



Landscape Analysis and Assessment – Overview

Office of Research and Development

National Exposure Research Laboratory

Environmental Sciences Division

Landscape Ecology Branch

Background

In the past, environmental policy generally reflected a reactive response to environmental perturbations with management efforts focused on short-term, local-scale problems such as pollutant abatement. The 1980s witnessed increased interest in protecting whole ecosystems from chronic environmental problems, but these were often partitioned in relation to specific media, e.g., water, air, or soil pollution.

Currently, environmental management philosophy is evolving toward examination of critical environmental problems over larger spatial scales and assessment of the cumulative risk resulting from multiple stressors. Concern over the condition of communities, watersheds, and ecoregions has received considerable attention. Subsequently, the U.S. Environmental Protection Agency initiated a landscape research program in 1992 to develop and test multi-scaled vulnerability assessment approaches.

Goals

Through development and application of landscape assessment approaches, the landscapes program is designed to enhance the ability of environmental managers and the public to:

- determine the status and trends of ecological resources at multiple scales;
- evaluate how conditions at a community scale are influenced by broader-scale landscape patterns and characteristics;
- evaluate impacts of multiple stressors on ecological resources;
- evaluate and prioritize the vulnerability of ecological resources to impairment due to a range of stressors at multiple scales;
- formulate a variety of landscape planning options within and among scales to reduce vulnerability of ecological resources to impairment, and to enhance and restore specific ecological resources;
- develop products, such as regional and watershed assessments, analysis tools, digital maps, and databases, for a variety of audiences.

Conceptual Approach

The landscapes program uses landscape ecology, i.e., the study of the distribution patterns of communities and ecosystems, the ecological processes that effect those



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patterns, and changes in both pattern and process over time, as its foundation. Research is focused on the interaction between landscape patterns and ecological processes, especially as they affect the natural flows of water, energy, nutrients, and biota in the environment. Landscape pattern metrics related to size, shape, and connectivity are used as indicators of ecological processes and stressors. These indicators are related to conditions in specific ecological resources through application of models and empirical studies, and therefore provide the basis for assessments of watershed condition (water quality, quantity, and vulnerability to flooding), landscape resilience (ability to sustain ecological goods and services when subjected to combinations of anthropogenic and natural stress), and biodiversity (wildlife habitat).

The latest in available technology relative to remote sensing, geographic information systems, and spatial statistics is being used. Remotely placed scanners, such as the Landsat satellites, provide data with: (1) broad temporal frequency, (2) complete spatial coverage, (3) ease and economy of acquisition, (4) capability to integrate measurements of ecosystem condition that are derived from site and remote sensing methods, and (5) an ability to assess ecological conditions at multiple scales. Landscape pattern metrics and indicators are derived from these data by using commercial and custom-designed spatial statistics software.

Implementation

The program is proceeding simultaneously along two lines: (1) a research component to develop and test landscape indicators and assessment protocols, and (2) an implementation component to demonstrate the application of landscape analysis protocols to multiple-scale, ecological assessments. The research and implementation agendas are being accomplished through regional studies throughout the United States, e.g., Mid-Atlantic Region. An overall research strategy (*Landscape Monitoring and Assessment Research Plan - 1994, EPA/620/R-94/009, 1994*) originally set forth a specific research agenda to resolve key technical issues, including sampling design, indicator development, and assessment protocols. This was later refined in a 10-year research strategy to develop *A National Assessment of Landscape Change and Impacts to Aquatic Resources (EPA/600/R-00/001)* published in January 2000.

Landscape indicators are in various degrees of development. Some are fully field tested and ready for immediate use; others are preliminary concepts developed from the theoretical basis of landscape ecology. A number of journal articles have been published by the landscapes program that address landscape indicator and assessment issues.

The landscapes program has developed an “Atlas” concept to communicate its analysis results to a variety of users. A landscape atlas consists of a set of indicators mapped across multiple scales. The maps give the reader an idea of the spatial distribution of landscape condition relative to specific environmental values at multiple scales. A demonstration of this concept, *An Ecological Assessment of the United States Mid-Atlantic Region (EPA/600/R-97/130)*, was published in November 1997.

Anticipated Contributions

Two major types of contributions should result from the program: (1) a set of key scientific findings regarding the application and interpretation of landscape indicators at multiple scales, and (2) a landscape assessment framework to analyze ecological resources that contribute to multi-scaled ecological vulnerability and risk reduction assessments.

The landscape assessment framework and methodologies should provide a number of benefits to environmental managers and the public:

- *An understanding of how conditions at a community level are influenced and constrained by broader-scale conditions of watersheds and ecoregions.*
- *An ability to address a range of environmental problems that have inherently different scales.*
- *An ability to address cumulative impacts to ecological resources.*
- *A framework for regional vulnerability assessments.*
- *An ability to communicate analysis and assessment results to a wide range of audiences.*

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