

Comparing Methods for Identifying Social Vulnerability to Environmental Hazards: A Case Study of Coastal Virginia



Sea Level Rise in Coastal Virginia

- By the year 2100, sea level rise in Virginia is projected to be as much as seven feet or more.
- Lots of factors are at play:
 - More water – this is happening everywhere.
 - Where the water is – changes in ocean circulation are pushing more water towards our section of the East Coast.
 - Sinking land – particularly bad in Virginia due to both groundwater extraction and geologic rebound.
 - Plus we have a very shallow coast, so the affected area is quite large.

What is Social Vulnerability?

- Social vulnerability is typically defined as the characteristics of an individual or group that influence their capacity to anticipate, cope with, resist and recover from a natural or man-made hazard.
- Socially vulnerable groups are less resilient to hazards and thus may face disproportionate losses from either a natural or man-made disaster.

Social Vulnerability vs. Environmental Justice

- EJ is the “fair treatment... of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.”
- SV tells us who is likely to face losses in a disaster and thus can inform whether a particular policy to mitigate or adapt to climate change achieves environmental justice.
- EJ is the legal hook, SV and building resilience to hazards is the policy concern.

Key thing to remember

- The best assessments of social vulnerability are context-specific.
 - What might make someone socially vulnerable in one location may not make someone vulnerable in another.
 - Additionally, a group may be vulnerable to one particular hazard but not to another.

How do we identify socially-vulnerable groups?

- ▣ Ideally, we want a comprehensive, rigorous, and adaptable approach to identifying the most vulnerable groups.
- ▣ Two key approaches:
 - ▣ Quantitative analysis of existing data and information.
 - ▣ Qualitative, community-specific analysis of vulnerable populations.

Median household income (In 2010 Inflation adjusted dollars)

ACS 2006 -- 2010 (5-Year Estimates)

Enter address or geography



Show data by:
Tract

Visualization type:
Shaded Area



The Quantitative Approach can take lots of different forms, but the basic idea is the same – use data on the characteristics of people in particular locations to identify socially-vulnerable communities.

Pros:

- Uses readily available data.
- No need to expend limited resources to conduct your own data collection/assessment.
- May identify areas that would otherwise “slip” through the cracks.

Cons:

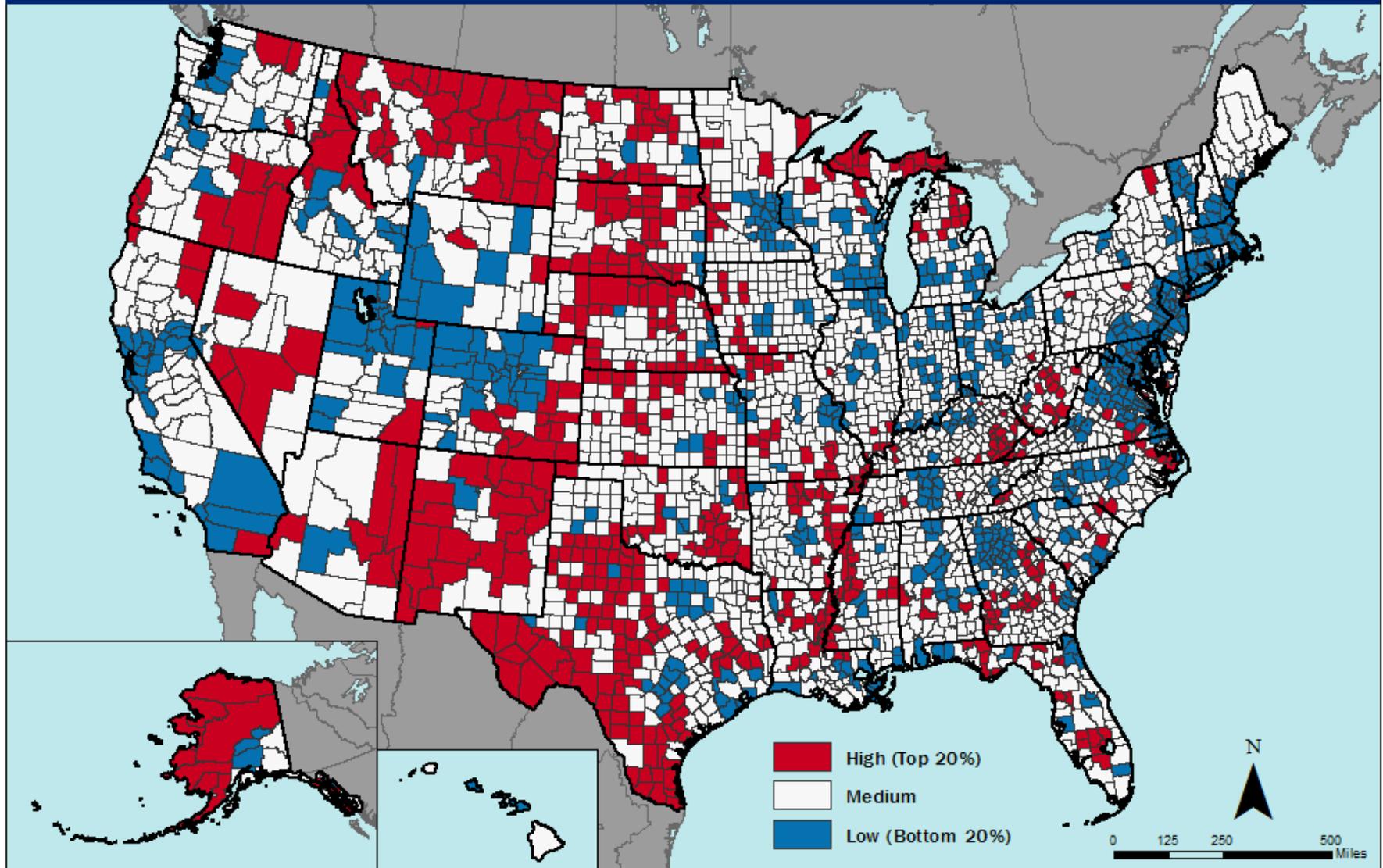
- Can only use readily available data, which is collected for lots of other purposes, not specifically to identify socially-vulnerable communities.
- Can't look at each community individually or completely.

