Acid Rain

The rising acidity of rainwater, due to rapidly rising rates of man-made pollution, may be having devastating effects on forestry, wild life and vegetation in many areas of the world.

By Barry Sulpor

Many scientists are becoming concerned that rain containing acid—often no stronger than weak lemon juice—is causing major ecological changes to lakes, streams and perhaps forests and agricultural crops, particularly in the northeastern U.S., Scandinavia and parts of Canada.

Acid precipitation, the existence of such acids as sulfuric and nitric in snow and rain, has been known and studied for years. It has been recognized as a problem around cities, near smelters or close to fossil-fuel power plants. But now scientists believe the situation is becoming much more critical.

Ellis Cowling, a professor at North Carolina State University and the chairman of the North Central Regional Project on Atmospheric Deposition, says there is no question that each year rain and snow falling in certain parts of the U.S. is becoming more acidic.

Cornell University scientists have reported that in 1955 and 1956 a pH of less than 4.5—very acidic—was found only in Pennsylvania, New York and certain parts of Ohio. But they now say that within the last few years acid precipitation of less than 4.5 has been received in almost the entire eastern U.S.

According to Gene Likens, a pioneer in research at Cornell, that area includes most of Michigan, Illinois, North Carolina, and all of Indiana, Ohio, Pennsylvania, Kentucky, Tennessee, Virginia, Maryland, Delaware, New Jersey, New Hampshire, Vermont, New York, Massachusetts, Connecticut and Rhode Island.

"What this means is that the relatively weak, naturally occurring carbolic acids once found in precipitation are now being dominated by much stronger acids mainly caused by man-made pollution," Likens says.

"It's not hard to understand," Cowling says, "that if 60 million tons of sulfur are emitted into the atmosphere, 60 million tons of sulfur are going to eventually come down somewhere in one form or another, including rain."

Effects of acid rain.

Scientists are divided, however, on the effects the acid rain is having on the environment.

According to Likens, forest growth between 1950 and 1970 has been reduced in southern Scandanavia and the northeastern U.S. However, he says, "It is not possible to state unequivocally that this decline is caused by acid precipitation." Forests are very complex ecosystems and acid precipitation is only one of many environmental stresses.

Carl Olof Tamm, a professor of forest ecology at the College of Forestry in Stockholm, Sweden, reports that "except in areas where trees show visible pollution symptoms, it has been difficult to establish that acid rain or other increases in atmospheric acidity effect the growth of trees. However, this does not exclude the possibility that such adverse influences may exist."

Moreover, Tamm said in one report, part of the acidity of rain is due to nitric acid or nitrogen oxides, so that the effect nitrogen has as a fertilizer might compensate for any harmful effects. And sulfur compounds, another key ingredient of acid rain, might actually help forests because sulfur is an indispensable plant nutrient in some forest lands.

Cowling, however, says that experiments indicate that highly acidic water can cause premature browning of older needles, increase the leaching of inorganic nutrients and organic substances from foliage, affect the reproduction of simple plants such as mosses and ferns and decrease the availability of nitrogen and other important plant nutrients from the soil. "These things collectively can diminish forest and agricultural productivity."

Crops affected.

Researchers for the U.S. Environmental Protection Agency at a laboratory in Corvallis, Ore., have found in preliminary tests that certain crops, such as beans and radishes, are affected by acid rain.

Under simulated acid rain conditions, David Weber, EPA plant pathologist, reports that "radishes were smaller and bean plants contained less than the normal amount of beans." But, he says, "detailed information on these effects or on the possible costs to the agricultural and forest industries are not yet known."

Other individual studies have produced similar results.

Carl Schofield, a research associate in Cornell University's Department of Natural Resources, who has studied lake and soil effects from acid rain over the last four years, has found dramatic effects in the lakes of the Adirondack Mountains in northern New York. Based on a survey by researchers at Cornell and the New York Department of Environmental Conservation, Schofield reports that lakes above 2,000 feet were found to be most severely affected by acid precipitation.

"About 50 percent of those lakes were below pH 5.0, which is considered a critical level for survival," he says. And more than 80 percent of the lakes were completely devoid of fish life. "What we are talking about are over a hundred lakes which are no longer capable of supporting fish life."

The researchers have observed that in lakes with a pH of less than 6.0, the number and variety of algae begin to decrease. Below 5.7, the insect populations, another food source for the fish, also drop. Fish eggs and newborns begin to die when the pH goes below 5.5.

Eventually, the lakes become populated with only large, aged fish that are incapable of reproducing. When they die or are caught, the lake becomes essentially barren.

The researchers have also observed kills of adult fish when a large surge of acidic water entered a lake, such as during the spring runoff of melted snow.

Since there is no industry in the Adirondack Mountains, Schofield says, the high levels of acid precipitation found there must be coming from other sources.

Questions remain.

Norwegian researchers have found that in the Tovdal River in southern Norway, which was one of the country's main salmon rivers, almost no salmon are now being caught.

Exactly how the fish are killed is only one of perhaps hundreds of questions still unanswered. Charles Hakkarinen of the Electric Power Research Institute (EPRI), a key sponsor of acid rain research, says three major questions need further study:

- How much of the sulfur and nitrogen in acid rain is caused by nature and how much is caused by man-made pollution from power plants, automobiles, smelting operations and other industrial processes?
- How do sulfur and nitrogen combine with other compounds when emitted into the atmosphere?
- How far away are these pollutants transported—a few hundred miles or several thousand miles?

Very little money, however, has been spent on acid rain research—less than $500,000 a year, according to Vance Kennedy, at the U.S. Geological Survey in Menlo Park, Calif.

"So far," says Kennedy, "it seems only a few scientists are aware of the problem and the public does not yet realize what is going on. It's very hard to stir up interest in something that may not have any real serious impacts for several years."

"The research right now amounts to a bunch of individual scientists pursuing their own particular interests in acid rain," Ellis Cowling says.

The North Central Regional Project on Atmospheric Deposition began a project in April to establish a national network to measure and analyze the changing composition of rain and snow and assess its effects on agricultural and forest lands and surface waters in the U.S.

Cowling says the participating experiment stations will be located in about 28 states, mainly in the East, federal agencies such as the Geological Survey, Environmental Protection Agency, Tennessee Valley Authority, Department of Energy and the National Oceanic and Atmospheric Administration will allow the project to use some of their meteorological and agricultural stations. Funding will come mainly from state agricultural experiment stations, the U.S. Forest Service and the Agricultural Research Service. ■

Barry Sulpor is former editor of Gas Industry Magazine.