PROJECT UPDATE

December 2005

New York State Energy Research and Development Authority

Environmental Monitoring, Evaluation, and Protection Program

ASSESSMENT OF FOREST HEALTH AND STREAM AND SOIL CHEMISTRY IN THE CATSKILL MOUNTAINS, NEW YORK

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Project Location

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For more information on this project see:

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Keywords

- Acidic deposition
- Forest health
- Geographic Information Systems (GIS)
- Soil calcium
- Surface water chemistry

PROJECT FOCUS

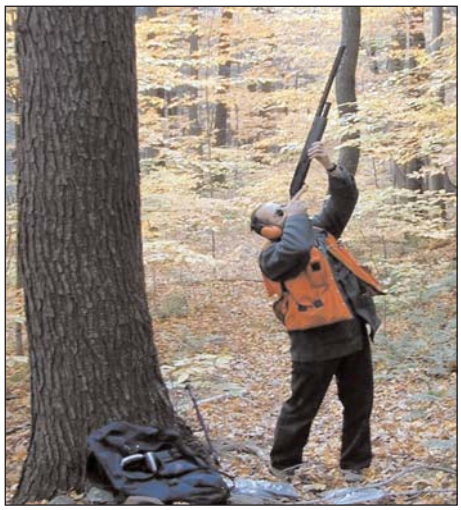
This project, a joint effort of the U.S. Geological Survey (USGS) and U.S. Forest Service (USFS), will combine field and remote-sensing data in order to produce the most detailed maps available of forest, soil, and surface-water conditions in the Catskill Mountain region of New York State (NYS). The database of geographical information compiled will highlight the forest stands and watersheds in the region that are sensitive to changes in atmospheric deposition and land use.

CONTEXT

Fossil-fuel combustion sources are major emitters of sulfur dioxide (SO_2) and nitrogen oxides (NO_X). Undergoing complex reactions in the atmosphere to form nitric and sulfuric acids, these pollutants affect ecosystems in complex ways and, through atmospheric deposition in forests and bodies of water, contribute to the acidification of soils, lakes, and streams. A major adverse effect of acid rain on forest health and productivity is a reduction in the available supply of calcium (Ca) and other base cations (positively charged ions) in soil that are needed for forest growth. The Catskill Mountain region of NYS has among the highest rates of sulfur and nitrogen deposition in the state and the lowest values for soil calcium availability. Significantly, the forested watersheds of this region provide the New York City water supply.

Credit: Rich Hallett
Researcher taking a disk from a 300-year-old spruce tree that blew down in a storm

Forest health and stream water quality depend on the integrity of biogeochemical cycles within forest ecosystems. It has been clearly established that both atmospheric deposition and forest management can alter the biogeochemistry of forest ecosystems, inducing significant changes in forest production, species composition, and stream water quality. Over the past 20 years, federal policies such as the Clean Air Act Amendments of 1990 (CAAAs) have resulted in decreased atmospheric emissions and deposition of sulfur in NYS. In the same period, atmospheric emissions of nitrogen, which were not capped by the CAAAs, have not changed significantly.



Credit: Rich Hallett
Sampling foliage with a shotgun

Monitoring the biogeochemical status of forest and stream ecosystems is a key component of assessing environmental quality in the northeastern United States. Spatially continuous monitoring of ecosystems requires remote-sensing technology. Forest canopies are the only portion of the system accessible to optical remote sensing instruments and thus offer the most likely target surface for monitoring forest health in this spatial mode. The usefulness of remote sensing of canopy chemistry depends on tight relationships between canopy chemistry and the critical processes of forest production and element losses in drainage water.

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December 2005

Credit: http://earthobservatory.nasa.gov
Forest canopy

Project Status

- Initiated July 2004
- Project ongoing

New York Energy Smart℠
Public Service Commission — NYSERDA

Since 1975, the New York State Energy Research and Development Authority (NYSERDA) has developed and implemented innovative products and processes to enhance the State's energy efficiency, economic growth, and environmental protection. One of NYSERDA's key efforts, the Environmental Monitoring, Evaluation Protection (EMEP) Program, supports energy-related environmental research. The EMEP Program is funded by a System Benefits Charge (SBC) collected by the State's investor-owned utilities. NYSERDA administers the SBC program under an agreement with the Public Service Commission.

METHODOLOGY

Building on three years of research on the correlation between depleted soil calcium, forest health, and runoff water quality, the USGS and USFS will further develop existing remote-sensing methods for mapping the condition of forests. These improvements will make it possible to assess regional changes in forest health (e.g., levels of foliar calcium and nitrogen, tree decline) on a much finer scale across the landscape. The result will be an integrated picture of the sensitivity of the landscape to disturbance as well as a better understanding of the spatial variability in potential forest and surface water responses to decreased or increased levels of acidic deposition.

Project Components

- Developing field-based maps of forest soil Ca concentrations, stream chemistry, and forest stand characteristics for the Catskill watersheds;
- Assessing forest cover types, forest health (including pre-visual decline symptoms), and canopy chemistry (nitrogen, carbon, calcium) using existing hyperspectral remote-sensing imagery (AVIRIS) for areas within the Schoharie, Ashokan, and Neversink watersheds.
- Mapping the abundance of sugar maple, red oak, and eastern hemlock within remote-sensing coverages; and
- Combining the data layers developed into a Geographic Information Systems (GIS) management tool that will predict sensitivity to disturbance on a pixel-by-pixel basis in the remote-sensing test areas and on an interpolated basis for the entire Catskills region.

PROJECT FINDINGS

Thirty plots have been sampled within the study area (for which hyperspectral remote sensing imagery was collected in 2001) in order to provide forest health, foliar chemistry, and soil chemistry data for calibration and validation.

The project team is also currently developing algorithms to map tree health by species using hyperspectral remote sensing imagery. Once developed, these techniques will be able to pinpoint areas of early decline before the symptoms are visible to ground crews.

Forest health, canopy chemistry, stream chemistry, species, and soil chemistry data layers will subsequently be compiled, providing the basis for an integrated GIS-based model that can be used to aid critical management decisions and help determine the extent and magnitude of terrestrial and aquatic responses to acidic deposition.

PROJECT IMPLICATIONS

This project will develop forest health and sensitivity indicators and first-generation maps of potential sensitivity to disturbance for the Catskill Mountain region. The methodologies and data layers created will help reveal the extent and magnitude of terrestrial and aquatic responses to acidic deposition, providing resource managers with useful information and tools that will benefit the development of sound management strategies, in particular those addressing critical loads of acidic deposition in the watersheds of the New York City water supply. In addition, the project will allow future assessments of forest conditions and more detailed forest sensitivity maps to be made at reduced costs.

Credit:http://www.tva.gov/
Northern Red Oak

Credit: http://www.tva.gov/
Eastern Hemlock