National Ecosystem Services Partnership

FEDERAL RESOURCE MANAGEMENT AND ECOSYSTEM SERVICES GUIDEBOOK

Federal Agency Explorations and Applications: Case 11 (U.S. Environmental Protection Agency)

Making Ecosystem Services the Focus of Determining Adversity to Public Welfare in Review of NOx and SOx Secondary Air Quality Standards

Christine Davis

FEDERAL AGENCY EXPLORATIONS AND APPLICATIONS: CASE 11

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How to cite:

Davis, C. 2014. "Making Ecosystem Services the Focus of Determining Adversity to Public Welfare in Review of NOx and SOx Secondary Air Quality Standards." In *Federal Resource Management and Ecosystem Services Guidebook.* Durham: National Ecosystem Services Partnership, Duke University, www.nespguidebook.com.

FEDERAL RESOURCE MANAGEMENT AND ECOSYSTEM SERVICES

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The National Center for Ecological Synthesis
The National Socio-Environmental Synthesis Center

Defenders of Wildlife
NatureServe
Resources for the Future
The Nature Conservancy

Spatial Informatics Group

Funding Sources

Primary Funding Sources

Gordon and Betty Moore Foundation
Duke University
National Center for Ecological Analysis and Synthesis
National Socio-Environmental Synthesis Center
USDA Office of Environmental Markets
And significant in-kind support from many of the institutional partners listed above

Seed Funding Sources

American Forest Foundation, Defenders of Wildlife, National Oceanic and Atmospheric Administration, Rights and Resources Initiative, Resources for the Future, U.S. Bureau of Land Management, U.S. Department of Agriculture Office of Environmental Markets, U.S. Environmental Protection Agency, U.S. Forest Service, U.S. Geological Survey

About This Document

This case is part of the Federal Resource Management and Ecosystem Services (FRMES) Guidebook created by the National Ecosystem Services Partnership (NESP). NESP, housed at the Nicholas Institute for Environmental Policy Solutions, seeks to enhance collaboration within the ecosystem services community and to strengthen coordination of policy implementation and research at the national level. The FRMES Guidebook represents a collaborative effort by federal agencies and outside experts to develop a credible and feasible approach to incorporating ecosystem services into the decision-making processes of federal agencies.

Cases are written and approved by the author(s)' agency, but they have not been peer reviewed. They describe the decision-making context within which that agency is considering or testing an ecosystem services management framework, and they present approaches or innovations that the agency is using to incorporate ecosystem services into its planning and decision-making processes. Cases informed development of the FRMES Guidebook and could be of value to others embarking on ecosystem services planning and management efforts.

To read other federal agency explorations and applications of an ecosystem services management framework, visit www.nespguidebook.com.

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Making Ecosystem Services the Focus of Determining Adversity to Public Welfare in Review of NOx and SOx Secondary Air Quality Standards

Background (Motivation and Decision Context)

The U.S. Environmental Protection Agency (EPA) conducted a joint review of the secondary National Ambient Air Quality Standards (NAAQS) for nitrogen oxides (NOx) and sulfur oxides (SOx) beginning in 2007 and concluding in 2012 with a final rulemaking for a NOx/SOx secondary standard.[1] Secondary standards are set to protect the public welfare from adverse effects due to air pollution in much the same way that primary standards protect human health. The review process includes an integrated science assessment (ISA), a risk and exposure assessment (REA), and a policy assessment (PA) that form the basis for the Administrator's decisions. As part of the NAAQS review process, the EPA is required to assess whether adversity to public welfare occurs with air quality that just meets the existing standard. The Clean Air Act describes public welfare as including:

> Effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effect on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants (Section 302(h)).[2]

The EPA has been moving toward using an ecosystem services framework for describing and, in some cases, quantifying the public welfare effects of air pollutants. This framework allows the agency to discuss ecological effects on the environment in terms of their effects on the public in a context more familiar to decision makers than ecological effects divorced from public welfare impacts.

