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EMEP

Environmental Monitoring, Evaluation, & Protection

Adirondack Soil Chemistry May Slow Lake Recovery

The Adirondack Mountains is the region most affected by acid rain in the U.S. New data on the current condition of its soils may tell us what the future holds for the recovery of lakes and streams throughout the region.

Purpose and Implications of the Study

Although lake water chemistry has improved over the last one to two decades following large decreases in acid rain, soil acid-base chemistry may be continuing to deteriorate in many of the most acid-sensitive watersheds of the Adirondack Mountains. That's the inference drawn by a team of scientists from E&S Environmental Chemistry, the State of New York, and university researchers in Maine, Oregon, and New York, who have completed a survey of the acid-base chemistry of soil in the Adirondacks – the U.S. region most affected by acid rain.

This research, undertaken with funding from NYSERDA's Environmental Monitoring, Evaluation and Protection (EMEP) program, fills a critical data gap. It is widely believed that air pollution and acid rain have damaged soils and lakes within the Adirondack region by depleting the stored reserves of exchangeable base cations in the soil, particularly calcium, thereby reducing the ability of both soil and surface water (lakes and streams) to neutralize acids from the atmosphere. However, data on soil characteristics were generally not available, thereby preventing scientists from quantifying or monitoring soil conditions. In addition, such soil data are needed for applying mathematical models that simulate future changes in lakewater chemistry in response to the Clean Air Act Amendments and other federal and state legislation aimed at reducing air pollution.

Research Methods and Results

Soil samples were collected from 199 locations within 44 statistically-selected lake watersheds plus 26 additional watersheds that are included in long-term lakewater monitoring programs. The statistically-selected study watersheds were chosen to be representative of the regional population of Adirondack watersheds whose drainage water chemistry has limited acid-neutralizing capacity (ANC less than 200 microequivalents per liter.

Researchers traveled to the randomly selected locations throughout the Adirondack Mountains to collect samples of organic and mineral soil horizons. Sites were accessed on foot or by boat, canoe, or motor vehicle. Samples were analyzed at the University of Maine, Orono, and results were extrapolated to the watersheds of 1,320 low-ANC lakes within the region.

More than 75% of the 1,320 lakes in the target population receive surface water drainage from watershed soils with B horizons that have low exchangeable calcium concentrations (less than 0.52 cmolc/kg; a reflection of the ability of the soil to support forest health and supply calcium to lakes and streams), base saturation (less than 10.3%; a measure of the soil's ability to neutralize acids) and pH (less than 4.5; a measure of soil acidity). These data provide a baseline against which to compare future changes in regional soil chemistry in response to air pollution, climate change, and other stresses.

Soil pits were excavated at each sampling location. Samples were collected of the O-horizon and upper B-horizon.

