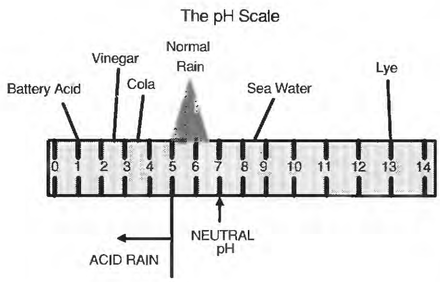
USGS Tracks Acid Rain

U.S. Department of the Interior—U.S. Geological Survey

What is Acid Rain?

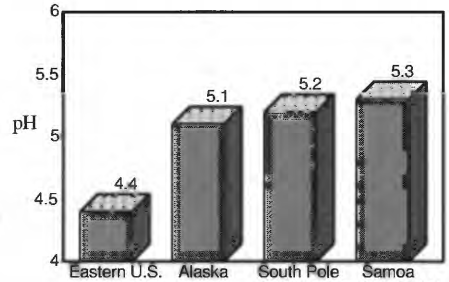
Rain and snow are naturally slightly acidic because of chemical reactions with carbon dioxide in the atmosphere. The term "acid rain" is used to describe rain or snow that has a pH lower than what is natural for a given area. pH is a measurement of how acidic or basic a material is and ranges from 0 to 14. The graph below depicts the pH values for some common substances. Precipitation with a pH value less than 5 is considered acid rain.



How Does Acid Rain Form?

Enormous quantities of manmade and natural material are added to the air every day. Most of the materials added to the atmosphere return to the ground through a process known as deposition. Deposition occurs when it rains and snows, but it can also occur when dust settles out of the atmosphere during dry periods. Gravity works to continually pull dry particles back to Earth. Uneven heating of the Earth results in global winds in the atmosphere. Global winds provide the energy for long-range travel of the gases, liquids, and dust in the atmosphere, which can travel great distances before falling back to the ground. The burning of fossil fuels like coal and oil products by automobiles and powerplants releases large amounts of sulfur dioxide and nitrogen oxides into the air. While being transported by winds, some of these particles get caught up in clouds. When sulfur dioxide and nitrogen oxide gases and particles come in contact with water droplets in clouds, chemical reactions can occur, resulting in acid rain. Additional processes called rainout and washout mix these acidic gases, liquids, and particles into raindrops and snowflakes and carry them to the ground. The figure below shows an overview of how acid rain forms.

Because of global winds and mixing in the atmosphere, every country's air pollution contributes to some degree to the Earth's problem of acid rain. In 1993, the United States released approximately 90 billion pounds of sulfur dioxide and nitrogen oxides into the air. Rain and snow that falls in the Eastern United States typically has a much lower pH than precipitation in other parts of the country. A comparison of the pH readings for the Eastern United States with parts of the world with fewer coal-burning powerplants and automobiles is shown in the bar graph that follows.



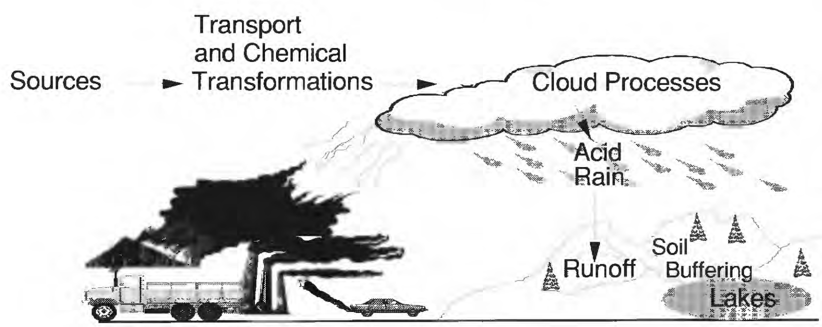
(Modified from Miller, 1984)

What are the Effects of Acid Rain?

