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"The Role of Social Science Research in Disaster Preparedness and Response"

The Role of Vulnerability Science in Disaster Preparedness and Response

By
Susan L. Cutter
Carolina Distinguished Professor and Director, Hazards Research Lab
University of South Carolina
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The American hazardscape stretches from border to border and from coast to coast. There are few, if any, places in the county that are truly devoid of any type of hazard—either from natural, technological, or human-induced sources. Some places are more hazard-prone than others, and some may experience more events or disasters than others, but they all contribute to the nation's landscape of hazards. My discipline, geography, has more than a half-century of research expertise and practice in examining responses to environmental hazards. Starting with Gilbert White's floodplain studies in the 1940s and continuing today, geographers have provided the scientific basis for disaster and hazard reduction policies and contributed to the nation's understanding of the regional variability in hazardousness[1].

The question posed for today's hearing, what makes people and places vulnerable to natural hazards and disasters, requires first, an understanding of the circumstances that place people and localities at risk, and second and perhaps more importantly from the social science perspective, an understanding of the circumstances that enhance or reduce the ability of people and places to adequately respond to such threats. These circumstances range from the individual characteristics of people or buildings to global-scale processes such as climate change or economic globalization.

Vulnerability science is an emergent multidisciplinary field that helps us to address those questions. It requires a place-based understanding of the interactions between natural systems, the built environment, and human systems. What I would like to do this morning is to provide you with three examples of social science contributions to our understanding of vulnerability science, largely drawn from the geographical sciences and then make a few remarks on how we can move the nation forward.

The first example is the improvement in the metrics, models, and methods for social vulnerability assessments. Our disaster field research tells us that there are certain pre-existing conditions that make certain social groups—the poor, the elderly, women, non-English speaking residents—more vulnerable to and slower to recover from disasters. And, these findings are consistent irrespective of the disaster agent involved (e.g. earthquakes, floods, hurricanes)[2].

Social scientists at the University of South Carolina have developed a quantitative method for assessing social vulnerability that permits geographic comparisons over time at the county level (Figure 1). As a comparative measure, the social vulnerability index (SOVI) tells us where the most socially vulnerable populations reside[3]. As a predictive measure, the social vulnerability index can help state and local officials determine where additional response and recovery resources may be needed before, during, and after the natural event occurs. This empirically based model of social vulnerability illustrates the disparities in social vulnerability and graphically delineates those areas where extra preparedness will be needed given the greater social vulnerability of the residents.

The second example where social science has made significant contributions to disaster preparedness is in the area of integrated hazards assessment methodology. Under the Disaster Mitigation Act, 2000 all state and local entities must have approved mitigation plans in order to retain eligibility for disaster relief funding under the Stafford Act. These mitigation plans must be based on empirically derived hazard vulnerability assessments. In 1997, working in conjunction with the South Carolina Emergency Management Division, the Hazards Research Lab first developed a GIS-based hazard assessment methodology that is now the standard for the state (Figure 2), and widely used elsewhere[4]. The method enables us to look at the geographic variations in the hazards themselves, but also the social vulnerability of residents. When put together, it is easy to discern those areas that have the highest levels of vulnerability, but more importantly, the GIS-based approach enables us to see what is contributing to it—social or physical factors. If all counties in the nation had this level of detail in their hazard vulnerability assessments, preparing for and mitigation disasters would be reflective of risk and vulnerability in a community.

In another example, the Hazard Research Lab has just returned from coastal Mississippi where we were mapping the geographic extent of Hurricane Katrina storm surge inundation in order to compare it to the SLOSH model and to the social vulnerability of residents. We were primarily interested in where the physical impacts were the greatest, where the most socially vulnerable populations resided, and where these areas overlap, for it is in these areas that residents will face significant challenges in the longer term recovery from the disaster.

The third example of social science contributions is in the area of warnings and evacuation behavior. Social science research tells us a number of things about evacuation behavior: people evacuate as family units; most evacuees seek shelter with other family members, friends, or in hotels; public shelters are the least preferred option and are only used if there is no other alternative; many people won't evacuate because they cannot bring their pets with them, and finally, many residents use distance to mediate the threat. This latter point is important as it influences and compounds the management of evacuations at the local level. For example, during the January 2005 train derailment and chlorine release in Graniteville, South Carolina, residents within a one-mile zone were told to evacuate. Nearly all residents complied with the order. However, our research demonstrated that 59% of the residents in a 1-2 mile zone (outside the mandated evacuation area) also evacuated, placing additional logistical and support burdens on

response resources, a phenomenon known as an evacuation shadow (Figure 3)[5]. These evacuation shadows are common, and if not considered in preparedness planning, they have the potential to overwhelm the local emergency response system. During Hurricane Rita, an estimated 400,000 people lived in the mandatory evacuation zone yet more than 2.4 million took to the roadways in advance of the storm, producing a very large evacuation shadow.