Social Vulnerability Index (SoVI)

- Uses Principal Component Analysis to reduce a large matrix of data to a single index of vulnerability.
- Larger values indicate a more vulnerable community.
- All values are relative – there is no absolute measure of vulnerability, just a ranking.

Example of SoVI Index

Social Vulnerability to Environmental Hazards



Social Vulnerability Index 2006-10

Based on U.S. Census 2010 & American Community Survey, 2006-2010



What Data is Used?

- Different sets of variables have been used for different iterations, but generally includes:
 - Age (mean age; pct. over 65, under 5)
 - Race (pct. Black, Hispanic, Asian, Native American)
 - Financial status (mean income, house value, and rent; pct. in poverty, unemployed, receiving soc. security)
 - Household characteristics (pct. female head of household, renter, living in mobile homes; mean number in household)
 - Other (pct. employed in service industries, extractive industries; pct. in nursing homes, without HS degree; pct. female labor force participation)

Limitations of SoVI

- ❑ Geographic scope and level of analysis affects the determination of vulnerability.
- ❑ Interpretation is difficult.
- ❑ Tracts that “hit” on lots of different factors score higher than tracts that hit on just one factor, but one factor alone may be enough to make a community vulnerable.
- ❑ Not as objective as it might seem.
 - ❑ The researcher must use her judgment at various steps in the process because the relationship between the different data elements and vulnerability is not always obvious or uni-directional.

Alternative Approach

- Rather than reduce a large matrix of data to a single index of vulnerability, we are using a cluster analysis to identify different “sets” of census tracts that look similar to each other.
- We can then look at the characteristics of each set and determine whether tracts in that set are socially vulnerable.

