Social Science Research Perspectives on Hurricane Science and Engineering

Susan L. Cutter
Department of Geography
University of South Carolina
scutter@sc.edu

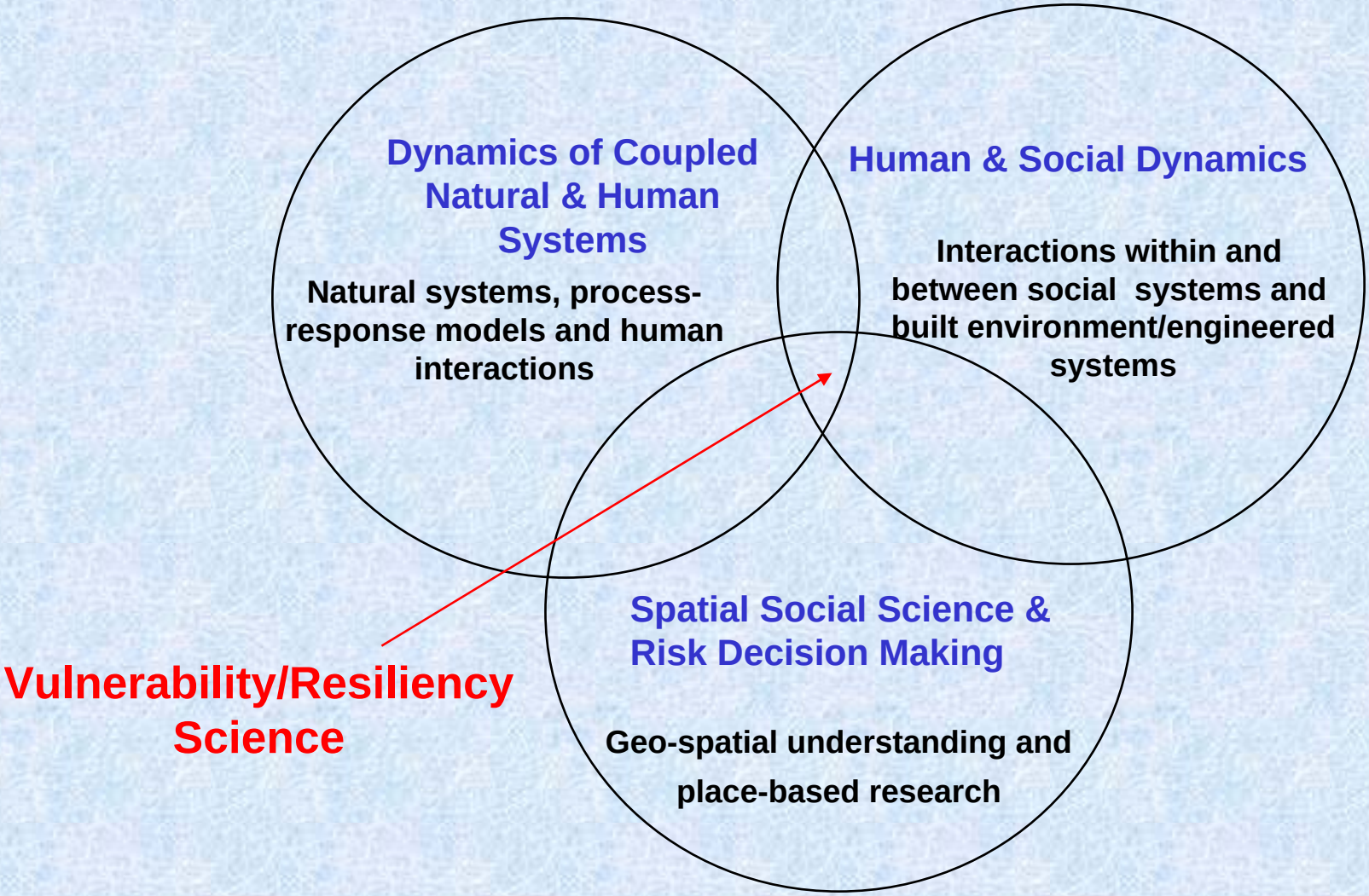
National Science Board Workshop

Task Force on Hurricane Science & Engineering

April 18, 2006

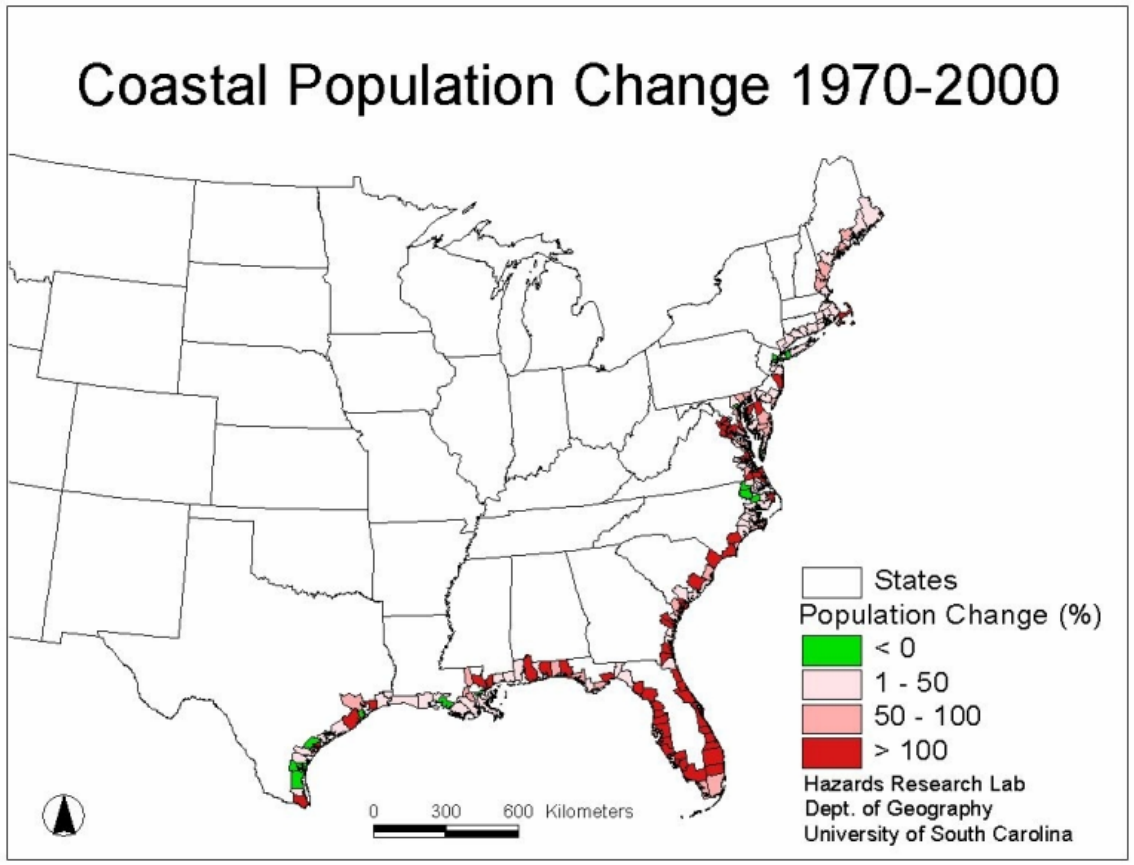
Pensacola, FL

