OFR 92-168

WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

ACID RAIN AND ITS EFFECT ON STREAMWATER QUALITY ON CATOCTIN MOUNTAIN, MARYLAND

The U.S. Geological Survey (USGS) is the Nation's largest water-science and water-information agency. The mission of the Water Resources Division of the USGS is to provide the hydrologic information and understanding needed for the best management of the Nation's water resources. To fulfill this mission, the USGS conducts water-quality and other types of investigations of the Nation's surface- and ground-water resources.

WHAT IS ACID RAIN?

Acid deposition (commonly termed "acid rain") is an environmental problem, particularly in the Eastern United States. Acid deposition is a term applied to all forms of atmospheric deposition of acidic substances—rain, snow, fog, acidic dry particulates, aerosols, and acid-forming gases. Water in the atmosphere reacts with certain atmospheric gases to become acidic. For example, water reacts with carbon dioxide in the atmosphere to produce a solution with a pH of about 5.6. The pH scale ranges from 0 to 14—pH 7 is neutral, pH 2 is strongly acidic, and pH 12 is strongly alkaline; each whole-number change in pH represents a tenfold change in acidity or alkalinity. Gases that produce acids in the presence of water in the atmosphere include carbon dioxide (which converts to carbonic acid), oxides of sulfur and nitrogen (which convert to sulfuric and nitric acids), and hydrogen chloride (which converts to hydrochloric acid). These acid-producing gases are released to the atmosphere through natural processes, such as volcanic emissions, lightning, forest fires, and decay of organic matter. Accordingly, precipitation is slightly acidic, with a pH of 5.0 to 5.7 even in undeveloped areas. In industrialized areas, however, most of the acid-producing gases are released to the atmosphere from burning fossil fuels. Major emitters of acid-producing gases include powerplants, industrial operations, and motor

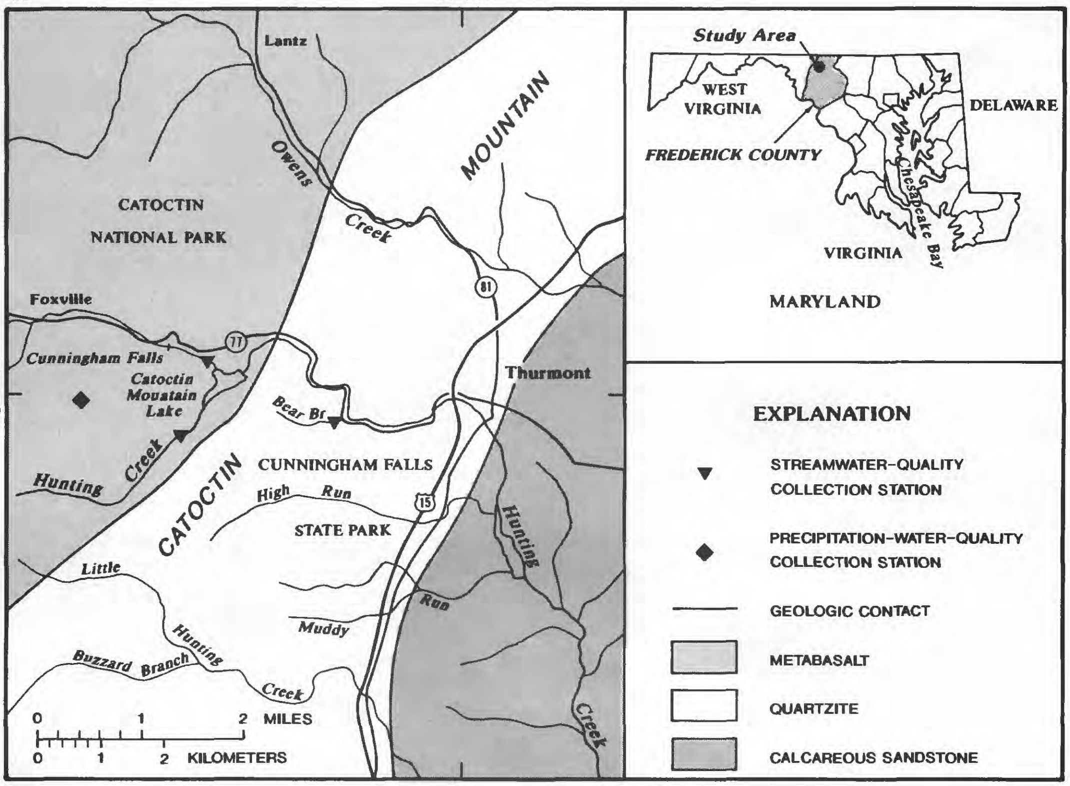

Figure 1. Location of the study area on Catoctin Mountain, Maryland, U.S. Geological Survey streamwater- and precipitation water-quality collection stations, and generalized geology.

vehicles. Acid-producing gases can be transported through the atmosphere for hundreds of miles before being converted to acids and deposited as acid rain. Because acids tend to build up in the atmosphere between storms, the most acidic rain occurs at the beginning of a storm and, as the rain continues, the acids "wash out" of the atmosphere. In order to make a fair comparison of the pH of precipitation in different localities, scientists account for the "washing out" effect by using the annual average pH of the entire volume of precipitation that is collected and measured at any one locality—a procedure known as volume-weighting.

