Acid Rain in Wisconsin

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http://dnr.wi.gov/air/aq/global/acidrain.htm

The effects of acid rain are evident in New York's Adirondack Mountains, in Germany's Black Forest, and industrial urban areas around the world--and the picture is not a pretty one. It includes stands of dying trees, lakes uninhabitable by fish, and weathered and damaged historic architecture.

While acid rain has not caused such severe problems in Wisconsin as in the places mentioned above, it is still an air pollution issue that generates concern among the state's residents. Frequently asked questions are: How bad is the problem in the state? What are the causes? What is being done to protect Wisconsin's resources?

What is acid rain? And where does it come from?

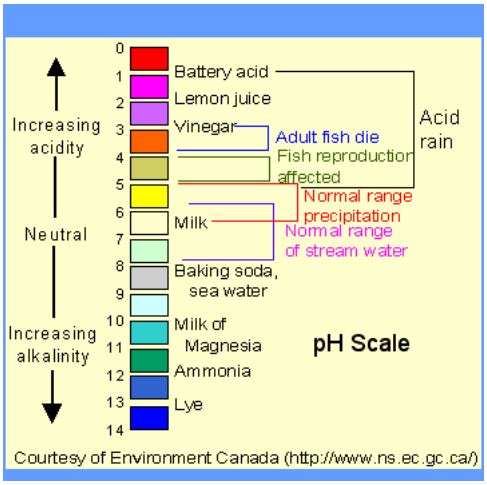
While pure rain is naturally slightly acidic, the higher level of acidity in acid rain makes it a threat to plant and aquatic life and to some manmade materials and structures. The slight natural acidity of pure rain is the result of carbon dioxide in the air dissolving in water to produce a weak carbonic acid solution. This natural acid in rainfall and snowmelt is partly responsible for the long, slow weathering of soil and rocks.

Acid rain, however, is the result of sulfur dioxide and nitrogen oxides entering the atmosphere. These two pollutants are mainly produced by human activities. Sulfur dioxide is most commonly produced by coal-fired power plants and factories, while nitrogen oxides are products of motor vehicles and off-road engines, coal-fired power plants and factories (such as pulp and paper mills in Wisconsin), and home furnaces.

Once these chemicals are released into the atmosphere, they combine with moisture, change chemically, and return to earth in the form of acidic rain, snow or fog. Acidic deposition also may occur in a dry form when acidic compounds attach to particulates (dust) and return to earth. These acids can overwhelm the neutralizing capacity of some soils and lake water. Simply stated, the environment is sometimes unable to defend itself against the effects of these acids.

How do we measure acidity?

Here is the pH scale, along with the pH of some common solutions:



Chemists use a pH test that measures the concentration of hydrogen ions in a chemical solution to determine the solution's relative acidity or alkalinity. This test rates the solution's acidity/alkalinity on a scale from 0 to 14. A pH value of 1 is very acidic (like battery acid), while a pH value of 14 is very alkaline (like lye). A pH value of 7 is neutral, like distilled water. The pH scale is logarithmic, which means that pH 6 is 10 times more acid than pH 7, and pH 5 is 100 times more acid than pH 7.

Rain uncontaminated by any pollutants has a pH of 5.0 to 6.0. Wisconsin Department of Natural Resources investigators consider rain with pH less than 5.0 to be "acid rain."

What do we know about the effects of acid rain in Wisconsin?

Acid rain has been studied in Wisconsin for more than ten years, and more than $7 million has been spent to assess the impact of this environmental problem, making the state a leader in research. Below are some general conclusions regarding the impact of acid deposition in the state:

Forests

Research has determined that while acid rain has been linked to declines in forest health in many regions of the world, no major forest declines due to these causes have been identified in

Wisconsin. However, acid rain can leach nutrients from forest soils, making trees vulnerable to other pollutants, climatic extremes and pest attacks. Research which looks at several possible causes of forest decline in Wisconsin is relatively new; more needs to be done to understand the complex interactions of environmental and human factors that affect the health of the state's forests.

Aquatic resources

Many factors affect whether, or at what rate, acidification due to acid rain occurs in bodies of water. However, bodies of water that are low in alkalinity or acid neutralizing capacity (ANC) are considered especially vulnerable to the effects of acid rain.

A body of water is considered "acidic" if it does not have any acid neutralizing capacity. That does not, however, mean that it is already devoid of fish and other aquatic life. As a body of water becomes more acidic, it loses some of its biodiversity as the more acid-sensitive species of plant and animal life die off or experience a decrease in reproductive success. The degree of threat from acid rain depends on the vulnerability of plant and animal species in that body of water to an acidic environment.

According to the DNR's Surface Water Resources Data Base, approximately 2 percent of the state's lakes are acidic. An additional 10 percent are "extremely sensitive" to acid rain, 25 percent are "moderately sensitive" and 60 percent are not sensitive. This will remain true only if present patterns of groundwater flow continue. Surveys done in northern parts of Wisconsin, however, where most of the state's lakes are located, show that these areas have an even greater incidence of acidic lakes. A survey done in 1984 by the U.S. Environmental Protection Agency showed that up to 9 percent of lakes in the northeast and north central region were acidic. On the other hand, Wisconsin's streams are not considered to be sensitive to the effects of acid rain.