The increasing technological sophistication of the spatial social sciences, especially those that incorporate GIS and remote sensing also have enhanced preparedness and response activities, especially in evacuation. Decision support systems produced by social scientists are used in Texas to assist public officials in making evacuation decisions[6]. Social scientists at the University of South Carolina have developed a spatial decision support system for state emergency managers to enable them to rapidly identify remote sensing assets and geo-spatial data that can be used during emergencies[7], while social scientists at the University of Utah have developed spatial decision support systems to aid in wildfire evacuation decision-making by local officials, to name but a few examples[8].

The Good News

The social sciences have produced the basic theory and models for understanding the social and behavioral responses to disasters and have demonstrated their application to disaster preparedness and response. Social science research has assisted in the nation's understanding of the root causes of disasters. We are better able to understand the disparities in vulnerability and how they lead to differential preparedness and response as a consequence of social science work on social vulnerability. The increasing use of geo-referenced data management systems, especially as the scale of impacts increase, has helped to enhance response and recovery efforts. Yet, state-of-the-art social science is often not translated into practice and the nation must relearn lessons derived from social science time and time again.

In response to terrorist attack of 9-11, the Association of American Geographers with support from NSF developed a research strategy and action agenda in order to harness the considerable expertise of the geographical community in understanding the complex issues of terrorism[9]. This social science research and action agenda was designed to address important public policy concerns and to identify critical research needs in three areas: regional and international research related to the root causes of terrorism; vulnerability science and hazards research; and geospatial data and technologies infrastructure research. The Department of Homeland Security's National Center on Social and Behavioral Aspects of Terrorism, the START Consortium is one outcome from this call for action from the social science community.

The Bad News

Despite our lengthy national experience with natural disasters, we still do not know how much disasters cost this nation on an annual basis, nor where those losses are occurring. How can we monitor the progress of disaster reduction and mitigation programs when we don't have any systematic baseline data on hazard events or the losses

they produce? How can the effectiveness of public policies designed to reduce losses be evaluated when such fundamental data are unavailable? With support from the National Science Foundation, we now have the beginnings of such a national dataset, the Spatial Hazards Events and Losses Dataset for the US (SHELDUS), which includes natural hazard events and losses for 18 different natural hazards for the entire country from 1960 to the present. As can be seen in Figure 4, losses are quite variable from year to year but show an overall increasing trend. These losses are mainly caused by weather-related events. The geographic pattern, shown here in Figure 5, is illuminating as well, with most of the losses in the Pacific Coast and Gulf Coast states including Florida, the Southeast, Iowa and the Northern Great Plains, and in the Northeast[10].

The Wish List

With additional investments in the social sciences, significant improvements in disaster preparedness and response are achievable. While the following recommendations have been made before, little has been done to implement them, thus they bear worth repeating. First, we need to create a national inventory or baseline on hazard events and losses housed in a social-science based National Clearinghouse with a mandate for an annual "State of Disaster" report on the nation's progress in achieving disaster resilient communities[11]. Second, we need to establish a multi-disciplinary national center (similar in scope to NSF's Science and Technology Centers or Earthquake Engineering Research Centers) to focus on vulnerability science, an effort that will help us develop and improve the data, methods, and models for understanding vulnerability and more importantly, developing tools and strategies for improving our resiliency to future disasters[12]. Third, we need to bring our social science to practitioners by providing a tool-box of data and procedures for local communities. Not only will this reduce the preparedness divide, but it will also create a more uniform baseline across the nation especially with place-based vulnerability assessments[13]. Lastly, we need to increase our support of rapid response research to secure critical social science and geo-spatial data and information in disasters. While the mechanisms are in place to activate such Quick Response research grants such as those at the Natural Hazards Center or through NSF's Small Grants for Exploratory Research, the funding levels are insufficient[14]. In an extraordinary example of recognizing the critical need to support such rapid response data collection, the University of South Carolina contributed $400,000 of its own money to support 18 research teams to gather perishable data in Katrina's aftermath[15].

