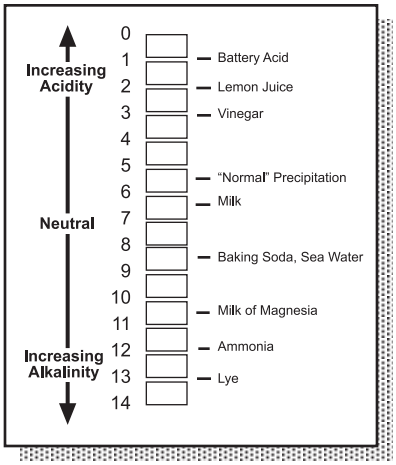
STUDENT RESOURCE

Acid Deposition

What Is Acid Deposition?

Acid deposition includes acid rain, snow, fog, humidity, and dust with an acidity level lower than pH 5.6—the lower the pH, the more acidic. Normal rain, which has a pH of about 5.6, is about 25 times more acidic than "pure," neutral water, which has a pH of 7.0. The acidity results from the conversion of atmospheric carbon dioxide in water vapor to carbonic acid, a weak acid. As of the year 2000, the most acidic rain falling in the United States had a pH of 4.3. In the past, scientists occasionally measured pH values in acid rain in the eastern United States as low as 2.1 and 3.0, which is about 10,000 to 80,000 times more acidic than pure water.



Wet deposition refers to acidic rain, fog, mist, and snow. Dry deposition refers to acidic gases and particles, which account for about 50% of the atmosphere's acidity. This deposition can acidify water in lakes and streams.

What Is Its Source?

Nearly 95 percent of the acidity below pH 5.6 comes from atmospheric sulfur dioxide and nitrogen oxides, which are products of fossil fuel combustion. Acidified rainwater contains combinations of sulfuric and nitric acids that form when water vapor and sulfur dioxide and nitrogen oxides react. Sulfur and nitrogen oxides may be transported by the wind in the atmosphere for many miles, crossing regional and international boundaries, before falling to Earth.

In the eastern United States and Canada, sulfur dioxide contributes much more to acid deposition than nitrogen oxides, which come mainly from automotive emissions. About two-thirds of the SO_2 and one-fourth of the NO_X comes from electric power generation using fossil fuels, particularly coal. Paper and wood pulp processing plants also contribute to sulfur dioxide pollution.

A market-based sulfur dioxide allowance trading system of the EPA's Acid Rain Program allows utilities to adopt the most cost-effective strategy to reduce sulfur dioxide. Power plants can reduce emissions through energy conservation, reduced reliance on renewable energy, employing pollution control technologies like scrubbers, switching to lower sulfur fuel, or development of alternative strategies. Utilities that reduce their emissions below the number of allowances they hold may trade allowances with other power plants in their system. They can sell their allowances on the open market or through EPA auctions, and they can bank them for future use.

The federal government has undertaken a wide range of research programs, many through the National Acid Precipitation Assessment Program, to study the complex processes associated with acid rain. To measure acid deposition quantity and chemistry, scientists collect rainfall samples at monitoring stations throughout the United States.

What Are Its Effects?

The effects of acid rain may not be immediately apparent. For example, at a glance, a lake might look clear and beautiful, but a closer look may reveal few living organisms. Some species of fish cannot reproduce in water with a pH of less than 5. Clams, snails, crayfish, and other crustaceans, brook trout, walleyed pike, and bullfrogs are especially sensitive to acidification. However, the detrimental impact of acidification to animal life is not necessarily caused directly by the acidity.

Trace metals such as aluminum, mercury, manganese, and cadmium, which are leached from sediment and rocks by the increased acidity, are toxic to life. Thus, the pH does not have to decrease very much before fish kills can occur. Because many insects cannot survive in strongly acidic streams and lakes, birds and mammals that depend on insects for food may suffer abnormally high mortality.

Acidification also interrupts normal decomposition of dead plant and animal material in lakes and streams because many of the bacteria that assist in decomposition perish. Without the usual decomposition processes, dead material settles to the bottom, making the water look crystal clear.

Acid deposition can alter soil chemistry, nutrient availability, and plant growth. In their weakened condition, trees and shrubs become vulnerable to insects, diseases, and fungus infestations. For example, the dominant tree in Vermont's Green Mountains, the red spruce, has suffered severe mortality and parts of the mountain range have become denuded. Sugar maples all over the northeastern United States and Canada have declined. In the Shenandoah and Great Smokey Mountains, some spruce and fir failed to reproduce and are dying. Also, pine trees are impacted.

Acid deposition contributes to the corrosion of metals and the deterioration and soiling of the stone and paint on buildings, statues, and other structures of cultural significance.

Particulate matter containing atmospheric sulfur dioxide and nitrogen oxide account for over 50 percent of the visibility problems in the eastern United States. In the West, these particles have been blamed for reducing visibility in the Grand Canyon of the Colorado River and other areas.

Adapted with permission from the U.S. EPA's Project A.I.R.E. (1994) and updated with information from the U.S. EPA Acid Rain web site, 2005.

Sources:

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