

Constructing Urban Vulnerability Index for Major U.S. Cities
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1. Overview

The primary focus of the research at Howard University has been to integrate the social and economic vulnerability assessment into counterterrorism measures. Specifically, this research develops an empirical method to measure the vulnerability of various population groups during a disaster. This work builds on CREATE efforts to develop Urban Vulnerability Index (UVI) to evaluate the social and economic vulnerability of major U.S. cities.

Vulnerability indices are computed on the basis of utility-maximizing consumer behavior and risk-averse public perceptions. Our model defines and measures vulnerability in terms of how fast a population group recovers from a disaster. This definition is consistent with the risk-averse social welfare function which assumes that consumers prefer a society in which the minimum level of shelter and food are provided for everyone.

Another objective of this study is to provide sound analytical and empirical guidance to decision makers regarding the most effective and efficient way to allocate resources among the cities to minimize the social and economic vulnerability. This index will help the DHS optimally allocate its limited resources based on the relative vulnerability rankings.

Results of this work have led to a new method of allocation of limited public resources to efficiently and effectively protect the vulnerable populations during a natural or man-made disaster. The UVI method developed at Howard University was applied to real-world data compiled after Hurricane Katrina. After testing the empirical method with more data on different urban areas, it can easily be applied to other cities. Application of urban vulnerability index to other cities requires only a few variables, such as household wealth and disaster strength. These variables are readily available from public data sources, i.e., U.S. Census Bureau and NOAA.

The research being done at Howard University has direct implications for risk-based resource allocation. In particular, the methods developed during the course of this work have combined socio-economic risks with geographical and spatial risks. The preliminary results indicate that the coastal counties pose significant risks. This study quantifies and ranks these vulnerabilities. Thus public resources can be allocated based on the relative vulnerabilities. Once complete, the urban vulnerability model will be useful in guiding policy makers and DHS to make better decisions to minimize risk for vulnerable populations.

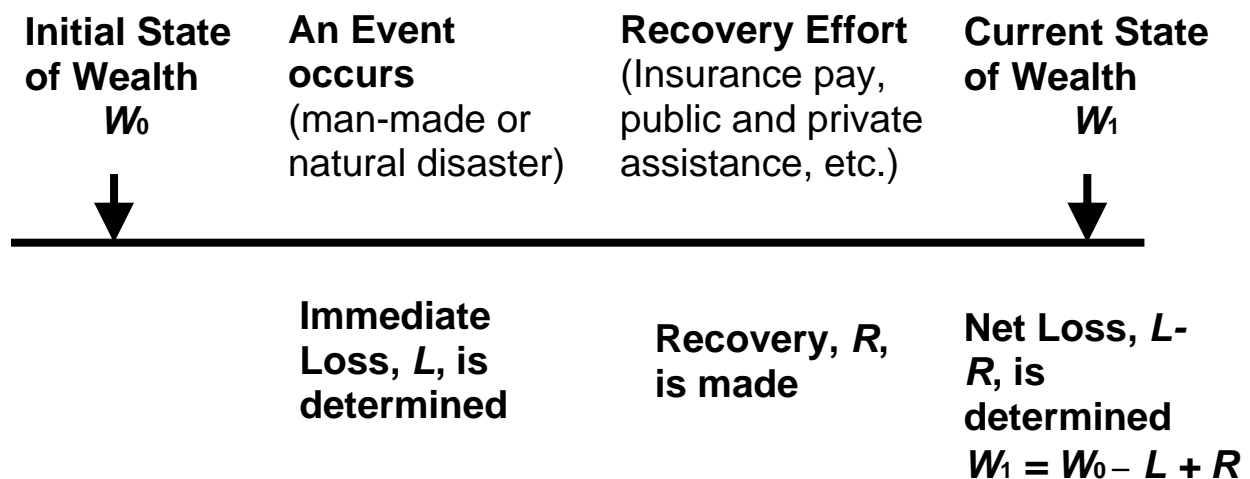
"This research was supported by the United States Department of Homeland Security through the Center for Risk and Economic Analysis of Terrorism Events (CREATE) under grant number 2007-ST-061-000001. However, any opinions, findings, and conclusions or recommendations in this document are those of the authors and do not necessarily reflect views of the United States Department of Homeland Security."

The urban vulnerability index model can be applied to data various geographic levels, i.e., federal, state, and local level. For example, a small city can easily estimate urban vulnerability index for its neighborhoods for a hypothetical disaster. Currently, methods are lacking for assessing and ranking vulnerabilities in a systematic and integrated manner. Once the urban vulnerability index model is tested and calibrated, it can be very useful in allocation of resources in a much more systematic manner. A prototype of model building and simulations for evaluating vulnerability under various scenarios is currently under development, and once completed, it will be transferred to CREATE.

2. Research Accomplishments

Currently, we are completing the urban vulnerability model. We estimated model parameters based the socio-economic and loss data compiled from public and private sources. The preliminary results are very promising. Our empirical method offers a novel approach to quantify and rank vulnerability.