The Hurricane Katrina crisis was precipitated by a physical event, but it was the failure of social and political systems that turned the natural disaster into a human catastrophe. As a nation, we need to understand the human decisions and organizational failures that contributed to this disaster so it won't happen again. We need an independent review of the local, state, and federal responses to Hurricane Katrina so we can learn the lessons of what went right and what went wrong in the response and use these to improve our preparedness and responses to future disasters. The social science disaster research community is ready and willing to step up to this challenge and participate in such an independent review. Are you willing to authorize one?

Figure 1 Social Vulnerability index for 1970 and 2000. In 1970, the most socially vulnerable populations lived in the southern half of the country and in Alaska and Hawaii. By 2000, there is an increase in social vulnerability in California, in the Lower Mississippi Valley, and in the upper Great Plains.

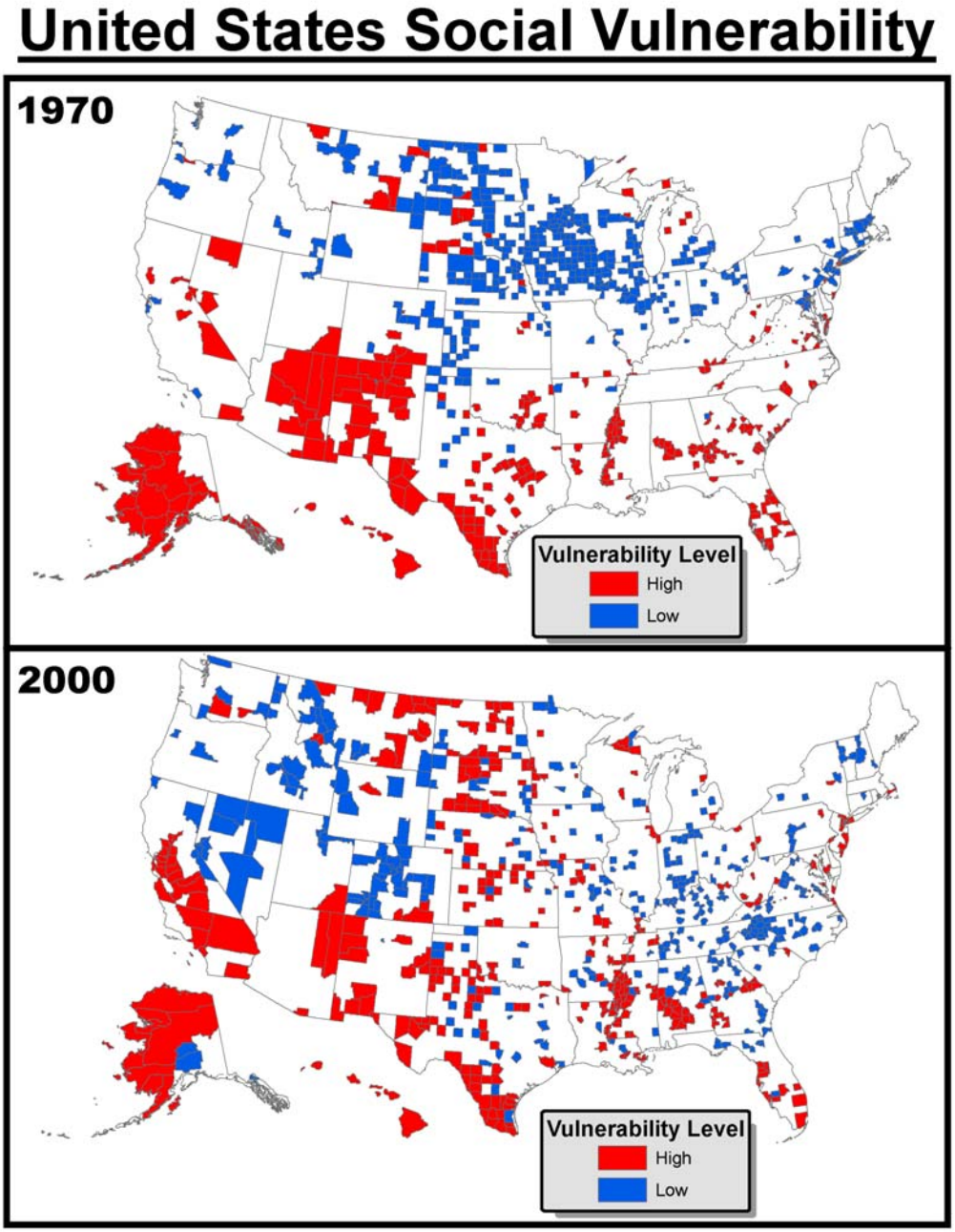
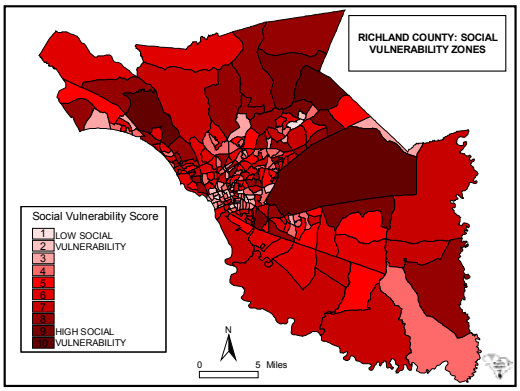
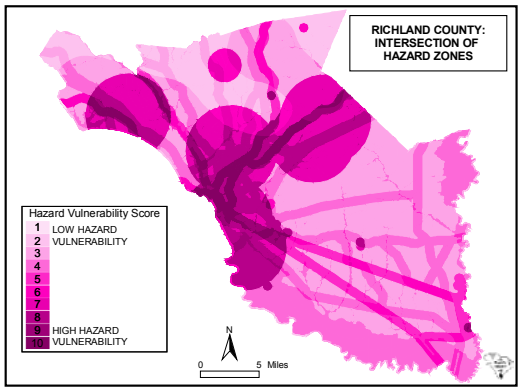