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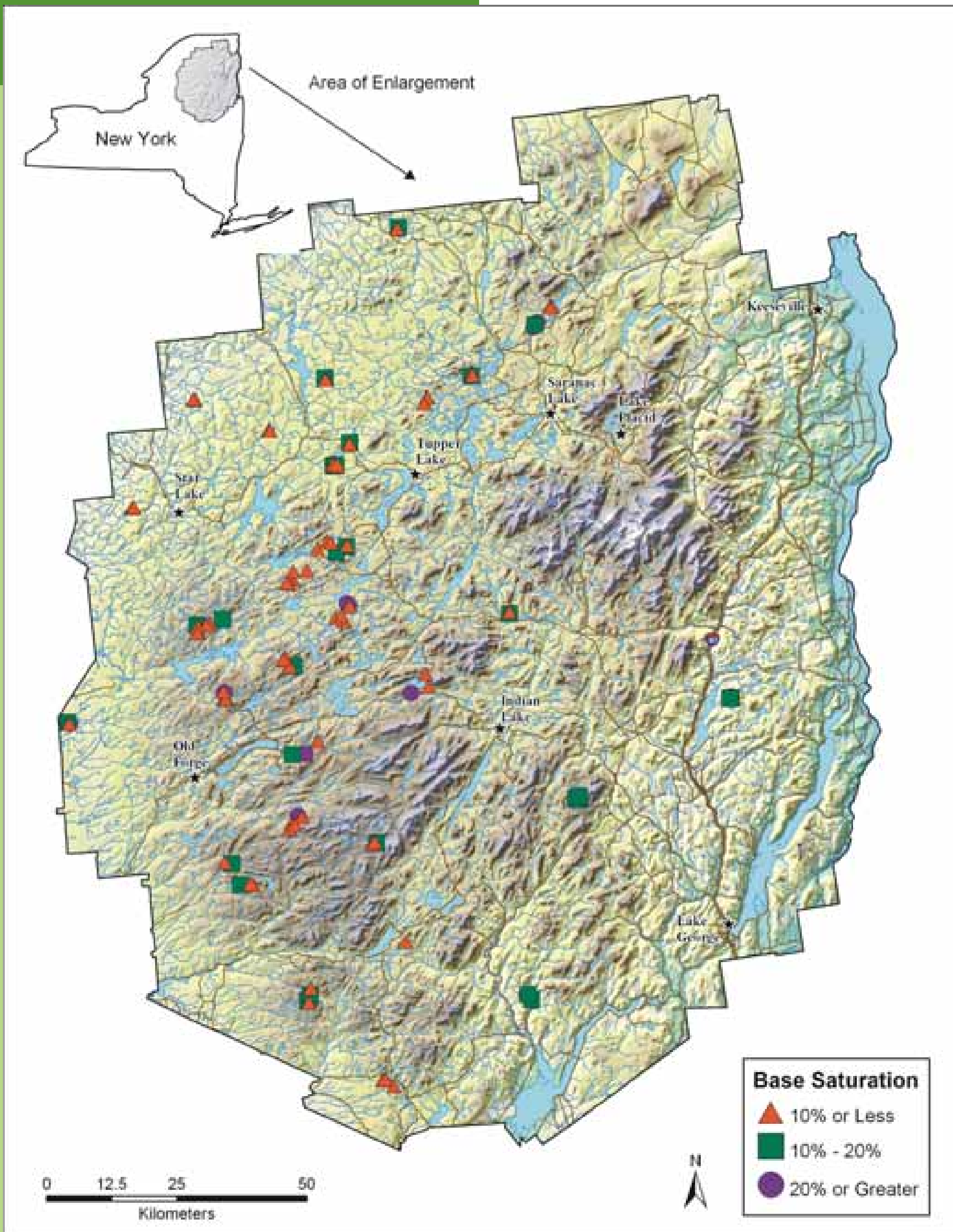

At most of the randomly-selected sites in the Adirondacks, soils were found to have low levels of base saturation, suggesting that soils in these watersheds provide little buffering of acids deposited from the atmosphere.

Are Soil Conditions Changing?

Comparison of data developed in this study and data collected by the U.S. Environmental Protection Agency in the mid-1980s suggests that despite reductions in acid deposition, Adirondack soil acid-base chemistry may have worsened. It appears that this deterioration in soil condition may have occurred even while lake chemistry was getting better. Such a soil effect would be expected to restrict the extent to which lakes will be able to recover in the future from acidification and might contribute to future adverse impacts on forest vegetation.

What Does the Future Hold?

When results of the laboratory analyses were used as inputs to watershed models of acidification response, model projections indicated continuing reduction in soil base saturation into the future. The models project future chemistry of lakes throughout the region under various scenarios of emissions of air pollutants from power plants, industries, and vehicles. With continuing soil acidification, scenarios that assume future emissions based on regulations that existed in 2004, when the modeling was initiated, show future reacidification of many lakes that are currently recovering. Model results also suggest that this reacidification might be prevented under more stringent emissions controls. Policy implications such as these provided the impetus for the research. Clearly, watershed soil is the key to determining the extent to which Adirondack lakes will continue to recover in response to controls on air pollution. This study represents an important step in the ongoing process of unraveling these complex relationships.

Preliminary results were published in the January-February 2006 issue of *Soil Science Society of America Journal* and also presented at the NYSERDA conference "Environmental Monitoring, Evaluation, and Protection in New York: Linking Science and Policy," held October 25-26, 2005, in Albany. The full project report and more information on this project may be found at www.nyserda.org/programs/environment/EMEP/

Sample collection of the O-horizon of a hardwood forest.