Vulnerability Science: develop the metrics and understanding for analyzing societal vulnerability and resilience to environmental hazards and extreme events



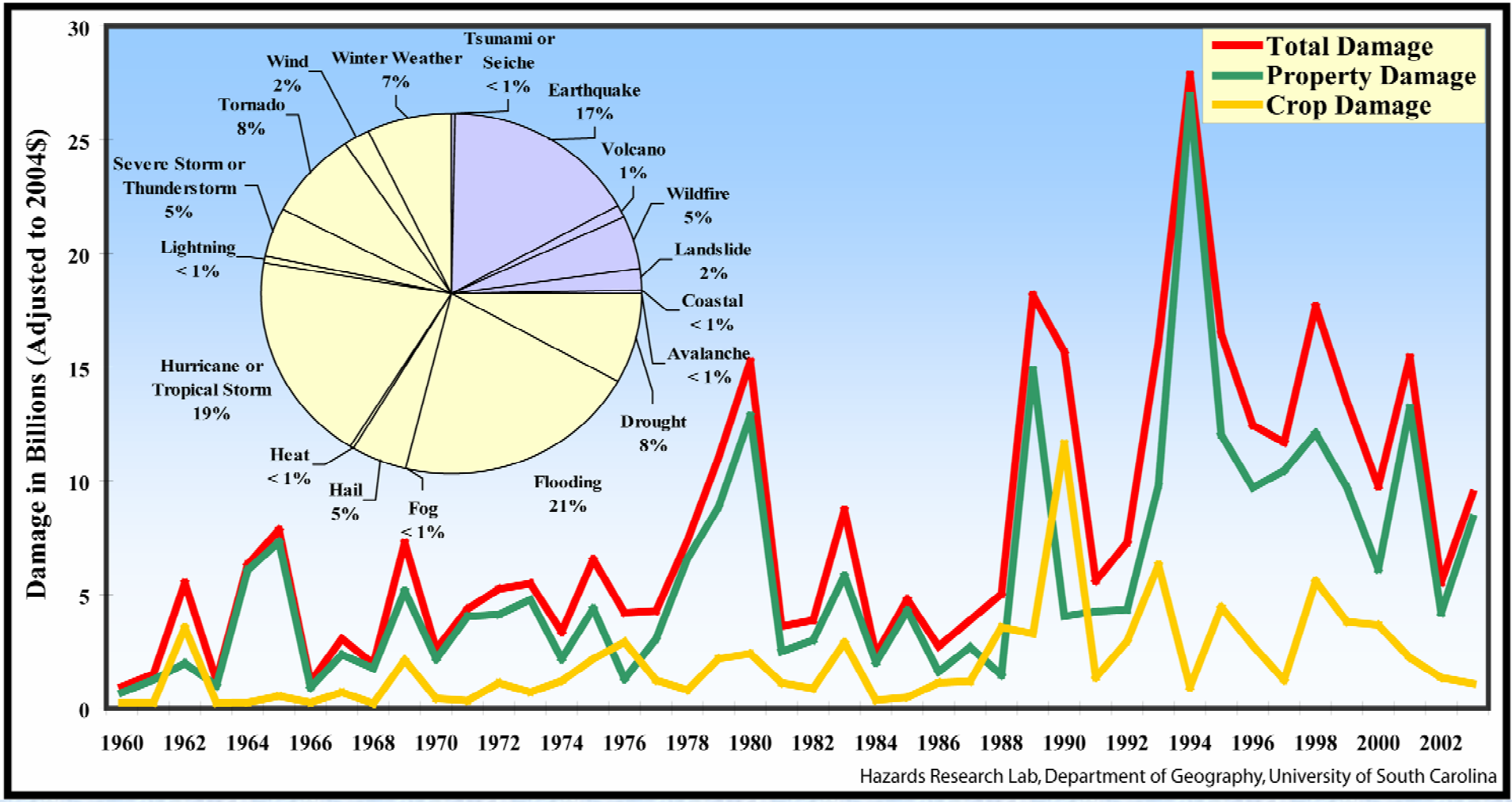
Coastal Demographics

- 53% of Americans live in coastal counties
- 153 million people (2003) up from 148.3 million (2000), and 133.4 million (1990)
- 11% change 1990-2000; 3% change 2000-2003 or roughly an increase of 1% per year



