

Integrating Forest and Water Monitoring: A Pilot Study

An Evaluation in the Delaware River Basin

Introduction

The US Forest Service (USFS), The US Geological Survey (USGS), the National Park Service (NPS), and other agencies are implementing a prototype environmental monitoring strategy that will integrate air quality, forest inventory, water monitoring, land use change, and remote sensing across the Delaware River Basin. This strategy follows the "Framework for Environmental Monitoring and Related Research" by the Office of Science and Technology Policy (OSTP) Committee on Environmental and Natural Resources (CENR). The CENR Framework, links existing intensive ecological research and monitoring stations, through collaboration among regional surveys, fixed-site monitoring networks and remote sensing programs, to track complex environmental issues at a range of spatial and temporal scales. For this integrated monitoring strategy, standardized approaches and scaling methodologies will be developed for these multiple processes. Environmental trend analysis and integrated modeling tools will be used for evaluating forested watershed conditions, attributing the causes of watershed and environmental changes, as well as predicting forest health, water quality and identifying sensitive regions.

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Process Research Studies

Causes, consequences, and regional extent of calcium depletion in the forests of the Appalachian Plateau
 Forest biomass and production in the Delaware River Basin: Augmenting and verifying FIA-based estimates of carbon stocks and fluxes.
 Protocols for Identification and Monitoring of Forests Vulnerable to Non-native Invasive Pests.
 Forest Fragmentation and associated ecosystem changes in the Delaware River Basin.
 The effect of terrestrial ecosystem health and land use on the hydrology, habitat, and water quality of the Delaware River and Estuary.

Remote sensing allows us to monitor land use change, forest fragmentation, and detect areas of special interest

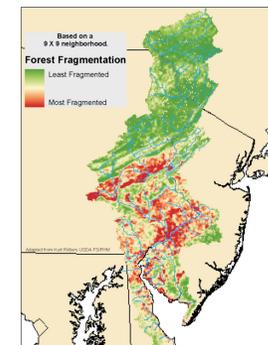


Fig. 6. Forest Fragmentation in the DRB.

Carbon: nitrogen ratios (C:N) from soil samples collected at FIA plots Contours show areas that are sensitive to N leaching loss.

By linking water quality sampling with FIA plots, associated forest data can be matched with soils data, atmospheric deposition inputs, and remote sensing of land use changes.

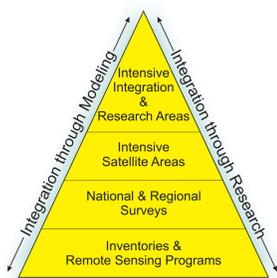


Fig. 1. Integrated research & monitoring framework for the Delaware River Basin

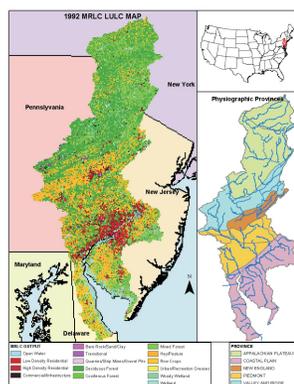


Fig. 2. Location and land use classification for the Delaware River Basin

The use of the larger number of extensive plots such as the FIA and FHM plots in the basin, provides the link with the intensive process study sites for regional scale monitoring and evaluation

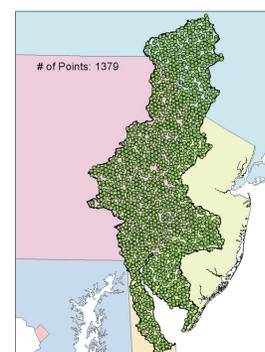


Fig. 4. Forest Inventory & Analysis (FIA) and Forest Health Monitoring (FHM) plots in the DRB.

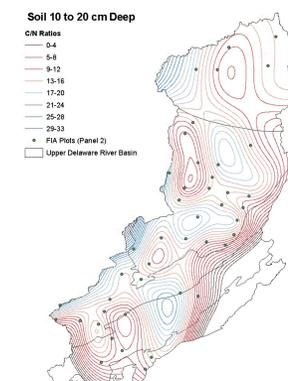


Fig. 7. Preliminary map of Sensitive areas in the Upper Delaware Basin

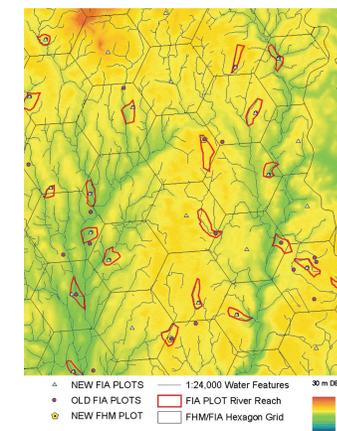


Fig. 8. Identification of first-order streams and riparian areas associated with FIA plots.