Figure 1. Time Line of Event



As displayed Figure 1, we measure vulnerability based on the pace of recovery. Given pre-disaster wealth data and loss data, our model parameters return one value to be used for setting policy priorities. We estimated different parameters for coastal counties and non-coastal counties. The estimated parameters are reliable and can be very useful to guide policy makers. We used sound economic and analytical reasoning consistent with utility maximization behavior and risk-averse public perceptions. We carefully estimated our parameters by using real-world disaster data compiled by FEMA, NOAA and HUD. Our socio-economic variables were derived from American Housing Survey (AHS) and U.S. Bureau's Public Use Micro Samples (PUMS).

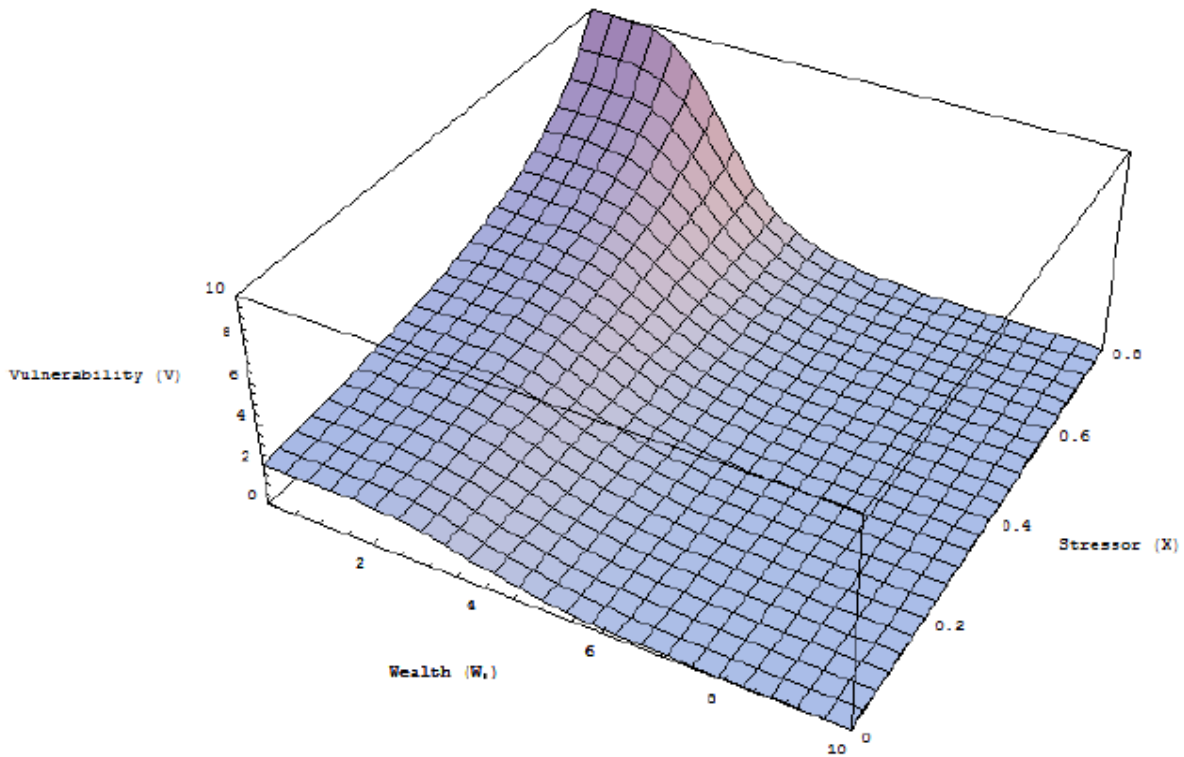


Figure 2: Ex. 2 Vulnerability by Wealth and Stressor

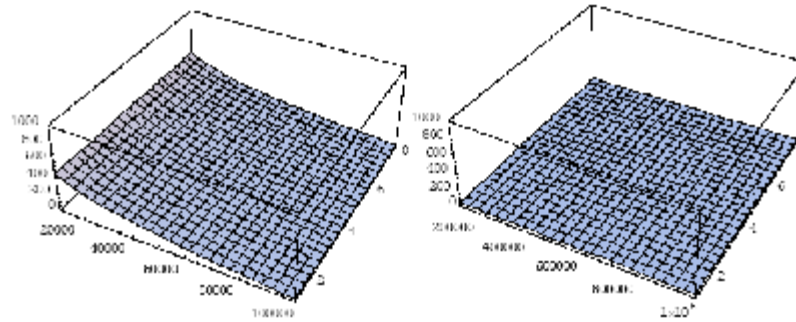
3. Applied Relevance

Research on risk and vulnerability assessment of disasters for various population groups has direct implications for risk-based resource allocation. The policy makers can make informed decisions on how to allocate scarce public sources to minimize the risks. Figure 2 graphically shows our empirical model and Figure 3 presents the estimated urban vulnerability index for different wealth groups in a disaster. Our empirical methodology can be used to construct map of vulnerability for every locality which can be shared with local and state government to coordinate and guide recovery efforts. We plan to create some of these maps for a set of cities by using Geographic Information Systems (GIS).