US Census Statistical Abstract of the US, 2005

Trend in Disaster Losses



Does not include 2004 and 2005, **yet**

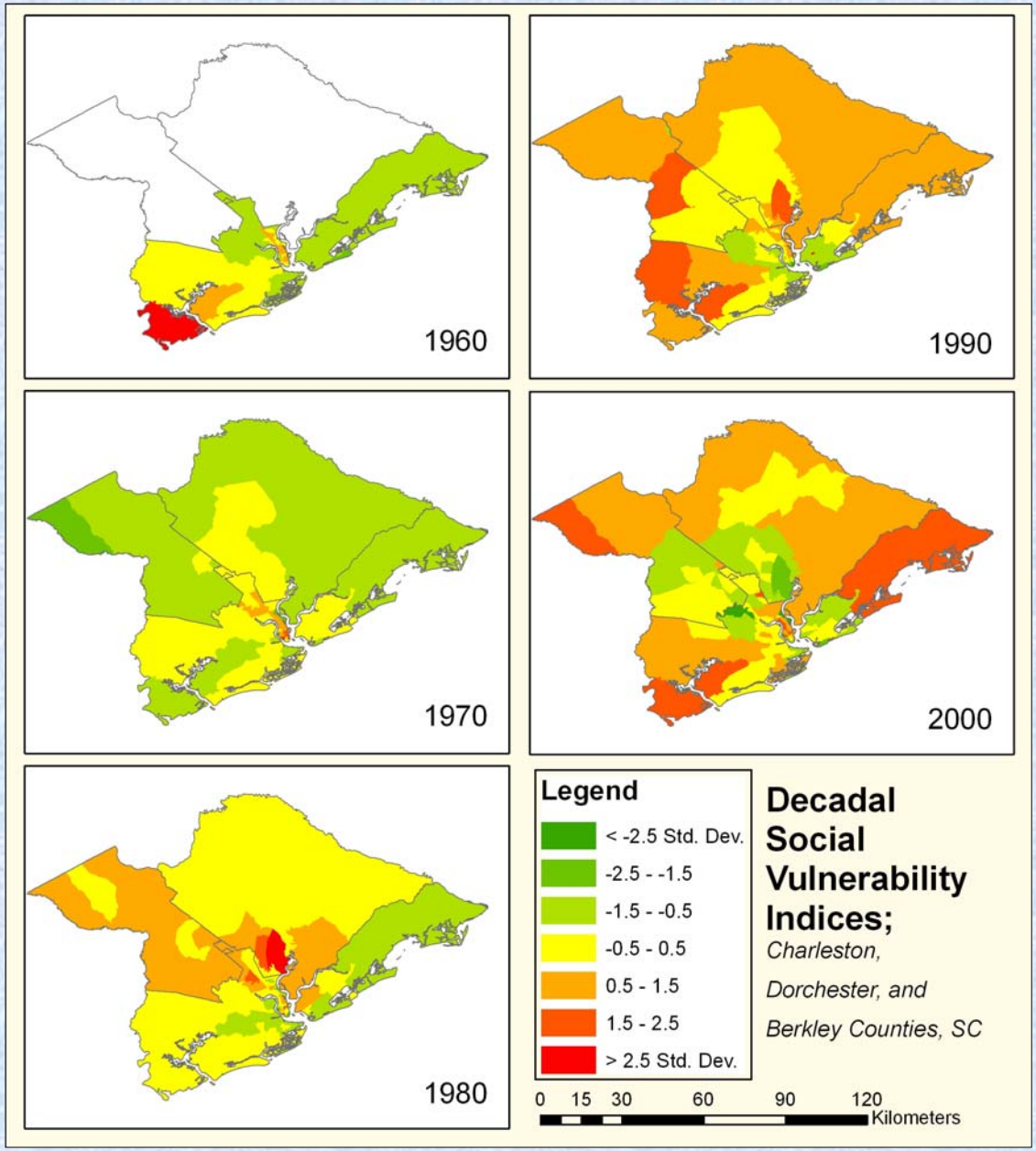
Research Needs: Three Examples

1. **Better integration of physical/social models to understand pre-existing vulnerability**.

2. Need for behavioral understanding of evacuation decision-making and response.

3. Place-based calibration of vulnerability/resilience and its influence on longer term recovery.

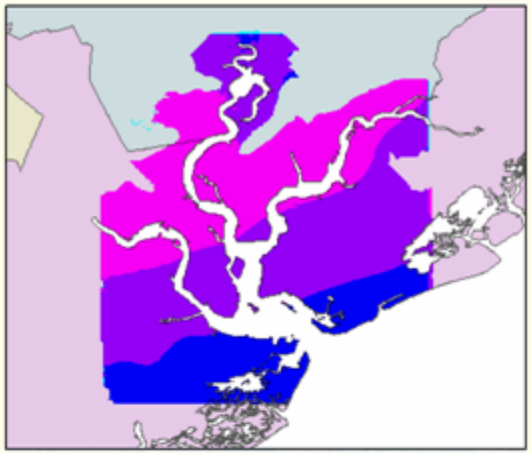
Changes in Social Vulnerability, Charleston, SC



	Factors	% Var. Exp.
1960	6	84.2
1970	7	83.1
1980	6	74.1
1990	6	83.9
2000	6	74.4

Recurrent Factors
Race (Black) and socioeconomic status
Gender, Families
Ethnicity, Immigration
Rural / Urban
Age, Nursing Home Residents
Gendered Labor
Occupation

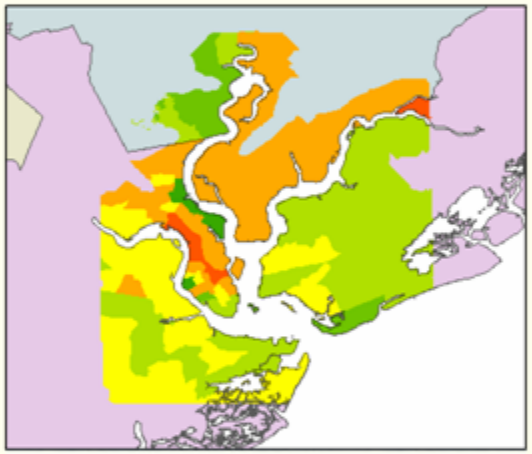
SC²risk
South Carolina and Southern California Risk



Hurricane surge inundation scenario

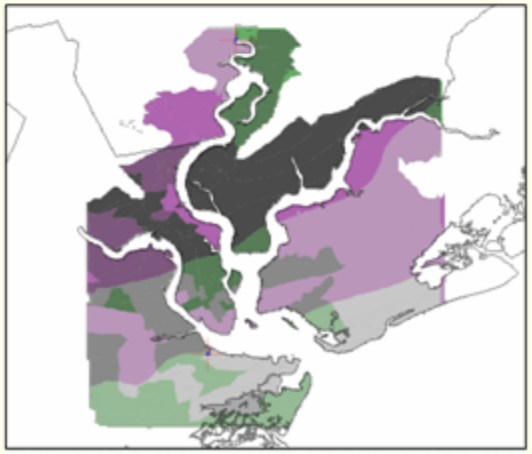
Depth (ft)

