A multiscale approach to assessing relationships between built and natural systems

Lisa A. Wainger, Joyce Cantrell and Kristen Arrildt, University of Maryland, Center for Environmental Science, Solomons, MD 20688

Summary

This work is contributing to the US EPA's Regional Vulnerability Assessment (ReVA) for the Mid-Atlantic Region. ReVA researchers are examining a wide variety of regional conditions and trends in order to describe risks created by the cumulative effects of decisions made locally.

Our goal in this part of the project is to reveal connections and feedbacks between human-dominated and natural environments that suggest risk to socio-economic conditions. To further this goal, two types of indicators will be developed: descriptive and leading. The descriptive indicators are intended to show combinations of features and conditions that suggest existing vulnerabilities of homes and businesses to ecosystem disruption. With the leading indicators, our intention is to assess the social and economic trends that are relevant to the management of the ecosystem.

By examining resource issues in terms of human concerns about the livability of developed areas, we will be demonstrating the tradeoffs between human uses of land and natural resource protection that play a part in making decisions about land use and management.

Goals

1. Analyze whether changes in natural resources are likely to disrupt businesses or households
2. Assess how quality of life may change given existing trends
3. Examine trade-offs of resource use decisions in terms of economic returns and quality of life

Watershed Groupings

Watersheds are grouped in order to define which ecosystem services are most important to people and most likely to be at risk.

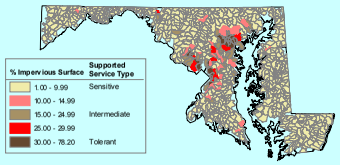
Descriptive Indicator:

% impervious surfaces

Evidence from a wide variety of studies suggests that the percentage of impervious surfaces within a watershed determines the quality of many natural resources.

The type of goods and services that may be supported by these watersheds varies from *Sensitive* resources such as trout fishing streams, *Intermediate* level resources such as uninterrupted walking trails, and *Tolerant* resources such as accessible picnic spots.

Watersheds shown in pink or red are in transition between service types.

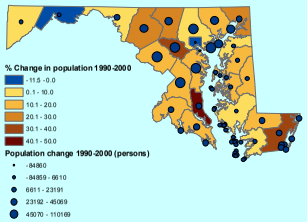


Leading Indicator

Rate of population change

The rate and magnitude of population change is the single most important variable in determining risk to ecosystem services. However many other variables will be important to understanding the type and level of risk.

The type and distribution of development can act to mitigate the risks from human activities.



Methods

Develop Descriptive Indicators Relevant to Vulnerability Assessment

Describe combinations of existing features that suggest vulnerability

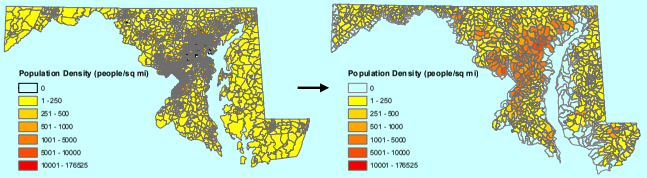
Develop Leading Indicators of Future Vulnerabilities

Describe trends or expected changes in those features that enhance vulnerability

Developing Information at Appropriate Scales

In evaluating the vulnerability of areas, we are concerned with processes occurring at several scales such as local land use decisions, regional preservation decisions, and change in networks between populated places.

Because most human decisions are made using information from a fine scale, it can be challenging to represent human concerns at a scale appropriate for regional analysis. This challenge is being met by conducting analysis at several scales and aggregating fine scale information in a manner useful for analysis at coarse scales.



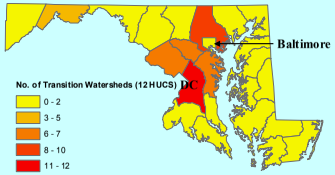
Use a scale relevant to human actions for analysis

Shown: Block group level data from U.S. Census Bureau

Aggregate demographic and other information to allow interpretation of the connections to biophysical factors

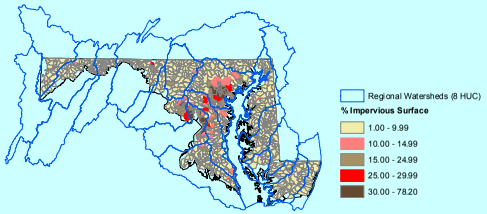
Shown: Data aggregated by small watersheds (Watershed data from Maryland Department of Natural Resources 12-digit HUC)

Aggregate information with meaningful statistics



The number of transition watersheds (pink/red watersheds in figure at left) within a county will help county planners understand local vulnerabilities to land use change.