Review of the NOx and SOx secondary standards represents the EPA's first effort to make ecosystem services the primary focus of the determination of adversity to public welfare. In both the risk and exposure assessment and the policy assessment, the review ecosystem services was highlighted to better define (1) the ecological effects of nitrogen and sulfur deposition as risks to public welfare and (2) the potential change in services that might result from meeting potential alternative standards.[3]

Key Contributors

The Office of Air Quality Planning and Standards (OAQPS) was the lead office for the cross-agency review of the NOx and SOx secondary standards. Staff from ORD's National Center for Environmental Assessment completed an integrated science assessment reflecting the full body of scientific research on the ecological effects of nitrogen and sulfur and including a chapter on ecosystem services, with an emphasis on policy-relevant research. The ecosystem services analyses conducted as part of the risk and exposure assessment and the policy assessment were supported by air quality modeling by the OAQPS's Air Quality Analysis Division and water quality modeling by the Office of Atmospheric Programs (OAP). The analysis and descriptions of potential effects on ecosystem services were the result of collaborations between the OAQPS Health and Environmental Impacts Division, the Office of Policy's National Center for Environmental Economics (NCEE), and RTI International staff working under contract to the EPA.

[1] See http://epa.gov/air/criteria.html.
[2] See http://www.epw.senate.gov/envlaws/cleanair.pdf.
[3] These documents are available at http://www.epa.gov/ttn/naaqs/standards/no2so2sec/cr.html.

Existing Resources and Organizational Capacity

OAQPS was able to leverage resources across the EPA. Each of the key players provided valuable inputs to the integrated science assessment, the risk exposure assessment, and the policy assessment. The EPA used its expertise in air and water quality modeling to simulate air and water quality under current conditions and under a scenario of pristine preindustrial conditions. Those estimates of air and water quality, the result of internal and external agency collaborations, underlie the analyses of changes in ecosystem services. Social scientists in the NCEE and at RTI helped relate the modeled scenarios to ecosystem services and, in a few cases, to estimation of monetary valuation of those services. Since this first-ever multi-pollutant review by OAQPS and the first to highlight ecosystem services, the EPA has devoted additional research resources to the development of ecosystem services methods, including ecosystem service mapping and classification.

Methodology (Location, Analysis, and Options Considered)

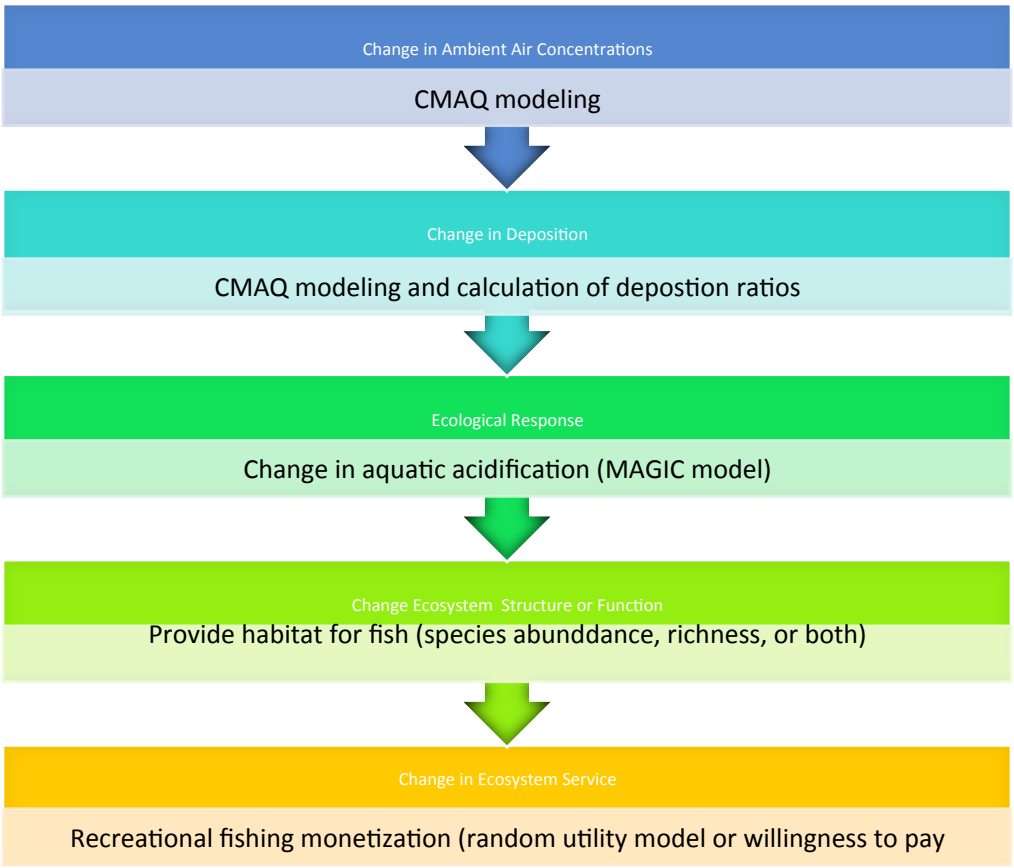
Analysis of ecosystem services impacts was complicated by the inclusion of two pollutants that alone affect multiple types of ecosystems and that together produce additive effects for certain types of ecosystem services.

