Social Vulnerability to Hurricane Disasters: Exploring the Effect of Place as a Mediating Factor

LORENZO D. SANCHEZ, PHD, CEM
THE UNIVERSITY OF TEXAS AT SAN ANTONIO
Background

- Annual threat of hurricanes (June 1 – November 30)
- Changing demographic composition of Gulf & Atlantic states influence social vulnerability (SV)
- SV is the relationship between social, economic, and demographic characteristics that influence resiliency
- Population growth in environmentally high-risk areas
- Place is understudied as a risk factor of SV
- Examples: Hurricane(s) Andrew (1992), Katrina (2005), Rita (2005), Ike (2008), Harvey (2017), Maria (2017)
Why is This Research Important?

- Examine components of social vulnerability across time and by type of place
- Does place serve in a mediating capacity of SV?
  - Does SV operate differently by type of place?
  - How has SV changed over time?
  - Does SV interact with place to influence disaster casualty risk?
- Policy implications for disaster management
  - Hazard mitigation planning
  - Federal and state funds to counties and local jurisdictions
    - UASI, SHSGP, EMPG
Risk & Vulnerability Theory

- Pressure and Release Model (PAR)
  - Intersection of SV and disaster risk
  - Catastrophe results when pierced
- Risk = Hazard + Vulnerability

Image Source: University of Alberta, Canada
**Data & Methods**

**Research Goals**
1. SV by Type of Place
2. Temporal Change in SV by Place
3. SV & Disaster Casualty Risk

**Methods**
- Multi-Group Principal Component Analysis (mgPCA)
- Generalized Estimating Equation Model
- Zero-Inflated Negative Binomial Mixture Model

**Type of Place**
- Large Metropolitan
- Urban Adjacent (Suburban)
- Urban Non-Adjacent (Isolated Urban Area)
- Rural

**DATA 1:** IPUMS National Historical Geographic Information System (NHGIS - 1990–2010)
**VARIABLES:** Sociodemographic Variables, Housing, SES

**DATA 2:** Area Health Resource Files (AHRF – 2015)
**VARIABLES:** Rural-Urban Continuum Codes, Elevation

**DATA 3:** Spatial Hazard Events and Losses Database for the U.S. (SHELDUS – 2017)
**VARIABLES:** Injury & Fatality Rates
Area of Analysis

- 71/330 Tropical Systems to Landfall Between 1990 - 2010
- 9 States in Analytical Area:
  1. Texas
  2. Louisiana
  3. Mississippi
  4. Alabama
  5. Georgia
  6. Florida
  7. South Carolina
  8. North Carolina
  9. Virginia

Source: U.S. Department of Commerce – National Oceanic and Atmospheric Administration
Research Goal One: Exploring the Relationship Between Social Vulnerability and Place

Research Aim:
Seeks to identify factors relative to social vulnerability with place-based considerations, which may predispose populations to higher or lower risks to hurricane-related disasters given spatial variations of place.

Research Questions:
- What factors are influential in measuring social vulnerability?
- Does social vulnerability operate in the same way across type of place?

Methodology:
- Multi-Group Principal Component Analysis
Components of Social Vulnerability by Type of Place - 2010

Legend
- Baseline SoVI
- Large Metro
- Rural
- Urban Adjacent
- Urban Non-Adjacent
Research Goal Two:

Research Aim:
Builds upon place-based social vulnerability, and seeks to identify how dynamic the concept is, and will attempt to identify areas with significant change via increasing or decreasing social vulnerability measurements over time.

Research Questions:
- Does social vulnerability risk change over time and across place, and what areas consistently experience high risk values?
- Does the level of vulnerability correlate with certain characteristics of place, and do certain types of place increase or decrease risk?

Methodology:
- Standard Principal Component Analysis
- Generalized Estimating Equation Model
Average Vulnerability Across Time Periods

- Large Metro
- Rural
- Urban Adjacent
- Urban Non-Adjacent

Time Interval

Average Vulnerability

1990 - 2010
Research Goal Three:

Research Aim:
Seeks to determine if a relationship exists between disaster casualty risk and place-based dimensions of social vulnerability over time and across space.

Research Questions:
- Are there differentials in casualty risk relative to social vulnerability, and do certain environmental factors increase casualty risk more than others?
- Does type of place moderate the effects of social vulnerability on disaster casualty risk, and does this operate the same over time?

Methodology:
- Zero-Inflated Negative Binomial Mixture Model
Key Takeaways

- Social vulnerability is not a static construct, and variation is evident by type of place and over time.
- Consistent highest risk components for all 3 time intervals:
  - NH Black, <18 years, <HS education, public transit, poverty status, welfare, female headed-households, housing (1960-1979)
- Urban non-adjacent counties have the highest average SV risk across time; Large metropolitan counties have the lowest average SV risk.
- **Injury Model:** Higher risk of injuries in TP2 compared to TP1, large metropolitan had lowest risk – urban adjacent had highest risk.
- **Fatality Model:** Slightly higher risk of fatalities in TP2, large metropolitan had highest risk between time periods, rural lowest risk.
Policy Implications

- Target at-risk populations with tailored preparedness programs and services
  - Identify specific needs within the population, and address those through targeted approaches (i.e. special needs evacuation programs, etc.)

- Implement mitigation programs that increase community resiliency
  - Many programs focus on the county level – SV is a useful barometer for risk and conversely resiliency

- “One size-fits-all” planning may not be the best strategy – doesn’t account for sociodemographic and place-based variation of risk
Limitations

- Data consistency over time, consistent measures of place
- Type of place (county level) doesn’t account for variation of smaller community units
- Direct/Indirect casualty measurements may not fully be captured in data (i.e. enumeration of count data by Presidential Disaster Declarations)
- Numerous counties with no values for casualty risk
Future Research & Conclusion

- Further identification of place-based factors that influence social vulnerability
- Examine if social vulnerability manifests differently for other hazards/threats and by type of place
- Identify other variables, such as damage to homes, infrastructure, agriculture, etc., and impact on SV
- Exploring the dimensions of SV through research can increase resiliency within our communities
Questions? Thank You!

Lorenzo D. Sanchez, Ph.D.
UTSA Director of Emergency Management
(210) 458-6756, lorenzo.sanchez@utsa.edu