HOW ACIDIC IS THE PRECIPITATION ON CATOCTIN MOUNTAIN?

The USGS has been monitoring the pH and water quality of precipitation and streamwater in Cunningham Falls State Park since 1982 (fig. 1). The park, located in the Mid-Atlantic region of the United States, currently receives some of the most acidic rain (lowest pH) in the Nation (fig. 2). The annual volume-weighted pH values of precipitation collected in the park since 1982 are shown in table 1. The volume-weighted average pH of precipitation on Catoctin Mountain is nearly 10 times more acidic than precipitation unaffected by acid-producing emissions, and individual rainstorms commonly are nearly 100 times more acidic. A statistically significant upward trend in pH, equal to approximately 0.02 pH unit per year, was detected for the 10 years of data that were collected. This indicates that the precipitation has become slightly less acidic over time.

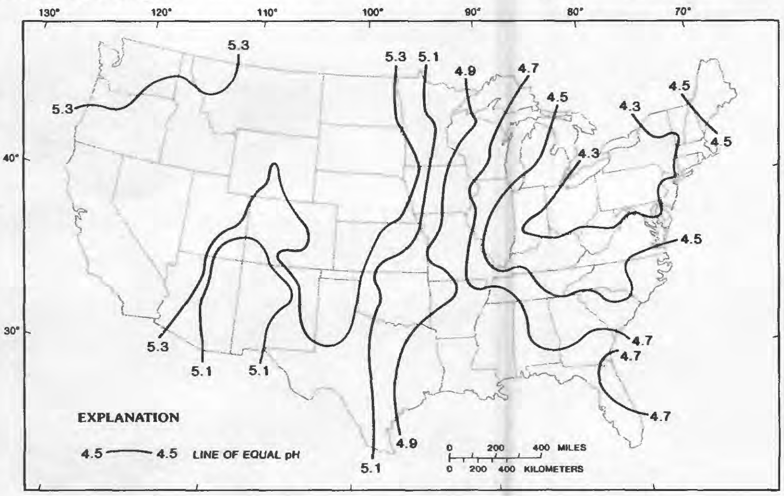

Figure 2. Volume-weighted average annual pH of precipitation in the conterminous United States, 1991. (Based on data from the National Atmospheric Deposition Program/National Trends Network.)

Table 1. Volume-weighted average annual pH of precipitation on Catoctin Mountain, Maryland,1982-91

Year	Amount of precipitation used to volume weight (inches)	Average volume-weighted pH (units)	Lowest pH recorded (units)
1982	32.86	4.10	3.40
1983	54.76	4.12	3.43
1984	56.65	4.20	3.68
1985	40.41	4.32	3.35
1986	36.72	4.15	3.44
1987	42.69	4.27	3.49
1988	36.28	4.03	2.96
1989	40.87	4.30	3.89
1990	49.65	4.22	3.61
1991	37.70	4.11	3.17

EFFECTS ON QUALITY OF STREAMWATER

The volume-weighted average of the acid precipitation falling on Catoctin Mountain is 4.2, but the pH of water in streams flowing from the mountain ranges widely from a minimum of 4.5 to a maximum of 8.5. Reasons for the wide range in the pH of streamwater in this area include seasonal effects of biological processes, flow conditions, soil cover, and topography, but the major influence on streamwater pH and chemistry is the type of bedrock that underlies the watershed. For example, limestone, which is composed of calcium carbonate, is capable of neutralizing highly acidic precipitation so that a stream flowing on limestone may have a pH well above 7. In contrast, quartzite, which is composed of silica, has little neutralizing capacity and the pH (4.5 to 5.5) of a stream flowing on quartzite will closely reflect the same pH as the precipitation falling on the watershed. Metabasalt (a good neutralizer) and quartzite (a poor neutralizer) are the dominant types of bedrock on Catoctin Mountain (fig. 1).

MONITORING ACID RAIN IN MARYLAND

In addition to the long-term monitoring of precipitation on Catoctin Mountain, other ongoing USGS studies include long-term monitoring of the quality of streamwater, research on the effects of seasonal cycles on the quality of streamwater, and research on episodic acidification (the temporary decline in pH and decline or loss of acid-neutralizing capacity) of streamwater caused by rain or snowmelt. Additionally, studies include monitoring concentrations of trace elements, such as aluminum, arsenic, lead and zinc, in precipitation and the movement of those trace elements through the watershed.

For further information on these and related studies, contact:

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Open-File Report 92-168 June 1992