Ideally, the analyses conducted for the review of ecosystem services would be national in scope, because ambient air quality standards are national in scope. However, because the environmental impacts of excess nitrogen and sulfur deposition vary across the country, the assessments were subdivided into effects categories, and case study areas were selected to represent each effect:

- Acidification due to nitrogen and sulfur deposition
    - Aquatic (Adirondack State Park in New York)
    - Terrestrial (northeast forests and southern Appalachian forests)
- Nutrient enrichment due to nitrogen deposition
    - Aquatic (Potomac River Basin-Chesapeake Bay and Neuse River Basin)
    - Terrestrial (San Bernardino County and Sierra Nevada Mountains—coastal sage scrub and mixed conifer forest)

Connecting air pollutant emissions to ecosystem service effects requires several steps, each with its own analysis leading. Figure 1 illustrates the steps involved in using aquatic acidification and recreational fishing as an example. This diagram can be modified for any of the other ecosystem service endpoints that correspond to the ecological effects caused by nitrogen and sulfur deposition.

Figure 1. Steps in Ecosystem Services Analysis for Air Pollution: Aquatic Acidification.



The ecosystem services associated with the ecological effects of nitrogen and sulfur were identified for each case study area as described. These services were then divided into quantified and un-quantified categories. For some services, the analysis included monetization. For many others, the analysis stopped at qualitative descriptions of anticipated effects on services and at description of the current magnitude of the potentially affected services. Table 1 illustrates the substantial difference between the number of quantified and un-quantified services.

Table 1. Quantified and Un-quantified Ecosystem Services Related to Nitrogen and Sulfur Deposition.

Ecological Effect	Quantified	Qualitative Discussion
Aquatic acidification	Recreational fishing Total ecosystem services*	
Terrestrial acidification	Timber market effects for sugarmaple and red spruce	Recreation (hiking, wildlife viewing, hunting) Fall color viewing Maple syrup production Non-use (existence, bequest)
Aquatic eutrophication		Commercial fishing Loss to seafood industry due to fish kills Recreational saltwater fishing Motor boating Bird watching Beach use Non-beach coastal visits
Terrestrial nutrient enrichment		Habitat for T&E species Existence Recreation (hiking, fishing, hunting, wildlife viewing) Alteration of fire cycle

*Total services are included in the willingness-to-pay survey used to quantify services related to Adirondack lakes acidification. The survey authors found that respondents were including near-shore effects on forests and bird populations as part of the total recreational experience when fishing.

Analysis and Tradeoffs

In the NOx/SOx review, assessment of the ecological production of ecosystem services used models when available and appropriate. The EPA's state-of-the-art air quality model, CMAQ, was used to generate deposition surfaces that in turn were incorporated into a water quality model, specifically the Model of Acidification of Groundwater Catchments (MAGIC) model. MAGIC model results were used to inform a random utility model for recreational fishing effects. The air quality surfaces were also incorporated into the greenhouse gas version of the Forest and Agriculture Sectors Optimization Model for forestry market effects.