- 0 - 4
- 5 - 13
- 14 - 21
- 22 - 25
- 26 - 32



Subset of 2000 tract social vulnerability

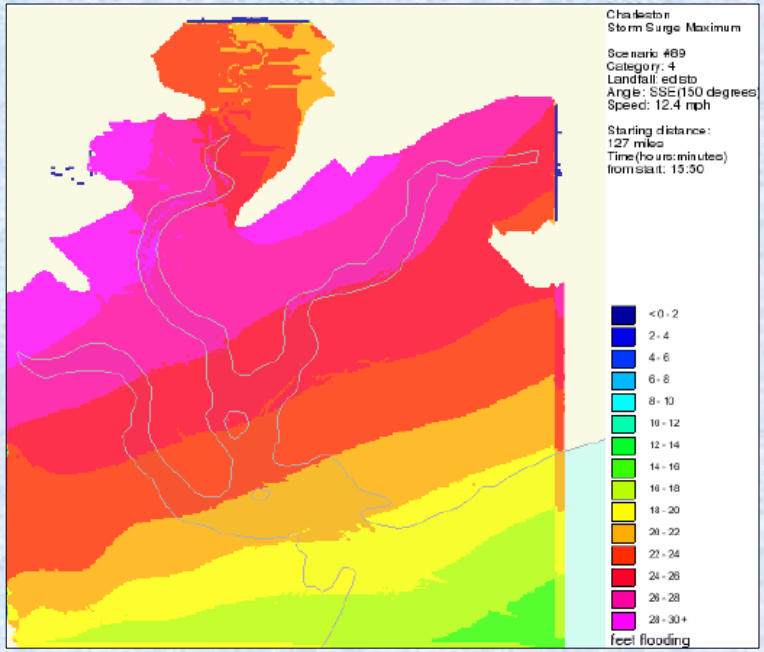
- < -2.5 Std. Dev.
- -2.5 - -1.5
- -1.5 - -0.5
- -0.5 - 0.5
- 0.5 - 1.5
- > -2.5 Std. Dev.



Combined inundation and social vulnerability

Surge inundation (quantiles)	1	2	3
3			
2			
1			

Tract social vulnerability (quantiles)



Hurricane Inundation: Worst Case Category 4

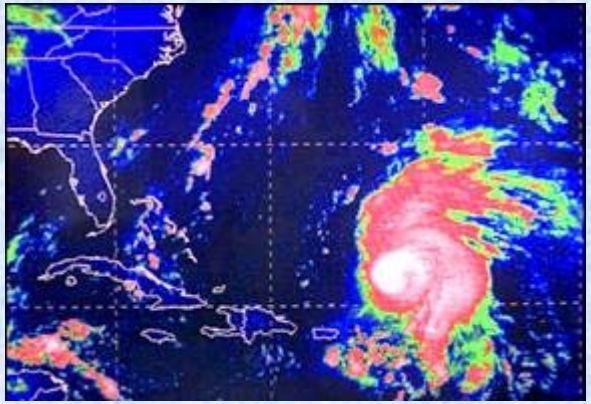
SC²risk
South Carolina and Southern California Risk

Research Needs: Three Examples

1. Better integration of physical/social models to understand pre-existing vulnerability.

2. **Need for behavioral understanding of evacuation decision-making and response.**

3. Place-based calibration of vulnerability/resilience and its influence on longer term recovery.



Hurricane Evacuation

Decision-Making

•Individual assessment of risk, based on diverse sources of information

•Past experience

•Location in “high risk” areas or housing

•Households with children

Behavior

- Households evacuate as units
- Use private transportation (coastal areas take as many automobiles as possible)
- Not use congregate care facilities (last resort only)
- Job obligations and pets reduce compliance
- Use distance as protective measure
- Influenced by risk perception & warning information

Managing Evacuations: Clearance Times

Time required to clear roadway of all vehicles prior to the arrival of tropical storm force winds

Function of :

- Mobilization time (time required to enter the road network)
- Queuing delay time (time spent enter the road network due to traffic congestion)

Behaviorally-Informed Transportation Systems and Engineering: **Clearance Times**

- Number of vehicles taken
- Timing of departure

Hurricane Floyd:

25% evacuees took 2 or more cars

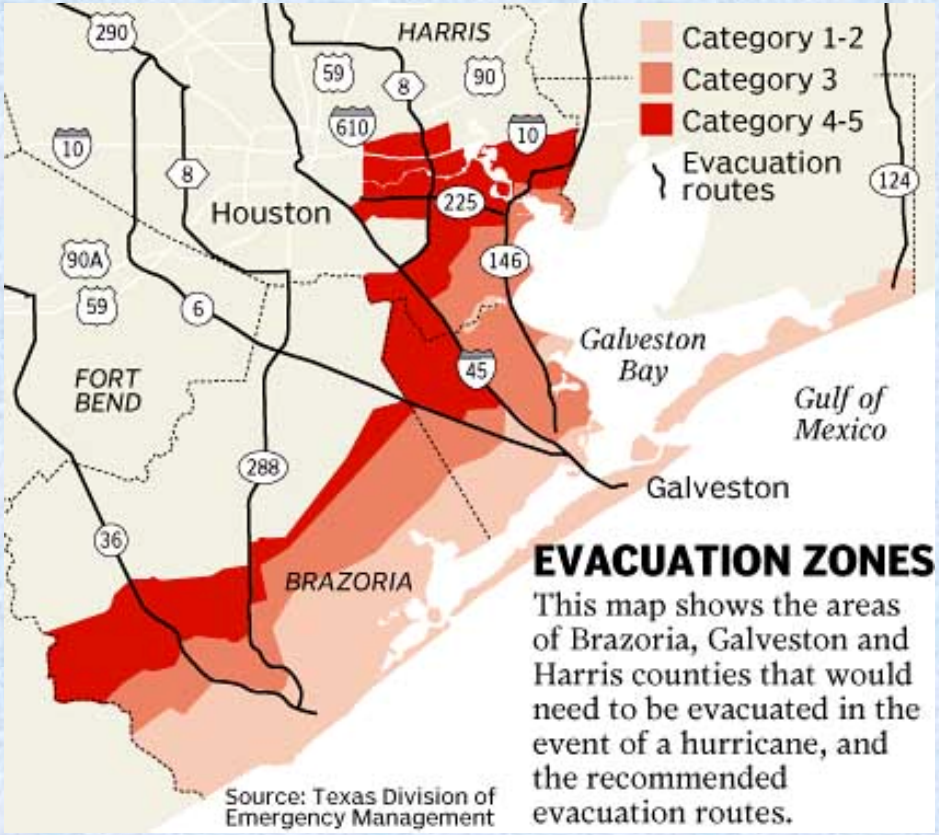
Hurricane Katrina:

25% New Orleans residents not have cars

Behaviorally-Informed Transportation Systems and Engineering: **Compliance**

Evacuation shadows

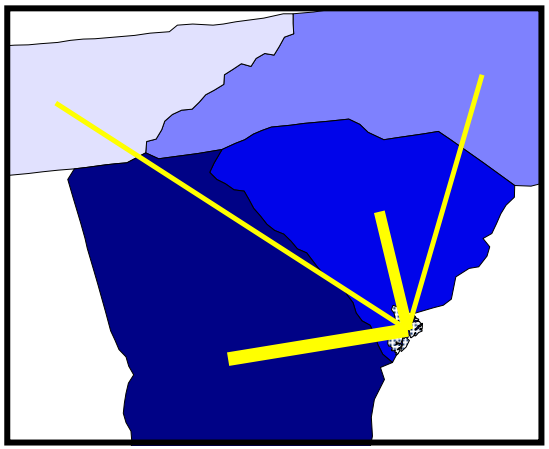
- Three Mile Island—72% increase in population from 0-5 to 5-10 miles
- Graniteville, SC –59% increase from 1-2 miles
- Hurricanes– 10-20% increase depending on storm strength



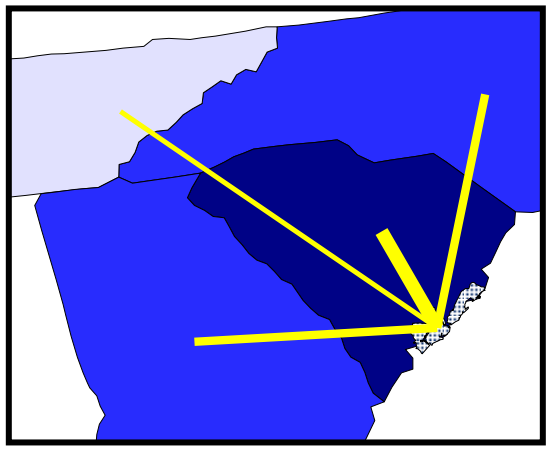
Hurricane Rita:
2.4 million total evacuees
1.5 million shadow evacuees

Behaviorally-Informed Transportation Systems and Engineering: Route Selection and Distance

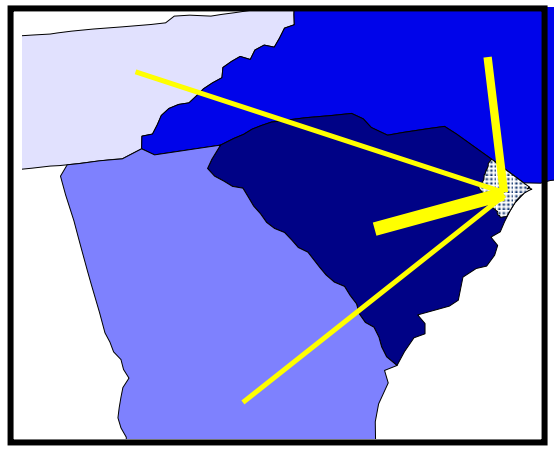
Beaufort



Charleston



Horry



Hurricane Floyd Evacuees:

Use I-95 and I-26

Percentage of Evacuees
- 1-10
- 11-20
- 21-30
- 31-41
- County of Origin

Charleston:
65% had maps; only half used them for alternate route selection

Research Needs: Three Examples

1. Better integration of physical/social models to understand pre-existing vulnerability.

2. Need for behavioral understanding of evacuation decision-making and response.

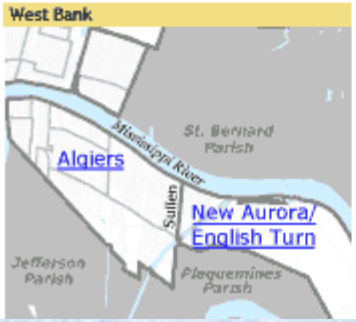
3. **Place-based calibration of vulnerability/resilience and its influence on longer term recovery**.

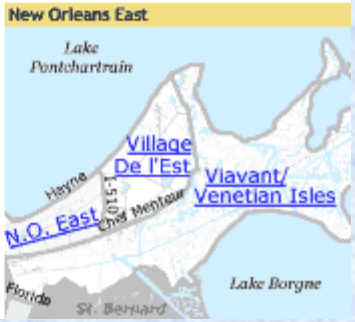
Hurricane Katrina:

Different place-based impacts

Lakeview
Breach of the 17th Street Canal

http://www.gnocdc.org/

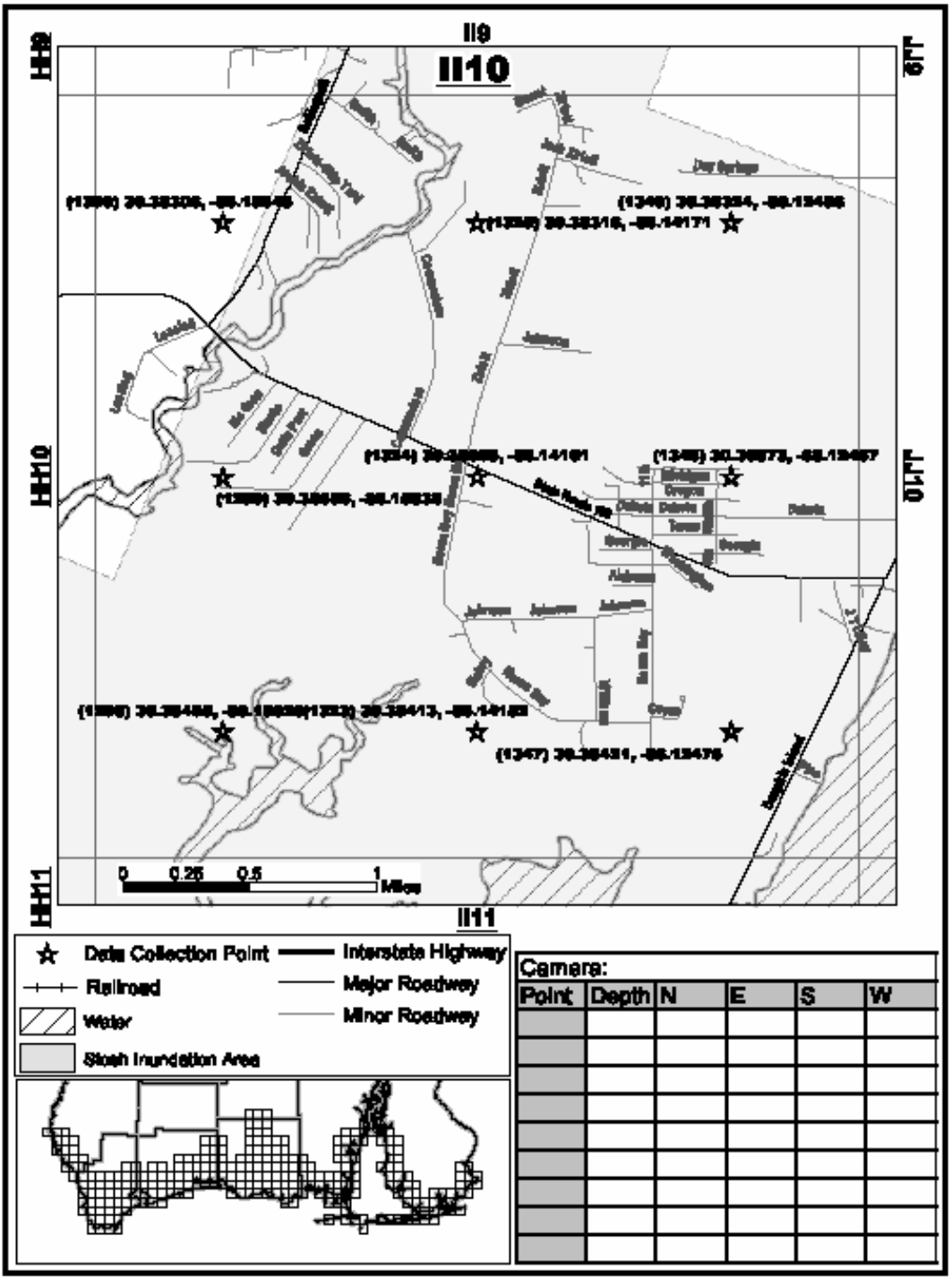


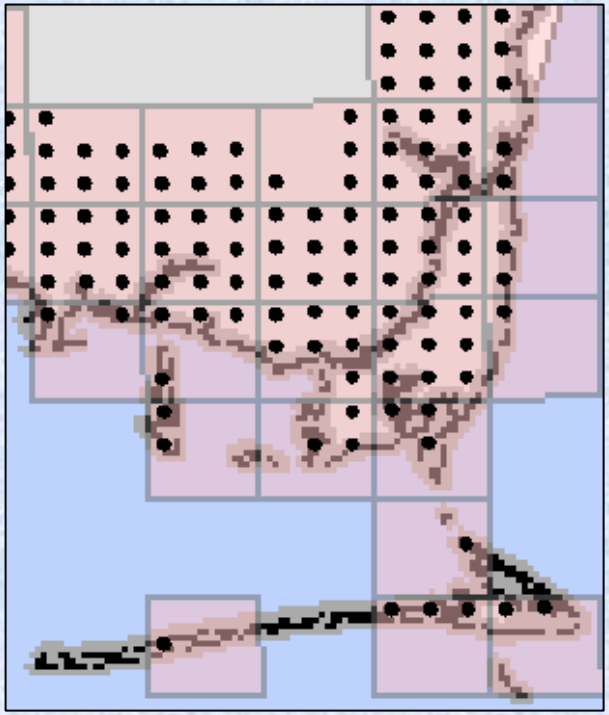


http://www.gnocdc.org/

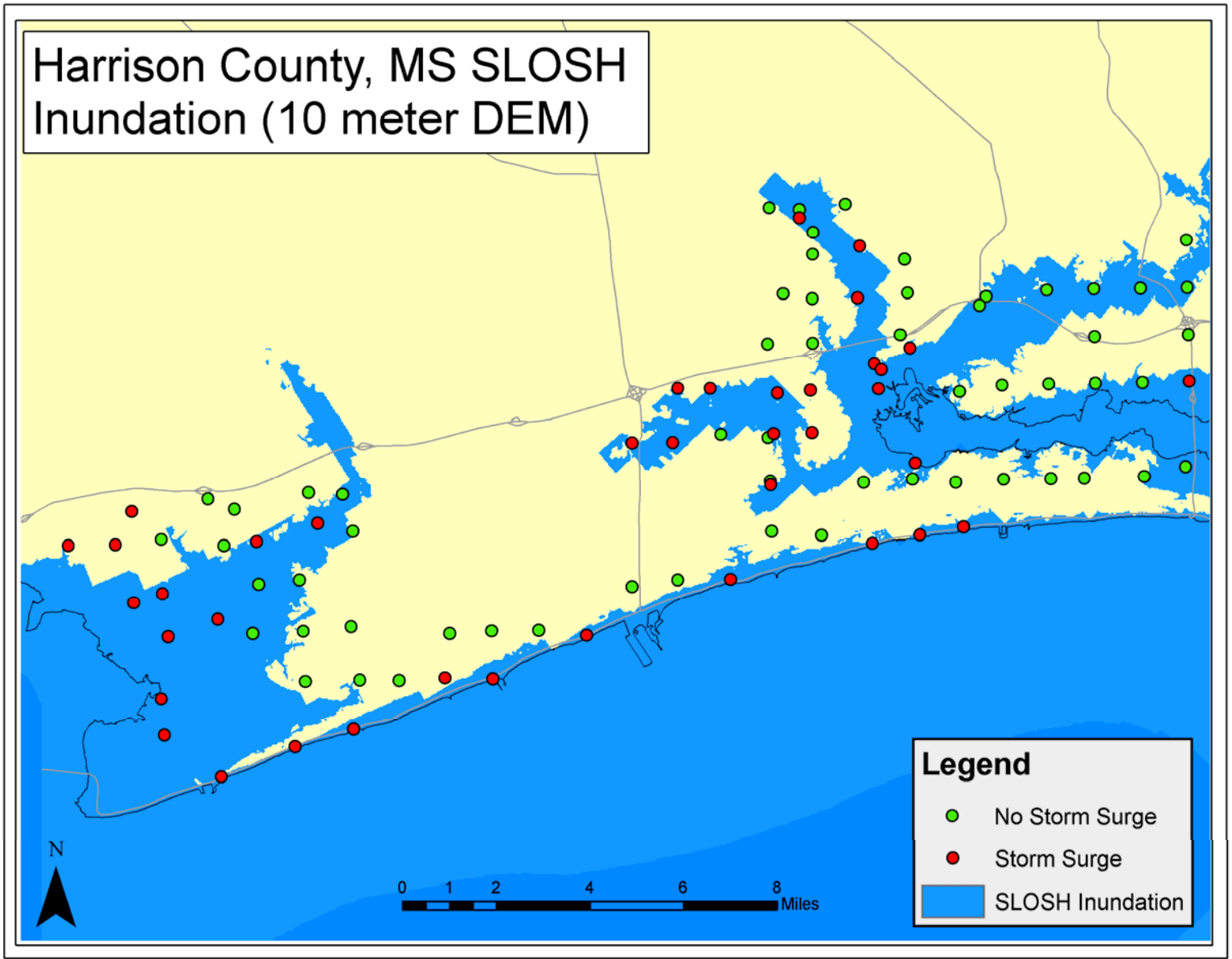
Hurricane Katrina:
Quick response field based research