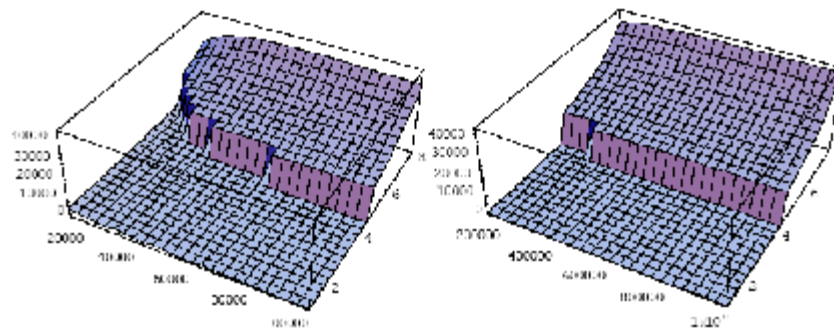
4. Collaborative Projects

Currently, we are working on a proposal to be submitted to the City of Washington DC to create vulnerability maps for DC neighborhoods. We would plan to present our working paper to the researchers at Department of Housing and Urban Development for feedback and possible future collaboration.

LOUISIANA NON-COASTAL



LOUISIANA COASTAL



Vulnerability Functions for Louisiana

Figure 3. Vulnerability Assessment in Louisiana

5. Research Products

Research Products (Please detail below)		#
5a	# of peer-reviewed journal reports published	
5a	# of peer-reviewed journal reports accepted for publication	1
5a	# of non-peer reviewed publications and reports	1
5a	# of scholarly journal citations of published reports	
5b	# of scholarly presentations (conferences, workshops, seminars)	2
5b	# of outreach presentations (non-technical groups, general public)	1
5c	# of products delivered to DHS, other Federal agencies, or State/Local	
5c	# of patents filed	
5c	# of patents issued	
5c	# of products in commercialization pipeline (products not yet to market)	
5c	# of products introduced to market	

5.1. Publications and Reports

Publications	Ref	Not Ref
1. Kurban, H., Kato, M., "Vulnerability Index," working paper, 2008		x
2. Henry-Nickie, M., Kurban, H., Green, R., Phoenix, J., "Leveling the Playing Field: Enabling Community-Based Organizations to Utilize GIS for Effective Advocacy," <i>URISA Journal on GIS in Public Health</i> , forthcoming	x	
3. Momoh, J., Fanara, P., Iwarere, J., "Building an Efficient Reliable and Sustainable Power System: An Interdisciplinary Approach," forthcoming in <i>Electric Power Networks Efficiency and Security</i> , Mili, L., Momoh, J., (eds.) Wiley Inc.	x	
4. Kurban, H., Kato, M., "Urban Vulnerability Index," discussion paper, Howard University, 2008		x
5. Momoh, J., Zhang, Y., Fanara, P., Kurban, H., Iwarere, J., "Social Impact Based Contingency Screening and Ranking," <i>International Journal of Critical Infrastructure</i> , Vol 3:1-2, 124-141, 2007	x	

5.2. Presentations

Conferences:

- Kurban, H., Meepagala G., Perkins, M., "The Pace of Recovery and Post-Katrina Composition of Neighborhoods in New Orleans," paper presented at the *2008 American Real Estate and Urban Economics Association (AREUEA) Istanbul Conference*, Istanbul Turkey, July 4-6, 2008
- Kurban, H., Meepagala G., Perkins, M., "A Time Series Analysis of the Recovery in New Orleans Neighborhoods," paper presented at the *2008 ASSA National Economic Association Sessions*, New Orleans, LA, January 4-6, 2008

5.3. Models, Databases, and Software Tools and Products

Prototype software for urban vulnerability index methodology will be transferred to CREATE once completed. The estimated model parameters and research output, papers, maps and graphs will be shared with CREATE and DHS. The P.I. (Haydar Kurban) will present the Urban Vulnerability Index methodology at Southern Economic Association Meetings in DC (November 22, 2008). His paper has been accepted and included in the SEA conference program.

6. Education and Outreach Products

Education and Outreach Initiatives (Please detail below)	#
# of students supported (funded by CREATE)	1
# of students involved (funded by CREATE + any other programs)	21
# of students graduated	
# of contacts with DHS, other Federal agencies, or State/Local (committees)	
# of existing courses modified with new material	1
# of new courses developed	1
# of new certificate programs developed	
# of new degree programs developed	

Alexis Miller, who is an MA student in Economics, was supported by this project. She is working with the PI and the research team to develop UVI for major U.S. cities. Alexis Miller is expected to graduate in May 2009 with MA in economics.

In the fall 2007 semester and fall 2008 the PI (Haydar Kurban) has incorporated some aspects of developing Urban Vulnerability Index into his Introduction to Urban Economics course. Three students wrote papers on differential effects of disasters on inner city and minority population. They used GIS and U.S. Census data for their analyses.

In the spring 2008, two graduate students constructed vulnerability indices for various population groups in Baltimore and Atlanta. Their papers focused on physical housing conditions, such as structure and elevation. They also used GIS and regression analysis.