

INTERDEPENDENCIES BETWEEN PHYSICAL AND SOCIAL VULNERABILITY IN A STORM RISK ASSESSMENT FRAMEWORK APPLIED TO HAMPTON ROADS, VIRGINIA

Anmol Haque, Virginia Tech, anmol91@vt.edu

Jennifer L. Irish, Virginia Tech, jirish@vt.edu

Yang Zhang, Virginia Tech, yang08@vt.edu

SIGNIFICANCE AND MOTIVATION

Risk assessment frameworks such as HAZUS-MH (FEMA, 2010) have been used globally to estimate potential losses like physical damage to structural establishments, economic loss, shelter requirements, displaced households, etc. due to multi-hazards like earthquake, flood and hurricane hazards. However, HAZUS-MH fails to consider interdependencies between physical and social capacities of affected communities. The present study aims to develop a conceptual risk assessment framework for storm hazards in coastal communities that addresses these limitations through an integrated physical and social vulnerability assessment applied to Hampton Roads, Virginia. By including interdependencies, interactions between the physical and social vulnerability will be studied. We hypothesize that changes in housing occupancy status affect the physical damage and changes in population density affect the social vulnerability. Therefore, the integrated physical and social vulnerability will change in response to a current event and therefore make the same region more or less impacted in a subsequent future event.

METHODOLOGY

The maps of social vulnerability, physical damage, combined physical damage and social vulnerability map and housing occupancy are constructed. The physical damage also termed as physical vulnerability is expressed as an expected damage percentage due to storm surge flooding and wind using a weighted average method. Social vulnerability is represented as the deviation from the mean Social Vulnerability Index (SOVI) (Cutter et al., 2003). The SOVI map is then synthesized with the physical damage map to assess the differences in patterns between damage and SOVI. Finally, interdependencies between the combined social vulnerability and damage patterns from one event, subsequent recovery, and the impacts on vulnerability in future events based on existing literature are determined; housing occupancy and population density information is used to support this analysis. Herein, we will demonstrate the framework for interdependencies related to changes in housing occupancy and population density.

PRELIMINARY RESULTS

The method described above was applied to the Hampton Roads city of Norfolk to demonstrate the proposed conceptual framework (Fig 1). HAZUS-MH was used to assess wind and storm surge damage for Hurricane Irene (1955). The SOVI and physical damage estimates were jointly interpreted to evaluate combined social-physical vulnerability. There are distinct differences in damage patterns irrespective of low or high SOVI (Fig 1(c)). We expect that post-disaster recovery varies depending on this combined physical damage and social vulnerability,

and its characterization is thus essential for more accurate assessment of risk in future events. Zhang (2012) found that marginalized neighborhoods were prone to vacancy and abandonment in Miami-Dade County, Florida post Hurricane Andrew between 1991-2000. In the presentation, we will further demonstrate our framework by characterizing the future combined vulnerability following housing occupancy change arising during the post-disaster recovery phase for a current storm event, using the findings in Zhang (2012). The base housing occupancy (Fig 1(d)) is based on the 2017 American Community Survey (ACS)-5 year estimates. We anticipate that the dark red areas and dark blue areas (Fig 1(c)) will exhibit high abandonment and vacancy respectively. Therefore, the combined impact on Hampton Roads will significantly change following a subsequent future storm event.

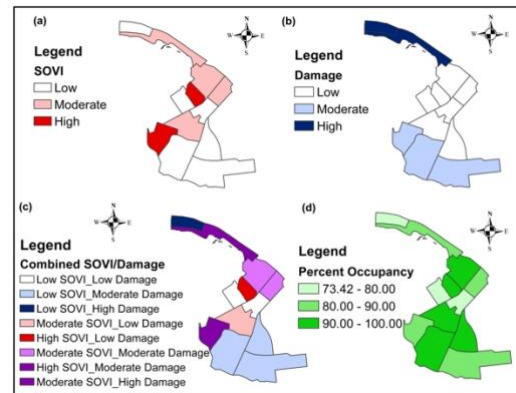


Figure 1 - Physical damage map after Hurricane Irene synthesized with SOVI map and housing occupancy status map for City of Norfolk, Hampton Roads.

ACKNOWLEDGEMENTS

This material is based upon work supported by the National Science Foundation under Grant No. 1735139. Center for Geospatial Information Technology (CGIT), Virginia Tech facilities supported this research.

REFERENCES

- Cutter, Boruff, Shirley (2003): Social Vulnerability to Environmental Hazards, SSQ, WILEY, vol. 84, pp. 242-261.
- FEMA (2010), Hurricane Model HAZUS-MH 2.1 Technical Manual. <http://www.fema.gov>
- Zhang (2012): Will Natural disasters accelerate neighborhood decline? A discrete-time hazard analysis of residential property vacancy and abandonment before and after Hurricane Andrew in Miami-Dade County (1991-2000), EPB: Planning and Design 2012, SAGE, vol. 39, pp. 1084-1104.