Figure 2 Hazard Vulnerability Assessments using the Hazards of Place Model. Incorporating hazard and social information allows us to determine which sub-areas within counties are the most vulnerable, and what is contributing to this, social or environmental factors. This example is from Richland County, South Carolina.





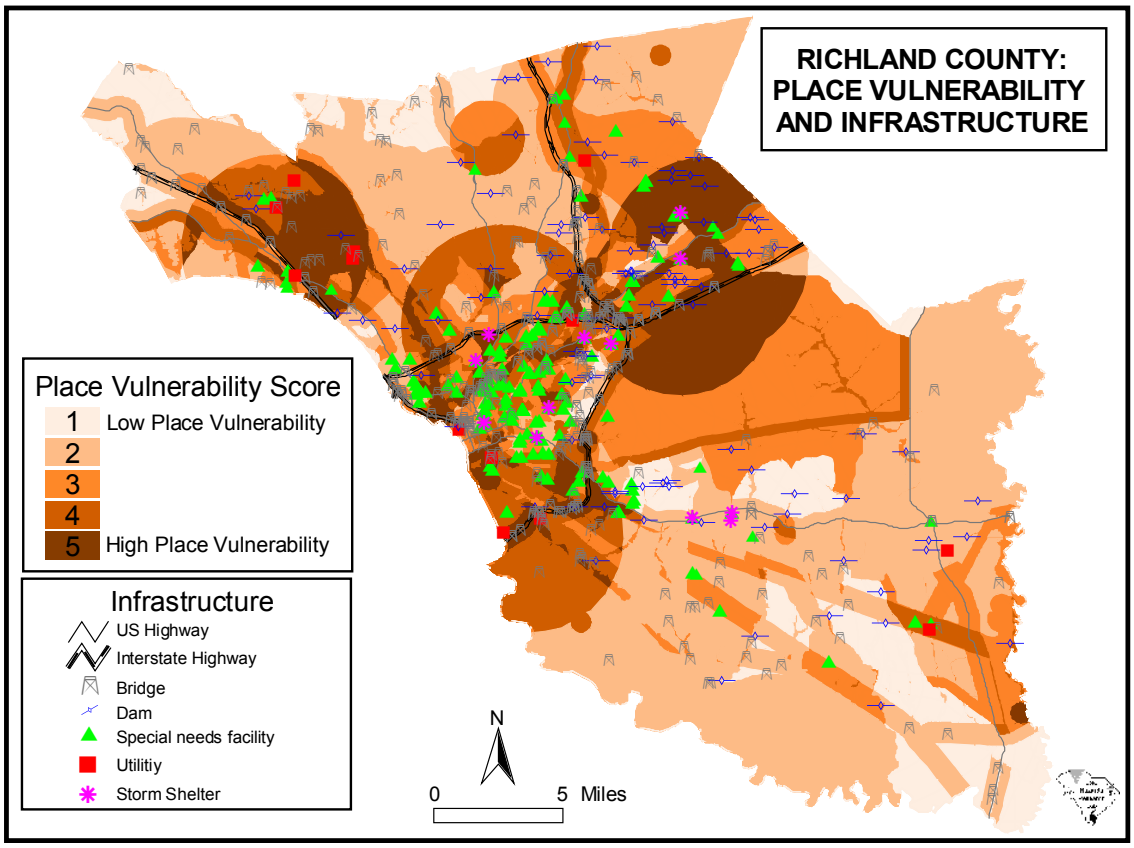


Figure 3 The Graniteville, SC train derailment and chlorine spill. Nearly all residents in the mandatory one-mile zone evacuated (98.4%). However, an additional 59% of residents in the 1-2 mile buffer also evacuated, adding an estimated 2,000 more people to the mandated evacuee population of 4,000, creating a sizeable evacuation shadow.

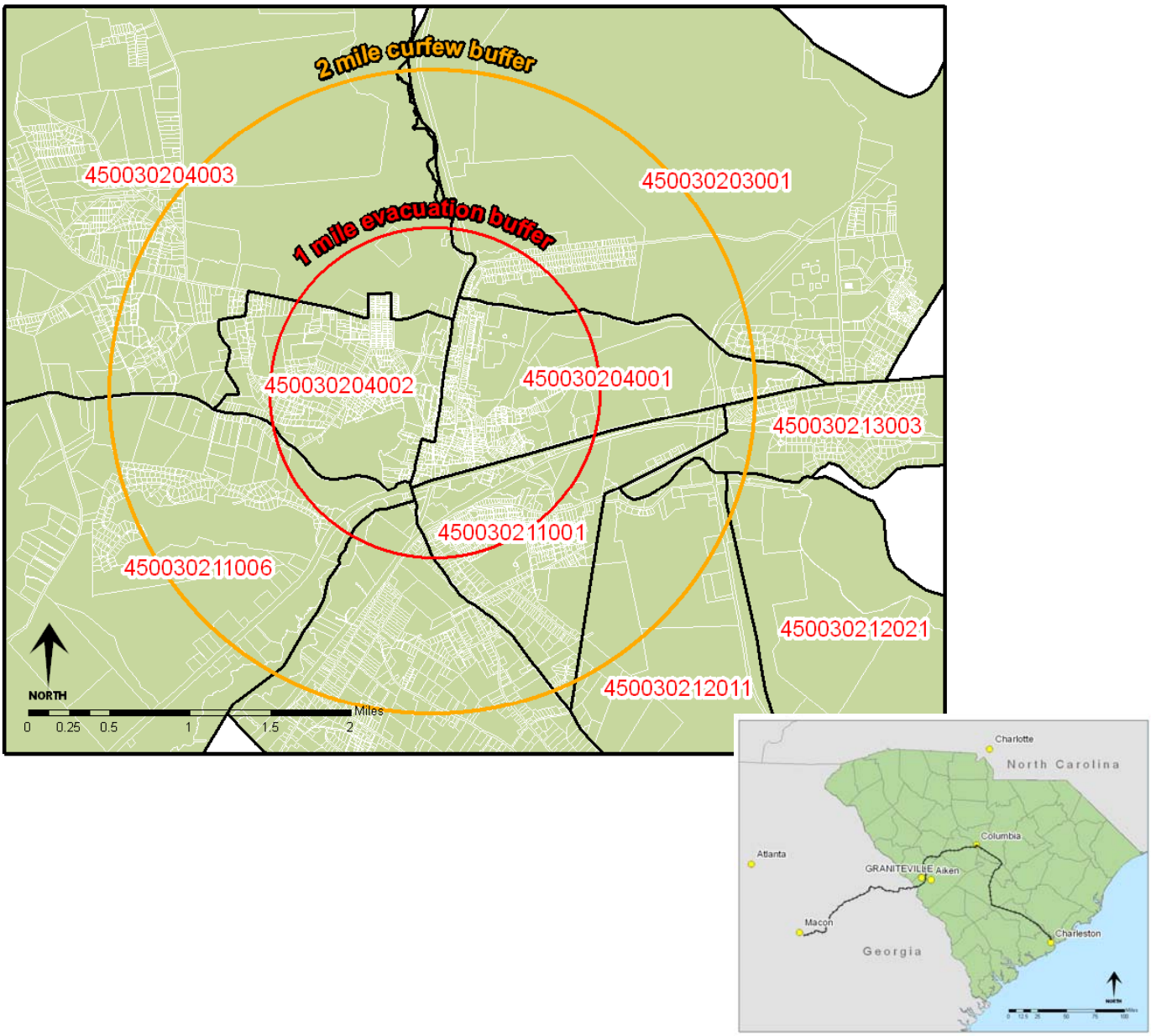


Figure 4 The increasing cost of natural disasters. There is an upward trend in dollar losses during the past 40 (1960-2003) years with weather related events producing more losses over time than geophysical events. Data are from SHELDUS (http://sheldus.org).