Cluster Analysis

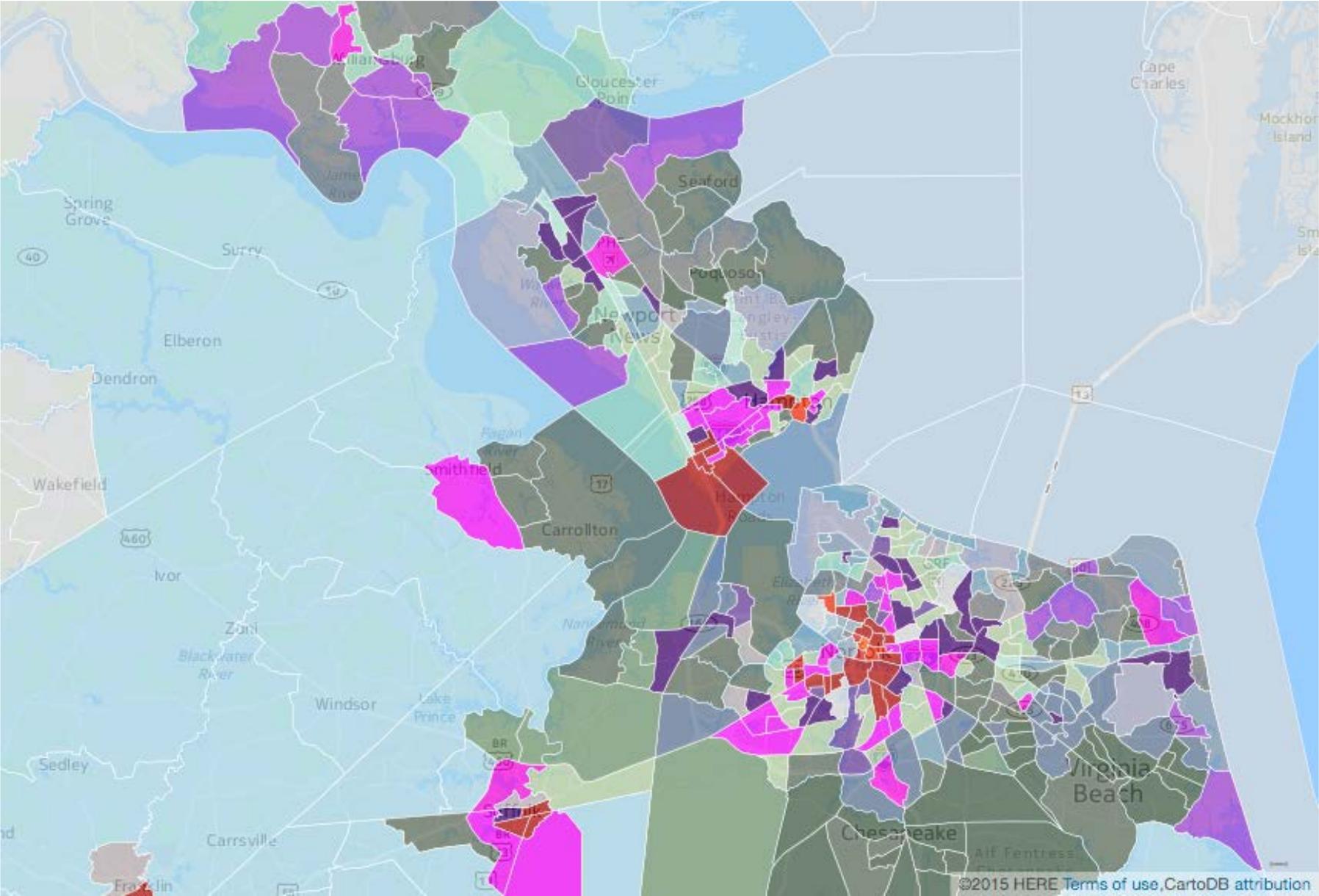
■ Pros

- Identifies tracts that may be vulnerable in only one or two dimensions.
- Allows factors to be considered holistically.
- Allows researchers to make the vulnerability determination.

■ Limitations

- Researchers have to make value judgments.
- Clustering process can miss some vulnerable tracts and can include non-vulnerable tracts.

Cluster Results for Hampton Roads



Advantages of Cluster Analysis

- Each cluster is represented by a prototype. The prototype describes the cluster along all of the dimensions used in the analysis, so that one can interpret the data in context.
 - Rural communities and urban communities are both potentially vulnerable but the characteristics that make them vulnerable are not the same.
- Interpretation is much easier to explain to non-technical users and the method is more transparent.
- In our case study, the results are more consistent than a PCA or index measure.

Disadvantages of Cluster Analysis

- More labor intensive than PCA – researcher must examine each prototype.
 - For larger geographic areas, would want to use more clusters – requiring more hands-on analysis.
- Less automated than PCA.

Caveats to all Quantitative Approaches

- The theories about social vulnerability are just theories. Very little work has been done that ties measures of social vulnerability to actual experiences.
- Available data sources have significant limitations and cannot fully capture the nature of a community regardless of what method is used to analyze the data.
- If a locality has the time and resources, a qualitative approach may provide better results.
 - However, some socially vulnerable communities are, by definition, ones that localities will have the most difficulty documenting.