In the absence of available models for various ecosystem services assessments, the EPA relied on published literature to provide ecosystem response functions that were useful to describe potential effects on services. It also used publicly available reports from the U.S. Forest Service (Cordell et al. n.d.) on recreation participation and published data on willingness to pay (WTP) for recreation activities (Kaval and Loomis 2003) to describe the current magnitude of the recreation services anticipated to be at risk from nitrogen and sulfur deposition. As a complement to the recreational fishing model, the EPA related water quality changes to the WTP survey of New York residents for fishing in the Adirondacks (Banzhof et al. 2006).

Under the Clean Air Act, the EPA is prohibited from considering the cost of regulation when setting a national ambient air quality standard, which is to protect public welfare from known or anticipated adverse effects without regard to implementation cost. This prohibition does not prevent the EPA from considering the adverse economic effect of damage to the environment—indeed, that adverse effect was a component of the ecosystem services analysis for the NOx/SOx review.

Implications and Next Steps

The review of the NOx/SOx secondary standards set a precedent for use of ecosystem services in risk assessments and provides examples of the methodologies for doing so.

Because of this precedent, the risk exposure assessment for the ongoing review of the ozone secondary standard was carried out with a focus on ecosystem services as the metric of adversity to public welfare. Moreover, ecosystem services analysis is likely to be part of any regulatory impact analysis that accompanies the standard.

The EPA is continuing to refine its methods to make analyses increasingly robust. In the next review cycle for the NOx/SOx secondary standard, the agency is again focusing on ecosystem services to assess the risks to public welfare. It is transitioning from the Millennium Ecosystem Assessment ecosystem services classification system to its own system: the National Ecosystem Services Classification (NESCS).[4] NESCS is based on the concepts applied in development of national economic accounts, specifically the North American Industry Classification System and the North American Product Classification System. NESCS is being designed to aid in analyses of the impacts on human welfare of policy-induced marginal changes in ecosystems. It will support risk assessments, policy assessments, and cost-benefit analysis while minimizing the double counting and categorization issues present in the MEA framework.[5] A draft report on the classification system is in preparation.

[4] http://water.epa.gov/learn/confworkshop/upload/FINAL-Summ-WS2-NESCS.pdf.
[5] For details, see water.epa.gov/learn/confworkshop/NESCS.cfm.

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Cover photo: Grand Canyon National Park Service

About the Author

Christine Davis has been with the EPA Office of Air Quality Planning and Standards for more than 10 years. Her duties include ecosystem services analysis in risk and exposure assessments and regulatory impact assessments for air quality rules.

About the National Ecosystem Services Partnership

The National Ecosystem Services Partnership (NESP) engages both public and private individuals and organizations to enhance collaboration within the ecosystem services community and to strengthen coordination of policy and market implementation and research at the national level. The partnership is an initiative of Duke University's Nicholas Institute for Environmental Policy Solutions and was developed with support from the U.S. Environmental Protection Agency and with donations of expertise and time from many public and private institutions. The partnership is led by Lydia Olander, director of the Ecosystem Services Program at the Nicholas Institute, and draws on the expertise of federal agency staff, academics, NGO leaders, and ecosystem services management practitioners.

About the Nicholas Institute for Environmental Policy Solutions

Established in 2005, the Nicholas Institute for Environmental Policy Solutions at Duke University improves environmental policymaking worldwide through objective, fact-based research in the areas of climate change, the economics of limiting carbon pollution, emerging environmental markets, oceans governance and coastal management, and freshwater management. The Nicholas Institute is part of Duke University and its wider community of world-class scholars. This unique resource allows the Nicholas Institute's team of economists, scientists, lawyers, and policy experts not only to deliver timely, credible analyses to a wide variety of decision makers, but also to convene decision makers to reach a shared understanding of this century's most pressing environmental problems.

For more information about the
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