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EPA

Environmental Information

Acid Rain– A Growing Environmental Problem

THERE WAS A TIME when "pure as rainwater" was a statement of quality. Today, however, many Americans live in areas where rain and snow are no longer so clean and pure. Rain and snow that fall over much of North America and Europe now contain considerable amounts of chemical acids.

The acid in precipitation is usually not strong enough to be tasted because it is diluted. There is growing evidence, however, of acid levels in rain and snow high enough to threaten agriculture and aquatic life and to damage buildings and national monuments.

It is becoming a serious international environmental problem.

The Problem and Its Source

Acidity is formed in rain from gases of sulfur oxide and nitrogen oxide discharged into the atmosphere. Sulfur oxides are emitted primarily by coal-burning utility and industrial plants. Nitrogen oxides are released during every combustion process.

In the upper atmosphere, the most common sulfur and nitrogen oxides, sulfur dioxide and nitric oxide, react with water vapor to form drops of nitric and sulfuric acid. These return to the earth in rain or snow. Or, they may be deposited in a dry, dust like form.

Sulfur oxides can be carried by prevailing winds for hundreds of miles. This fact was recognized after acid rain was first detected in Scandinavia. The acid was traced to the sulfur dioxides transported from industrial and power plants in Great Britain and Western Europe. In the United States, much of the acid rain that plagues northern New York and New England has its origins in the sulfur dioxide and nitric oxide from the heavily industrial eastern third of the country. Industrial and electric power plants on both sides of the U.S.-Canadian border contribute to the acid rainfall in the eastern United States and Canada, and negotiations are underway between the two countries to solve the problem. Acid rain also has been detected in the southeastern United States, in the Rocky Mountains and in parts of California and the Pacific Northwest.

The widespread nature of the problem stems in part from the way our air pollution control law works. Under the 1970 Clean Air Act, States were required to set emission standards for specific pollutants from new or modified stationary sources (plants built prior to 1970 were exempted). Air quality measurements are made at ground level, where the air is breathed. To meet these ground level ambient standards many plants raised smoke stack heights to disperse pollutants high in the air. The tall stacks have helped to reduce local pollution levels, but actually have sent the problem elsewhere.

Under stronger standards set by the U.S. Environmental Protection Agency (EPA) in mid-1979, new or modified power plants will have to eliminate 70 to 90 percent of sulfur emissions. Emissions from existing plants, however, will remain constant for years to come.

Sulfur dioxide emissions should gradually be reduced as old power plants are replaced, but nitrogen oxide emissions continue to grow. New automobiles must meet stricter pollution standards, and now emit less nitrogen oxide. There is, however, no commercially available technology for controlling nitrogen oxide emissions from utility and industrial power plants. Research continues, but equipment and techniques to effectively control nitrogen oxide emissions are still years away.

Environmental Effects

The phenomenon of acid rain is a relatively recent discovery and there is still much to be learned about its orgin and effects. Scandinavian countries were the first to notice that environmental consequences follow increased rainfall acidity. Starting in the early 1950's, Norwegian authorities noticed a decline in the number of fish in the country's freshwater lakes. Careful research traced the decline to lake acidity, and the lake acidity to rainfall. Similar effects have been reported in Canada and the United States.

Glacial lakes appear to be the most vulnerable to acid rain. As natural bodies of fresh water in beds carved from granite millions of years ago, glacial lakes lack concentrations of buffering minerals such as limestone. As a result, the lakes cannot neutralize the acid in the rain and snow. Continuing acid precipitation increases the lakes' acidity.

The pH Scale

Chemists use a pH scale to measure the acidity or alkalinity of chemical compounds. The scale runs from 0 (highly acidic) to 14 (highly alkaline). The midpoint, 7, is neutral, neither acid nor alkaline. The pH of lemon juice is about 2; distilled water has a pH of 7; lye has a pH of about 13.

Rain water normally has a pH of 5.6. It is slightly acid because it contains carbonic acid, the product of a natural reaction with the carbon dioxide in the atmosphere. Rain or snow with a pH below 5.6 is considered to be strongly acidic. The average rainfall in the United States is now pH4.5, and is becoming increasingly acid.

