britain.

Western European nations, in conjunction with the European Union (EU) and on their own, reduced their emissions of sulfur dioxide as well. For example from 1980 to 1990, West Germany reduced sulfur dioxide emissions by 70 percent. The EU set strict levels that had to be met by all member nations. Those changes made a huge difference. From 1990 to 2009, EU nations reduced sulfur dioxide output by 80 percent and nitrous oxides by 45 percent.

The Problems of Eastern Europe

From 1945 to the early 1990s, the nations of Eastern Europe were under Soviet control. That meant that the Soviet Union controlled all aspects of their societies, including their economies and industries. Individual Eastern European countries had no say in the policies set for factories. Their factories were forced to produce as much as they could, and there were no rules in place to control air, water, or soil pollution. The results were horrific. The truth about the pollution was hidden from the rest of the world. With the collapse of the Soviet Union in the early 1990s, the effects of acid rain in this region became evident.

Beginning in the 1990s, the world discovered that the industrialized areas of Eastern Europe were an ecological disaster. For the 40 years that they were under control of the Soviet Union, Eastern Europe had never created any pollution controls.

One of the worst affected areas was called the “black triangle,” made up of sections of Poland, East Germany, and the former Czechoslovakia. In the Polish section, called Upper Silesia, about two million people lived in what was later declared an environmental disaster area. The main pollutant was a type of soft coal, which, when burned, created the highest levels of sulfur dioxide in the world. It left levels of heavy metal in the soil that polluted the region’s agricultural lands. The water system was heavily polluted, too, from untreated industrial sewage full of contaminants. This meant that there was, in effect, no water pure enough for people to drink. About 20 percent of the food produced was so full of toxic chemicals that it could not be eaten.



These fish were killed by high acid levels in a freshwater stream.

The EU, as well as the United States and the United Nations, helped the emerging countries of Eastern Europe by providing them with money and technology to deal with the environmental cleanup of the region. In many cases, the aging industrial

centers were destroyed, and newer, more efficient plants were built. When those nations wanted to join the EU, they had to show they were following the organization's strict environmental policies.

The problems of acid rain remain in Eastern Europe and around the globe. One of the major problems of acid rain is that it takes pollutants from a heavily industrialized area and dumps them in another location. It does not recognize "political borders." The problems caused by acid rain become the problems of all countries surrounding an affected area.

Although European nations have been successful in cutting back the amount of sulfur in the air, there are other components of acid rain that still cause concern. For example nitrogen is now the main component in acid rain. It has a negative effect on air quality. Ammonia, a nitrogen compound, is a major byproduct of agriculture and contributes more than 90 percent of the nitrogen emissions in Europe. Nitrogen oxides, produced by fuels used for transportation and industry, also contribute to the problem. Controlling and ultimately eliminating these emissions, and with them the threat of acid rain, is the goal of scientists, citizens, and governments in Europe and around the world.

After reading the passage, answer the following questions:

1. What is the main source of acid rain?
 - A. decaying plants
 - B. burning of fossil fuels
 - C. burning wood
 - D. erupting volcanoes

2. Where is the “black triangle”?
 - A. England, Ireland, and Scotland
 - B. Poland, France, and Germany
 - C. East Germany, Ukraine, and Russia
 - D. Poland, Czechoslovakia, and East Germany

3. Which of the following explains why acid rain is a global problem?
 - A. Every place on the planet regularly receives acid rain.
 - B. Acid rain can move from one location to another.
 - C. All governments ignored the problem until the 1990s.
 - D. All countries are industrialized with factories that pollute.

4. Acid rain is a problem, but there is hope. How has Europe worked to address the problem of acid rain? Provide details and evidence to support your answer.