More than 30 years ago, scientists noticed that in some lakes in remote wilderness areas, fish populations were mysteriously declining. Some lakes that once teemed with fish were found to contain none at all. In their search for what caused the fish to die, scientists concluded that acid rain was the problem. Researchers continue to document that acid rain is harmful or fatal to fish (Walk and Godfrey, 1990). Acid rain also has been found to speed up the natural decay of stone monuments and historical buildings. Other materials such as iron, steel, zinc, and paint also can be damaged by acid rain. The human-health effects of acid rain also are of concern. Although people aren't directly in danger from exposure to acid rain, the particles in the air that lead to acid rain may be a risk to human health (Semonin and Stensland, 1984).

Acid Rain Investigations

The U.S. Geological Survey (USGS) has been actively studying acid rain for the past 15 years. When scientists learned that acid rain could harm fish, damage to our natural environment from acid rain became a concern of the American public. Research by USGS scientists and other groups showed that the processes resulting in acid rain are very complex. Scientists were puzzled by the fact that, in some cases, it was difficult to demonstrate that the pollution from automobiles and



factories was causing streams or lakes to become more acidic. Further experiments showed how the natural ability of many soils to neutralize acids could reduce the effects of acid rain in some locations—at least as long as the neutralizing ability lasted (Young, 1991).
The USGS has played a key role in establishing and maintaining the only nationwide network of acid rain-monitoring stations. This program is called the National Atmospheric Deposition Program/National Trends Network (NADP/NTN). Each week, at approximately 200 NADP/NTN sites across the country, rain and snow samples are collected for analysis. The USGS supports about 80 of these sites. The information gained from monitoring the chemistry of our Nation's rain and snow is important for testing the results of pollution-control laws on acid rain.

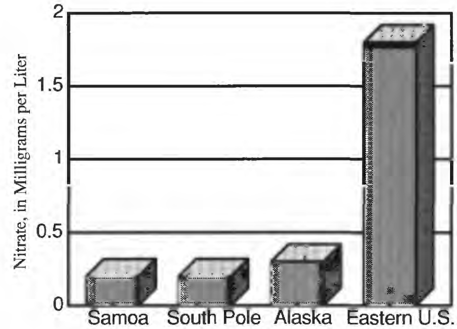
Making Sure Data are Accurate

The USGS also has invested much time and effort to make sure that the data collected by the NADP/NTN are accurate and reliable. Due in part to the quality-assurance experiments done by the USGS, the data on acid rain collected by the NADP/NTN are regarded by scientists as some of the most reliable data of any long-term environmental measurement program. The ability to detect changes in rain and snow chemistry from NADP/NTN data collected over the years is improved by USGS quality-assurance programs.

Importance of Continuing Acid Rain Research

The NADP/NTN has been in operation for more than 15 years, and some might wonder if that isn't long enough to answer all the questions about acid rain once and for all. The atmosphere and our world are both very dynamic and in a state of constant change. Without a continuing acid rain network, the effects on acid rain from natural changes in weather and the impacts of man's changing activities could go undetected. Without the NADP/NTN, the effectiveness of new air-pollution-control programs and other activities, such as the recent Clean Air Act Amendments passed by Congress in 1990, would be unknown. Although stricter controls of sulfur dioxide pollution are being phased in, nitrogen oxide pollution is forecast to increase in the next 20 years. The following bar graph shows that the nitrate amounts in rain and snow in the Eastern United States are already much higher than in precipitation in less populated or industrialized areas. (Nitrate is a chemical that is found in rain and snow as a result of chemical reactions involving nitrogen oxides.) Therefore, rain could become more acidic in some areas despite stricter controls on sulfur dioxide pollution from coal-burning powerplants.

An important reason to continue long-term monitoring is that climate changes tend to occur slowly over long periods of time, and year-to-year changes in weather can mask long-term increases or decreases in acid rain. Decisions to balance the tradeoff between less acid in our rain as a result of pollution-control laws and the higher industrial productivity that might be possible without stricter powerplant and auto-pollution controls require the best possible environmental-monitoring data.



(Modified from Miller, 1984)

References

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For additional information, call the National Water Information Clearinghouse at 1–800–H2O–9000 (1–800–426–9000)

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