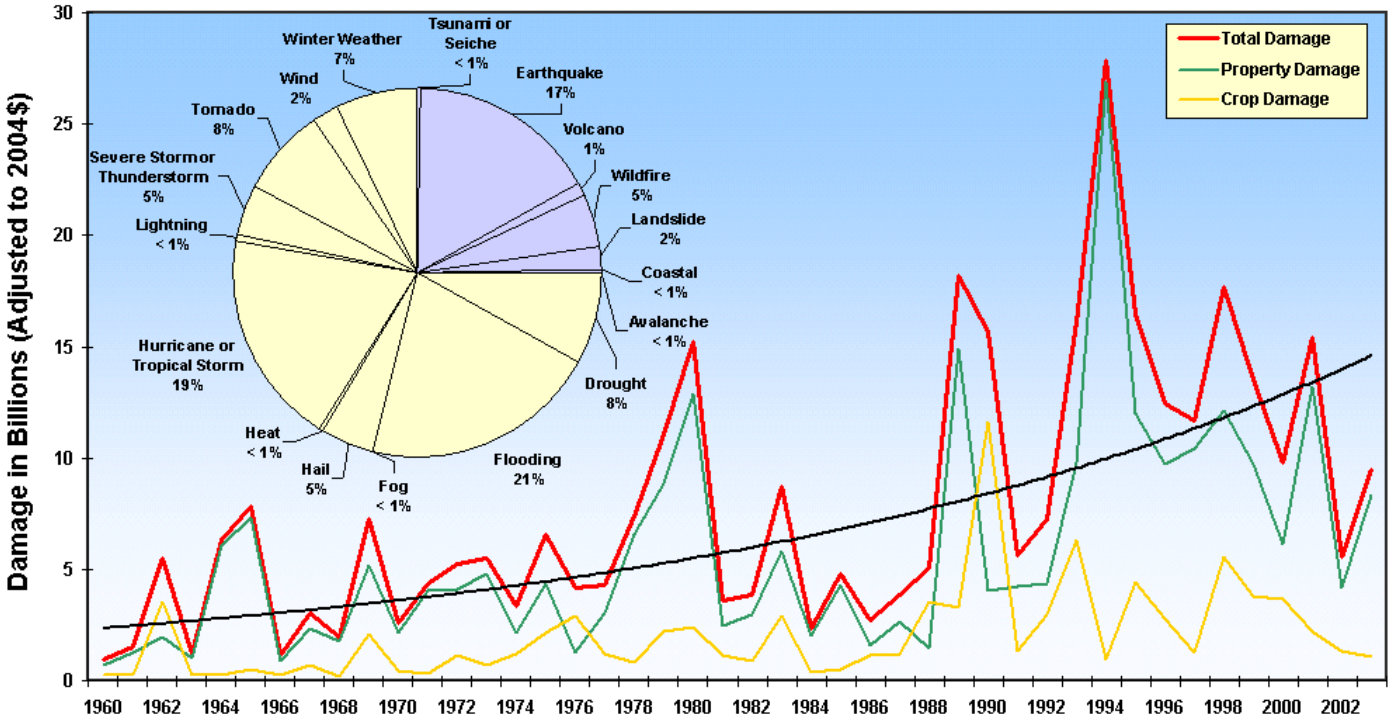
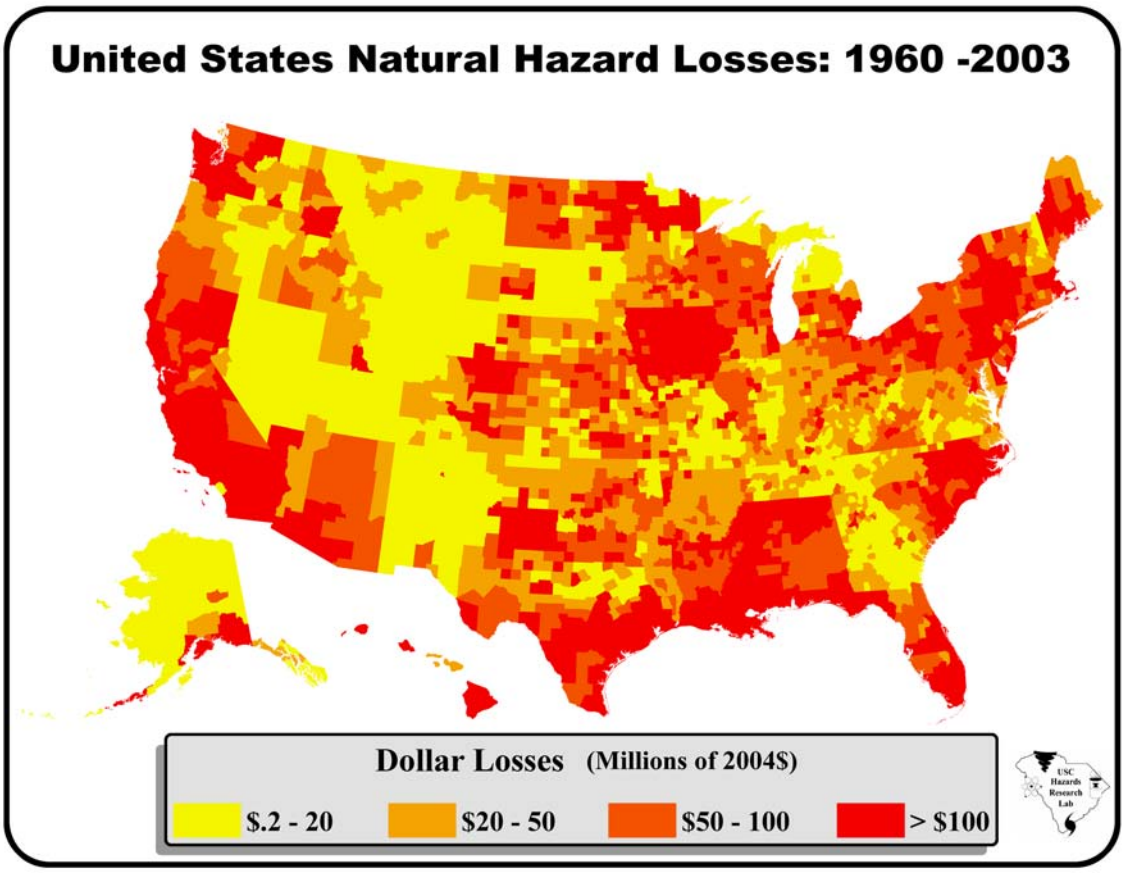