Health effects

A direct effect of acid deposition on human health results from exposure to acid aerosols inhaled from the surrounding air. Acid aerosols are mixtures of several different pollutants including particles (large and small), strong acids (e.g. sulfuric acid), weak acids and vapors (e.g. nitric acid). Long-term exposure to acid aerosols is known to damage lung tissue and contribute to the development of respiratory diseases such as asthma and chronic bronchitis, especially in children and the elderly.

Acid deposition also has been connected to elevated mercury concentrations in fish and fish-eating wildlife such as the common loon, mink, otter, and eagles. Researchers believe that acidification of bodies of water increases the formation and movement of methylmercury--a toxic form of mercury--into the aquatic food chain. This also endangers the health of people--especially infants and children--who eat fish from affected lakes, as well as the health of fetuses carried by women who eat contaminated fish.

Exposure of humans to mercury may result in damage to the kidneys, brain and central nervous system. It may also cause developmental defects. Recent research indicates that prenatal exposure to mercury concentrations much lower than the current "safe" levels established by the World Health Organization may result in subtle neurological defects in children, such as abnormal reflexes and delayed motor skill development.

Visibility

Pollutants associated with acid rain interfere with light transmission in the atmosphere which results in reduced visibility. A trend analysis was conducted for the years 1950 through 1987, using visibility observations at two National Weather Service locations in Milwaukee and Green Bay. Results for both locations showed a decrease in the number of days reporting good visibility, and an increase in moderate visibility reported. The highest frequencies of reduced visibility for both locations in recent years occurred during the summer, probably due to the chemical processes which result in summertime "smog" (ozone) and haze. An additional study is currently underway using photographs to see if changes in visual range are taking place.

Materials damage

Although no materials research has been done in Wisconsin, research done elsewhere indicates that the pH levels of rain in the state have been low enough to cause damage to building materials such as paint, stone, mortar and metals. In addition to damaging building materials, acid

rain can also cause increased weathering of historic structures and outdoor art objects, such as the Bradley Sculpture Garden in Milwaukee.

What legislative action has been taken?

Wisconsin passed one of the first and strongest state acid rain control laws in the nation in 1986, making the state a leader in acid rain policy. The law required Wisconsin's major electric utility companies to reduce their sulfur dioxide emissions by 50 percent from 1980 emission levels by 1993.

By 1990, overall annual sulfur dioxide emissions from electric utility companies had fallen 46 percent, and in 1992, these companies filed compliance plans indicating that they would easily meet the requirements of the law.

Meanwhile, Congress passed the Clean Air Act Amendments of 1990 which also contain strong acid rain control measures. The federal law requires electric utility companies nationwide to reduce their collective sulfur dioxide emissions by 10 million tons per year from 1980 emission levels by the year 2000. This represents a 40 percent reduction in nationwide sulfur dioxide emissions. Utility sulfur dioxide emissions will be capped at about nine million tons per year in the year 2000 and thereafter. The law also will result in a reduction in nitrogen oxide emissions of about two million tons per year.

These measures--especially the state law--are credited with a reduction in emissions that has been associated with a noticeable decrease in the acidity of rainfall in the state. The most recent analysis of wet acid precipitation data (1990) indicates that the annual average pH in Wisconsin ranged from 4.59 in the southeast to 5.06 in the northwest. In contrast, the annual average pH in the early 1980s ranged from 4.4 in southeastern Wisconsin to 4.8 in the northwestern part of the state. The goal established in the state law is to raise the pH of the state's rain to 4.7 or greater across the state.

What can you do to help?

Because a substantial amount of the acid rain that falls in Wisconsin results from pollution sources within the state, there are a number of things Wisconsin residents can do to combat the acid rain problem. Using electrical energy wisely could have a significant impact because a lot of the emissions that contribute to acid rain originate from coal-burning electric power plants. You can reduce electrical energy use in a number of ways:

- Insulate your home so it is more energy efficient during the winter and the summer.
- Replace your heating system if it is over 25 years old.
- Keep the thermostat down in the winter.
- Open windows and use fans instead of the air conditioner during the summer.
- Use energy-efficient compact fluorescent bulbs instead of incandescent ones, and turn off lights when not in use.
- Purchase energy efficient appliances, especially those which use large amounts of electricity such as hot water heaters, ranges, dryers and refrigerators.
- Turn off electric appliances, such as computers, when you aren't using them, and make sure that they run as efficiently as possible.

In addition, driving a fuel-efficient vehicle and driving less overall both help because motor vehicle exhaust is a significant source of nitrogen oxide emissions.

With a combination of education and action, Wisconsin residents can continue to reduce acid rain and help preserve the natural beauty of the state for ourselves and for generations to come.

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