Acidity in freshwater lakes takes it toll on fish sensitive to the effects of changes in pH levels. A recent survey in Norway showed that 70 percent of the lakes with pH values below 4.5 were fishless. Only 10 percent of the lakes which had pH levels between 5.5 and 6.0 were without fish. Lakes in the Adirondack Mountains of New York State surveyed in the 1930's had an average pH level then of 6.5. A 1975 survey showed the level had dropped to pH4.5 in 40 percent of the lakes. Today, more than 90 Adirondack lakes no longer support fish.

Although the number of lakes surveyed is limited, results indicate a pattern of rising acidity in the glacial lakes. It appears that fish are most vulnerable to the effects of pH changes during spring spawning, and it is the spring snow melts which bring sudden changes in lake water acidity. Often the melted snow will contain an entire winter's accumulation of acid and pollutants.

Acid in rain and snow is also believed to have a leaching effect on soils and minerals. The acids free minerals and potentially toxic metals from their chemical bonds with soil and rock and dissolve them in water. Aluminum, for instance, is found in high concentrations in fishless lakes. It is only released from soil with a pH level of 4.5 or less. In addition, increasingly acid rainwater in reservoirs and pipelines may leach heavy metals into public drinking water systems, posing a possible public health problem in the future.

Acid rain also is suspected of leaching away vital soil nutrients. Scientists suspect, and are now trying to document, that acid rain affects agricultural crop yields. Foresters are concerned about the acid balance of forest soils and possible long term changes in growth rates. Certain leaf crops, such as lettuce and tobacco, and some root crops are susceptible to direct damage from acid rain. Other crops, such as tomatoes, which thrive in acid soil, may actually benefit.

The human-made environment is not immune to the damaging effects of acid rain either. Sulfuric and nitric acid in rain and snow seriously corrode masonry and stone work. Porous rocks such as limestone are especially vulnerable to damage. Harm to outdoor monuments and statuary is a severe threat. After standing for 2500 years, the classical Acropolis in Athens shows terrible deterioration as a consequence of this century's air pollution. Similar effects on statuary and other historic buildings have been observed all over the world.

Much of the damage to the structural environment is caused by sulfates and nitric oxides deposited directly on stone surfaces. As soot, ash, or as gases, sulfur dioxide and nitrogen oxide are deposited on and absorbed into statues and building materials. Mere contact with water in the form of rain, or even fog, converts the deposits and gases into destructive acids.

<u>What's being done?</u>

There is no easy solution to the acid rain problem. In the United States, the effort to increase the use of coal as an oil-conservation measure complicates the task of reducing sulfur dioxide emissions. Plants could be required to clean coal before burning it, or stringent sulfur dioxide emission control standards could be applied to existing plants. Such steps could not be taken without changes in the law, however. EPA is considering measures it can take now to curb acid rain without changing the law.

The international ramifications of the acid rain problem are even more complicated. International agreements or treaties on air quality standards and pollution controls must be negotiated by the industrial nations.

In North America, Canada and the United States have agreed to pool their data and conduct research into acid rain and its effects. Eventually, this joint effort could bring a uniform air quality control program. The North Atlantic Treaty Organization (NATO), through its Committee on the Challenges of Modern Society, is investigating means of alleviating the airborne spread of pollutants, a concern on both sides of the Atlantic.

In the United States, President Carter in August 1979 called for a 10-year Federal research program into the cause and effects of acid rain. More than $10 million is to be spent in each of the next 10 years by a group of government agencies led by EPA and the Department of Agriculture. The information gathered will become the basis of any governmental regulatory program. Industry, particularly utility and coal companies, are also spending millions of dollars to research the causes and environmental effects of acid rain.

Like air and water pollution problems of the past, acid rain will not go away overnight. Reversing its effects will be slow and costly. It will be many years before some freshwater lakes can support fish life again, if they can be restored at all. Farmers may have to find new hybrids that are more resistant to the effects of acid rain, or plant increased acreage to make up the difference in crop loss.

Acid rain at least is recognized now as a growing environmental problem. That's the first step.