Figure 5 The distribution of hazard losses at the county level. Utilizing the Spatial Hazard Events and Losses Database for the U.S. (SHELDUS), we can see the regional variability in hazardousness and where the greatest losses have occurred.



[1] G.F. White, 1945. *Human Adjustment to Floods. A Geographical Approach to the Flood Problem in the United States.* Chicago: University of Chicago, Department of Geography Research Paper No. 29; Interagency Floodplain Management Review Committee, 1994. *Sharing the Challenge: Floodplain Management into the 21st Century*. Washington D.C.: Government Printing Office (also known as the Galloway Report).

[2] See W. G. Peacock , B. H. Morrow and H. Gladwin (eds.), 2000. *Hurricane Andrew and the Reshaping of Miami: Ethnicity, Gender, and the Socio-Political Ecology of Disasters.* Miami: Florida International University, International Hurricane Center; E. Enarson and B. H. Morrow (eds.), 1998. *The Gendered Terrain of Disasters: Through Women's Eyes*. Westport, CT: Praeger; R. Bolin and L. Stanford, 1991. *The Northridge Earthquake: Vulnerability and Disaster*. London: Routledge; The Heinz Center, 2002. *Human Links to Coastal Disasters*. Washington D.C.: The H. John Heinz III Center for Science, Economics and the Environment. Susan L. Cutter, 2005. "The Geography of Social Vulnerability: Race, Class, and Catastrophe", Understanding Katrina: Perspectives from the Social Sciences, Social Science Research Council, http://understandingkatrina.ssrc.org/Cutter/

[3] S.L. Cutter, B. J. Boruff, and W. L. Shirley, 2003. "Social Vulnerability to Environmental Hazards," *Social Science Quarterly* 84 (1):242-261.