Consider effects at a variety of scales



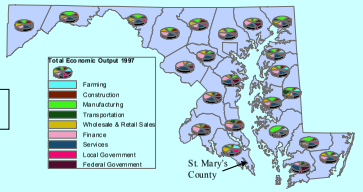
The scale at which indicators will be assessed will depend on the type of ecosystem service being evaluated and the scarcity and substitutability of that or a similar service. For example, the more scarce a recreational option is (such as viewing a rare bird), the larger the analysis area will be in order to capture the group of people willing to travel to undertake that activity.

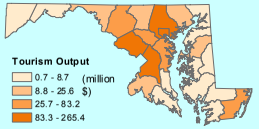
Examine Important Interactions between Indicators to Assess Vulnerability

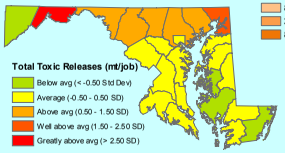
Threats to Economic Livelihood

- Economic Stability
  - Economic diversity
  - Trend in dominant industry output
  - Level of government transfer payments
  - Dependence on natural resources
  - Educational levels
- Protection of Inputs to Economy
- Management of Hazardous Outputs

Economic Dependencies



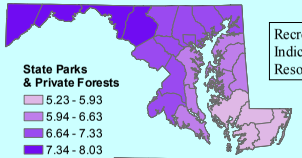


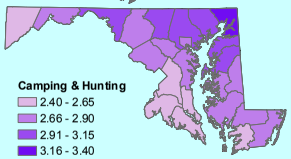


Understanding the structure of a region's economy allows us to identify resources needed to maintain or improve the economy. For example, in the pie chart figure above, the most recent economic data show that St. Mary's county has the highest dependence on farming within Maryland.

If maintaining a farming economy is important to that region, then resources will need to be managed to prevent a loss in the ability to farm from such activities as construction on prime agricultural soils.

Recreation Supply Indices by Resource Type





These maps summarize the relative availability of specific types of recreational resources available within a given county. The values shown represent the amount a county's recreational supply index score exceeds the national average.

The index scores account for the amount of recreational resources and the distance county residents would have to travel to reach the resources both within a county and within 200 miles of the county center. Resources close to the county center are given much more weight in the index score than resources further away. The index also incorporates county population as a means to consider the potential congestion at these resources.

The values shown were derived from the NORSIS database and are based on an analysis by English and Cordell (USDA, FS).

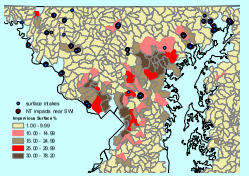
Threats to Quality of Life

- Aesthetics / Livability
  - Interspersion of housing, businesses and services
  - Open space / trees
- Recreation Supply / Congestion
  - Available facilities per capita
  - Diversity of recreation options
  - Protection of networks and adjacent lands (greenways, buffers around historical sites, etc.)
- Local Values and Customs
  - Preservation of economic activities of historical / cultural significance (farming, fishing)
  - Preservation of valued species or ecosystems
- Transportation Access / Congestion
  - Vehicle hours traveled
  - Public transit access
  - Bicycle / Pedestrian access
- Health and Safety
  - Change in air and water quality
  - Reservoir protection
  - Flood protection

Expected Results

1. Information valuable for prioritizing response to environmental threats based on local needs and priorities
2. Identification of regions with a comparative advantage in providing recreational opportunities dependent on natural resources, which will be useful for weighing resource protection in terms of future economic benefits.
3. Relative levels of resource use efficiency between counties or watersheds

Vulnerable Municipal Water Systems



Data Sources: Surface intakes from Maryland Dept. of Environment, watersheds from U.S. EPA, impervious surface calculated from population density using relationship developed by Hicks and Woods (2000).

Water supply surface water intakes and their locations relative to watershed impervious cover. Drinking water from intakes within pink or red watersheds are likely to experience degradation in water quality with increases in impervious cover. Changes in land cover such as non-tidal wetland losses could create a need for increased expenditures on water treatment.