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Regional Vulnerability Assessment for the Mid-Atlantic Region: Forecasts to 2020 and Changes in Relative Condition and Vulnerability

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Regional Vulnerability Assessment for the Mid-Atlantic Region: Forecasts to 2020 and Changes in Relative Condition and Vulnerability

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Executive Summary

The EPA's Regional Vulnerability Assessment (ReVA) Program develops and demonstrates approaches to 1) integrating spatial data and model results, 2) forecasting future scenarios, and 3) applying these methods towards regional priority setting and decision making. This report demonstrates the projection of multiple drivers of ecological change at a broad scale to the year 2020 followed by the application of different integration methods that synthesize results to address a suite of assessment questions to guide proactive decision making.

Identified drivers of change for the Mid-Atlantic region include land use change and population growth, non-indigenous species, pollution, and resource extraction (Smith *et al*. 2001). Making use of available data and models, projections were made for land use/land cover, population and demographics, non-point source pollutants in surface water, nitrogen in groundwater, and spread of non-indigenous species for the year 2020. These were then compared to a similar set of variables available for the current time period to assess changes in condition and vulnerability for the Mid-Atlantic region.

Selecting the appropriate integration method(s) to address specific assessment questions was an important objective of this project and the process followed results of earlier work evaluating a suite of integration methods for their sensitivity to different data issues and how well they addressed different assessment questions (Smith *et al.* 2003). To address questions associated with changes in pattern and condition, three integration methods were used: the Simple Sum, Principal Components, and State Space. Simple Sum and Principal Components have been shown to be complementary in their results as they are sensitive to different properties of the data. Together, they provide a good overview of regional conditions. State Space, used in this example to quantify the distance between each individual watershed and the most vulnerable watershed, is useful for quantifying how much change has occurred in that it highlights both where degradation is small and where major changes might occur.

To address questions related to identifying the most important stressors and resources now and in the future, the matrix method was used. While this method has been used for many years in a qualitative manner, correlation coefficients were used to quantify the relationship between stressors and resources based on the large amount of data available for the Mid-Atlantic region to rank among stressors and resources for both current and future periods.

Vulnerability questions were addressed using the Stressor-Resource Overlay method and the Criticality method. The Stressor-Resource method highlights areas where valued resources coincide with stressors that threaten them and where there are either no resources left or where there are only a few stressors threatening them. The Criticality method is based on the theory that as an ecosystem is moved further from its natural state it moves towards a state of being irreversibly damaged. Application of the Criticality method requires setting the suite of variables to values that are near "natural" which was done in this application using fuzzy numbers to reflect our imperfect knowledge.

Assessment results are necessarily the sum of the full set of analyses as each integration method provides different information and insights into the pattern of condition and vulnerability and how it may change for this region. Current patterns generally showed that the best conditions were in the Mid-Atlantic Highlands and the worst were in the urban areas of Baltimore, Washington, Pittsburgh and Raleigh. For future conditions, the Principal Components Analysis (PCA) showed less degradation of the urban areas as it adjusts for covariance among the stressor variables, which may underestimate the possibility of synergistic effects. The Simple Sum may thus be a more conservative predictor of environmental condition and better predictor of the probability of where cumulative effects can be expected. The State Space method indicated the least change in watersheds in the highlands and the most in watersheds in suburban areas around urban centers with intermediate changes projected for the coastal plain and piedmont. The State Space method maintains full dimensionality but minimizes the effect of covarying stressors so the pattern can be interpreted as the minimum change expected.

The matrix method identified land conversion by humans, nitrogen and phosphorus loading to streams, forest fragmentation, and soil erosion as the most damaging stressors to present environmental conditions. The most damaging stressors identified for the year 2020 were predicted to be the same with the exception of fragmentation, which was replaced by road density. The most vulnerable resources both now and in the future were small intact forest patches and forest cover in general.

The overlay analysis identified several watersheds in the highlands and several in the piedmont and coastal plains as vulnerable currently. Vulnerability to irreversible change as identified by the Criticality method was shown to be associated with more intense human activity particularly around Baltimore, Washington, north of Pittsburgh and east of Raleigh. Another 20 vulnerable watersheds were concentrated around urban centers. An additional five watersheds in eastern suburban areas entered this category of vulnerable to irreversible change with the 2020 projections.

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