[4] S. L. Cutter, J.T. Mitchell, and M.S. Scott, 2000. "Revealing the Vulnerability of People and Places: A Case Study of Georgetown County, South Carolina," *Annals of the AAG* 90 (4): 713-737; Also see http://www.cas.sc.edu/geog/hrl/products.html.

[5] For a copy of the Graniteville report see http://www.cas.sc.edu/geog/hrl/projects.html.

[6] The Evacuation Management Decision Support System (EMDSS) was created by social scientists at Texas A&M's Hazard Reduction and Recovery Center with support from NSF.

[7] The Remote Sensing Hazards Guidance System was developed by Michael E. Hodgson at the University of South Carolina with support from NASA. See http://www.rshgs.sc.edu/ for more details.

[8] Tom Cova (University of Utah) with support from NSF, developed a GIS-based animation of the 2003 Southern California wildfires evacuations that highlights the spread of the wildfires and the implementation of evacuation orders (http://www.geog.utah.edu/~cova/evac50sd.swf).

[9] S. L. Cutter, D. B. Richardson, and T. J. Wilbanks (eds.), 2003. *The Geographical Dimensions of Terrorism*. New York and London: Routledge.

[10] See S. L. Cutter and C. Emrich, 2005. "Are Natural Hazards and Disaster Losses in the U.S. Increasing?", *EOS,* Transactions of the American Geophysical Union, 86(41), October 11, 2005, pp. 381, 388-89.

[11] D. S. Mileti, 1999. *Disasters by Design: A Reassessment of Natural Hazards in the United States.* Washington D.C.: The National Academy of Sciences/Joseph Henry Press; S. L. Cutter (ed.), 2001. *American Hazardscapes: The Regionalization of Hazards and Disasters*. Washington D.C.: The National Academy of Sciences/Joseph Henry Press.

[12] See footnote 9, Cutter in footnote 11.

[13] See footnote 9

[14] For example, the Natural Hazards Center activated 25 Quick Response Grants in response to Hurricane Katrina (http://www.colorado.edu/hazards/qr/katrina.html), but these grants are normally less than $2,000 each. The NSF made 49 SGER awards, 14 of them to social scientists (http://www.nsf.gov/awardsearch/).

[15] Half of the awards are for social science related topics. See http://uscnews.sc.edu/rsrc223b.html for the press release.

BIOGRAPHICAL SKETCH
Susan L. Cutter

Dr. Susan Cutter is a Carolina Distinguished Professor of Geography at the University of South Carolina. She is also the Director of the Hazards Research Lab, a research and training center that integrates geographical information science with hazards analysis and management. She received her B.A. from California State University, Hayward and her M.A. and Ph.D. (1976) from the University of Chicago. Dr. Cutter has been working in the risk and hazards fields for more than twenty-five years and is a nationally and internationally recognized scholar in this field. Her primary research interests are in the area of vulnerability science—what makes people and the places where they live vulnerable to extreme events and how this is measured, monitored, and assessed. She has authored or edited twelve books and more than 85 peer-reviewed articles and book chapters.

She was the co-principal investigator on a National Science Foundation award to the Association of American Geographers to bring the nation's geographic resources to bear on this important national and international priority. This agenda and supporting documents were published as *The Geographical Dimensions of Terrorism,* edited by S.L. Cutter, D. Richardson, and T. Wilbanks (editors) in 2003. She is a co-principal investigator and member of the Executive Committee of the National Consortium for the Study of Terrorism and Responses to Terrorism (START)(a Department of Homeland Security Center of Excellence focused on the social and behavioral sciences).

In response to the 9/11 terrorist attack, Dr. Cutter led a team of researchers who examined the use of geographical information science techniques (e.g. geographical information systems, remote sensing) in the World Trade Center rescue and relief efforts. Dr. Cutter has also led post-event field studies of evacuation behavior from the 2005 Graniteville, SC train derailment and chlorine spill, and the geographic extent of the storm surge inundation along the Mississippi and Alabama coastline after the 2005 Hurricane Katrina.

In 1999, Dr. Cutter was elected as a Fellow of the American Association for the Advancement of Science (AAAS), a testimonial to her research accomplishments in the field. Her stature within the discipline of geography was recognized by her election as President of the Association of American Geographers in 1999-2000. She serves on many national advisory boards and committees including those of National Research Council, the AAAS, the National Science Foundation, the Natural Hazards Center, and the H. John Heinz III Center for Science, Economics, and the Environment.