Site & Methods

The USFS is enhancing its Forest Inventory and Analysis (FIA) and Forest Health Monitoring (FHM) programs according to a new national mandate to provide continuous (annual) monitoring of forest conditions. The USGS has a well established water quality research and monitoring programs. The Delaware River study unit of the National Water Quality Assessment (NAWQA) Program is currently engaged in both intensive and survey monitoring of surface- and ground waters in the basin. The District Offices of the USGS maintain discharge and water quality monitoring stations throughout the region in cooperation with local governments. The NADP/NTN has wet deposition monitoring stations within the study area.

Intensive Monitoring Sites

We have selected intensive research sites that are already part of the NAWQA program in order to build on their foundation monitoring network.

Neversink River Basin in the Catskills, an indicator site for the New York City water supply

Delaware Water Gap National Recreation Area, where water quality is impacted by forest fragmentation outside Federal boundaries.

French Creek State Park in Eastern Pennsylvania, where land use change and air pollution are factors affecting forests and water supplies.

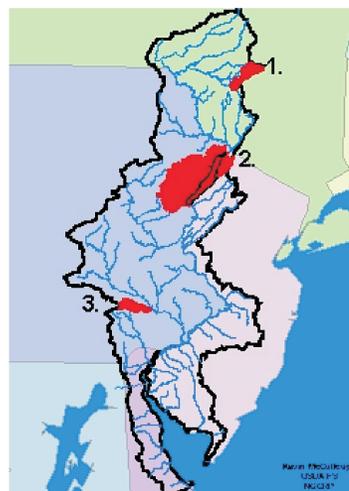


Fig. 3. Intensive Monitoring Sites:
 1. Neversink River Basin,
 2. Delaware Water Gap
 3. French Creek State Park.

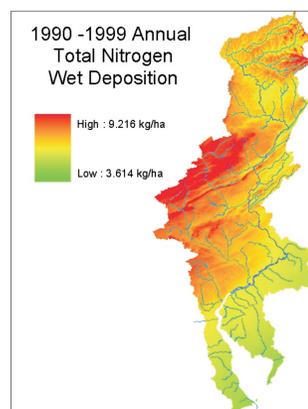


Fig. 5. Mapping of 1999 Annual Total Nitrogen Wet Deposition in the DRB.

The input of acidic and N deposition in the Mid-Atlantic region is among the highest in the nation, which affects water quality in the Delaware Basin and estuary. These deposition maps can be used in ecosystem models to estimate N leaching to streams.

Integration

Integration of Forest and Water Monitoring & Evaluation components to provide a framework for evaluation and assessment using:

Environmental Trend Analysis. Trend analysis using current monitoring networks will provide a benchmark to evaluate this Delaware River Basin study which links process research at intensive sites with observations at regional plot networks.

Applying Process based Ecosystem and Land-use Models for the Delaware River Basin Assessment.

The application of process based forest ecosystem models, such as PnET and the Terrestrial Ecosystem Model (TEM) will integrate issues such as nitrogen deposition and land use changes on water quality and forest health. The SPARROW model provides a statistically valid approach for looking at factors that affect transport of nutrients with different land uses.

Conclusions

The enhanced monitoring system is designed to integrate process-level understanding from forestry and hydrological research at intensive monitoring areas with extensive regional measurements from ongoing monitoring programs: USFS Forest Health Monitoring (FHM) and Forest Inventory and Analysis (FIA), USGS water monitoring stations and water-quality surveys, the National Atmospheric Deposition Program/National Trends Network, and operational remote sensors.

An additional 100 special FIA, FHM and carbon plots has been established within three intensive monitoring areas; the Neversink River Basin in the Catskill Mountains, the Delaware Water Gap National Recreation Area (NRA) and the French Creek watershed. This enhanced sampling is designed to allow integration with process-level studies, and facilitate scaling from intensive research sites to extended regions.

This enhanced monitoring system improves our ability to integrate monitoring information across resources and scales for evaluating forest health, water quality and identifying sensitive regions.

Participants <http://www.fs.fed.us/ne/global/research/drbl/>

- NPS Delaware Water Gap National Recreation Area
- USDA FS Forest Health Monitoring
- USDA FS Forest Inventory and Analysis Program
- USDA FS Inventory and Monitoring Institute
- USDA FS Northern Global Change Research Program
- USGS Biological Resources Division
- USGS National Mapping Division
- USGS National Water Quality Assessment Program: Delaware River Basin Study Unit
- USGS Water Resources Division