Navigating to each point: Map books; GPS units; in situ measurements

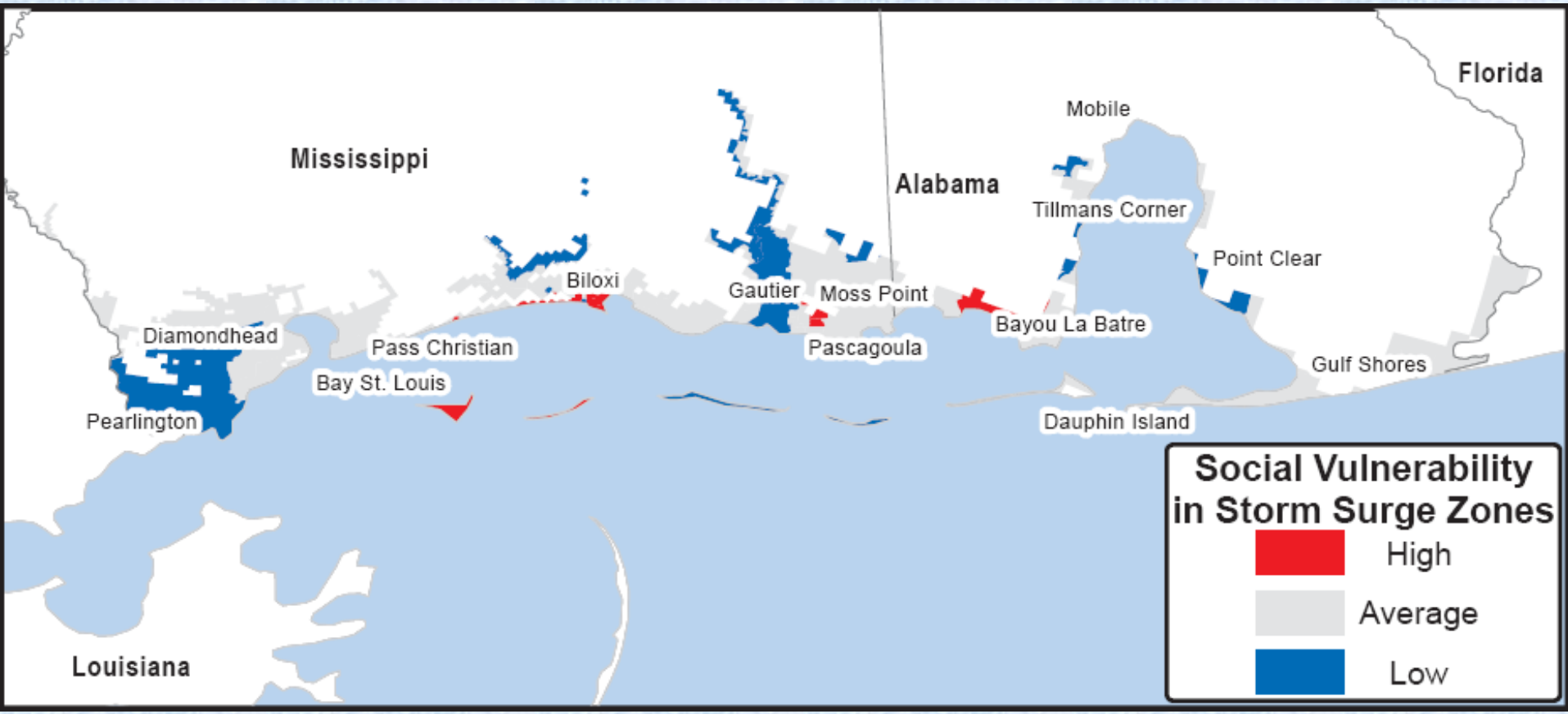




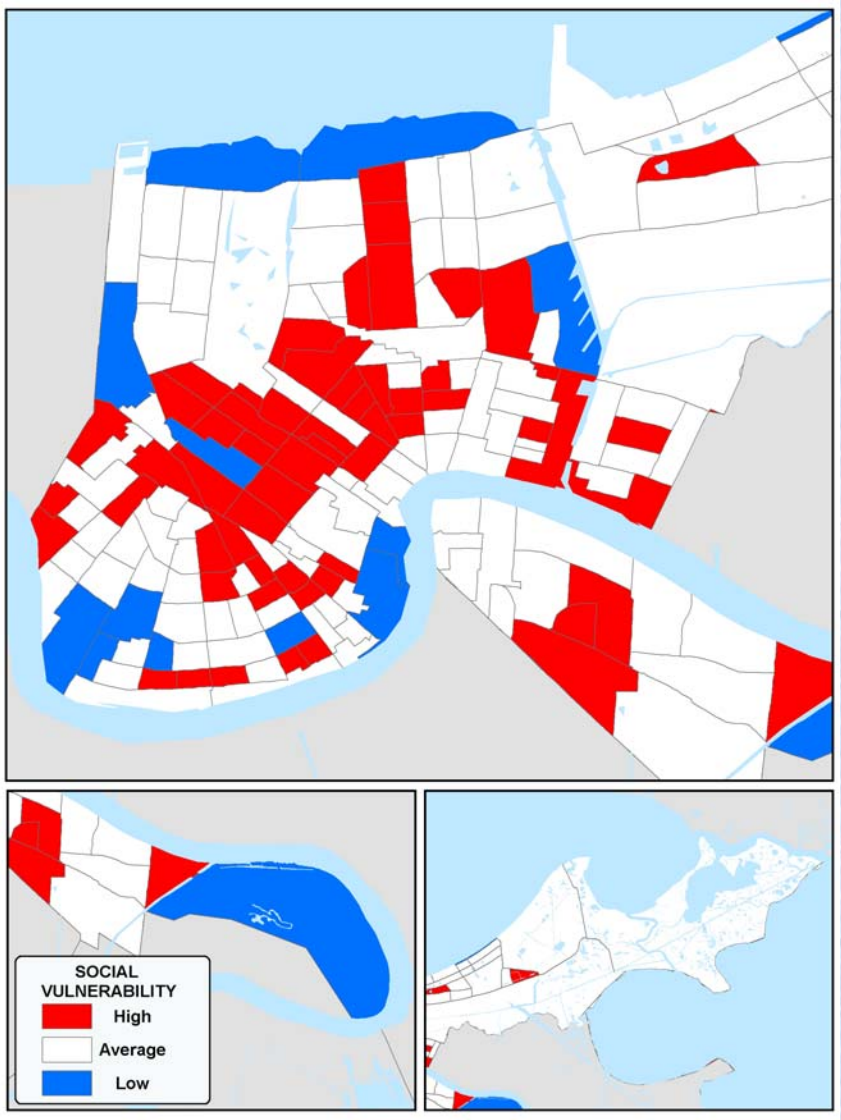
Hurricane Katrina: Comparing modeled impacts with in-situ field observations

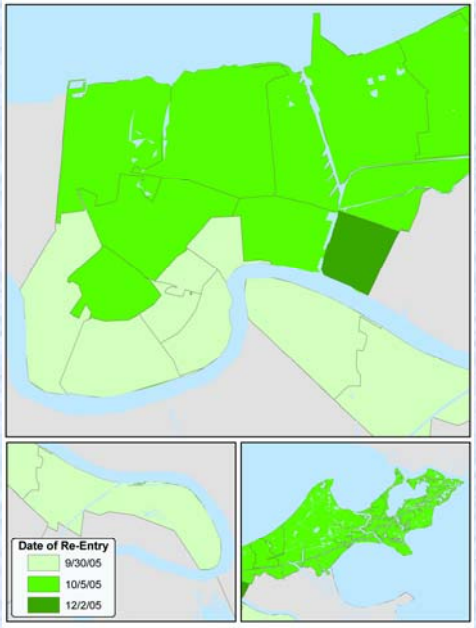


Hurricane Katrina:
Intersection of physical and social vulnerability and importance to long-term recovery



Hurricane Katrina: Disaster Recovery Divide





Take home messages

- **Systematic funding stream for quick response, place-based disaster research.**

- **Long term (post-event) monitoring programs (> 5 years) for measuring temporal and spatial changes in social vulnerability and resiliency along the hurricane coasts.**

- **National clearinghouse for pre-and post evacuation studies**
  - **monitor behavioral changes (temporally/spatially)**
  - **improve transportation systems models**
  - **improve risk communication as it relates to NHC forecast error and uncertainty.**

- **Integrated Research Centers with social sciences, natural sciences, and engineering as full partners.**

For More on Katrina

S. L. Cutter, 2005. The Geography of Social Vulnerability: Race, Class, and Catastrophe", Social Science Research Council, Understanding Katrina: Perspectives from the Social Sciences, http://understandingkatrina.ssrc.org/Cutter/

S. L. Cutter, C. T. Emrich, J. T. Mitchell, B. J. Boruff, M. Gall, M. C. Schmidtlein, C. G. Burton, and G. Melton, 2006. "The Long Road Home: Race, Class, and Recovery from Hurricane Katrina," *Environment* 48 (2): 8-20.

S. L. Cutter and C. T. Emrich, 2006. "Moral Hazard, Social Catastrophe: The Changing Face of Vulnerability along the Hurricane Coasts," *Annals of the American Academy of Political and Social Science*, Special Volume, Shelter from the Storm: Repairing the National Emergency Management System after Hurricane Katrina 604:102-112.

Funding provided by National Science Foundation, USC Office of VP for Research (CRISIS), and the DHS START Consortium.

START NATIONAL CONSORTIUM FOR THE STUDY OF TERRORISM AND RESPONSES TO TERRORISM
A CENTER OF EXCELLENCE OF THE U.S. DEPARTMENT OF HOMELAND SECURITY BASED AT THE UNIVERSITY OF MARYLAND