Social Vulnerability and Climate Change Hazards in the Southeast U.S.

North Carolina Climate Change Adaptation Workshop

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About the Project

- Built on a need to understand:
  - The pre-disposition of the populations in the SE to adverse impacts from disaster events
  - The types and places where one might expect to see higher incidence of hazard events
  - The product of a combination of these two things across space

- This work focuses on the identification of:
  - Social vulnerability (pre-event conditions of the population that either exacerbate or attenuate impacts from hazards and disasters).
  - Biophysical vulnerability (places threatened by climate change related hazards)

About the HVRI

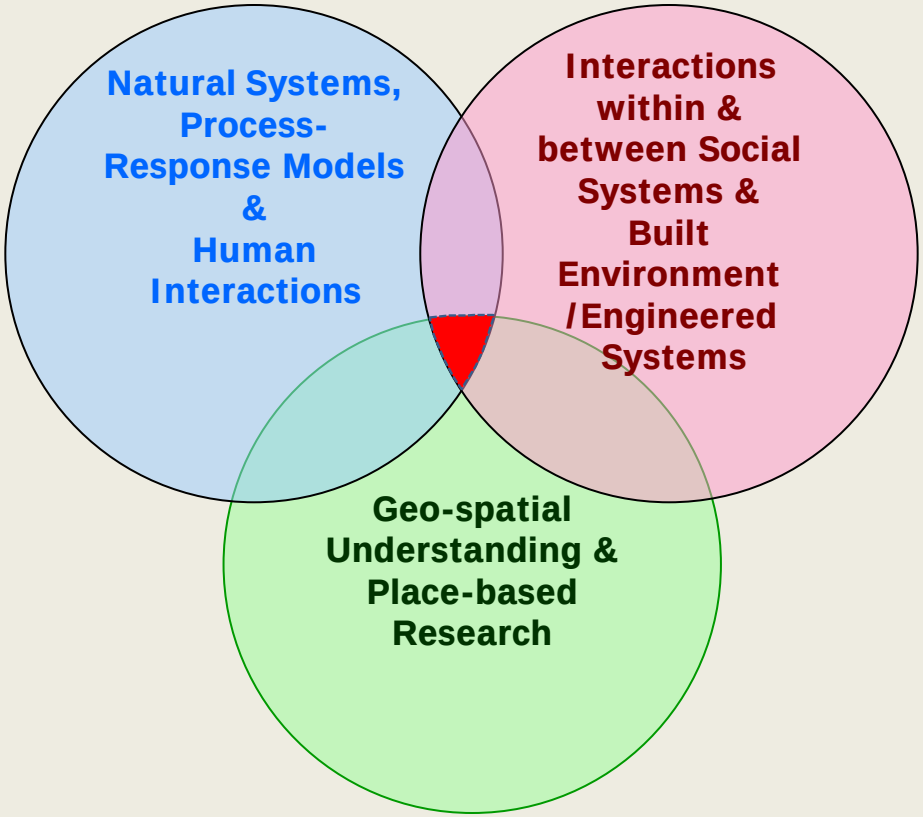
- Established in 1995 to support research, training, and outreach in hazards analysis and management
- More than 40 Ph.D. and master's students trained
- Over 100 peer reviewed articles
- Vulnerability and related grants from:

  DHS, FEMA, The Fritz Center, NASA, The National Science Foundation, Oak Ridge National Laboratory, South Carolina Emergency Management Division, NOAA

- Why HVRI is especially suited for this type of research
  - Broad range of related research
  - Extensive research within the Southeastern United States
  - Desire to support the policy of vulnerability through scientific exploration and analysis

Vulnerability Science

- Aimed at identifying and analyzing
  - The circumstances that place people and localities at risk?
  - The drivers of enhanced or reduced ability to respond to and recover from environmental threats?
  - The geographic patterns between and among places?



Goal: Provide scientific basis for disaster and hazard reduction policies through the development of methods and metrics for analyzing societal vulnerability and resilience to environmental hazards and extreme events

Population Characteristic and Specific Variable	Influence on social vulnerability
Race & ethnicity	Non-white and non-Anglo populations more vulnerable
Socioeconomic Status	Poverty makes communities less able to respond and recover quickly
Gender	Women often have more difficult time recovering quickly
Age	Age extremes (elderly and very young) increase vulnerability
Rural/Urban	Both rural and urban communities have challenges which make them vulnerable to disaster and quick recover
Renters	Renters face challenges which make them more vulnerable to disaster and recovery
Residential property	Value, quality, and density of residential construction affects disaster losses and recovery
Occupation	Jobs directly affected by disasters
Family Structure	Families rely on paid caregivers are more vulnerable
Employment	Communities with high numbers of unemployed workers are vulnerable because jobs are already difficult to obtain
Education	Limited education levels influence vulnerability to disaster and recovery
Population Growth	New immigrants face challenges which make them more vulnerable to disaster and recovery
Access to medical services	Lack of access to medical services lengthens recovery time
Social dependency and special needs populations	Residents totally dependent on social services are more vulnerable

Table 2: Social Vulnerability Index-Southeast (SoVI-SE)

Component	Label	% Variance Explained	Most Influential Variable/Correlation
1	Wealth	23.09	Per capita income (0.93), median rent (0.90), % poverty (-0.67)
2	Age	14.64	People per housing unit (0.84), pop over 65 (-0.88), median age (-0.89)
3	Race	10.79	% African American (0.87), % female headed household (0.84)
4	Ethnicity	6.56	% Hispanic (0.72)
5	Rural	5.1	% employed in natural resources extraction (0.55), % rural farm residents (0.50)
6	Special Needs Population	5.0	Hospitals per capita (0.70); Nursing home residents (0.62)
7	Gender	4.6	% females (0.91)
8	Employment	4.6	% employed in utilities, transportation, or communications (0.73)
Total Variance Explained		**74.40**	

Equation for SoVI-SE= (-) Factor 1 + (ll) Factor 2 + Factor 3 + Factor 4 + Factor 5 + Factor 6 + Factor 7 + (-)Factor 8

Wealth

- Wealth is the number one contributor to social vulnerability in the SE
  - It is important to understand that lack of wealth (alone) ≠ increased vulnerability
- It is the two extremes of income that lead to changes in vulnerability
  - Wealth is more influential than poverty at the regional level
- Since SoVI is a multi-dimensional concept we should use caution when de-coupling the results
  - It is the interaction of all variables that lead to changes in vulnerability
  - However, we can look at individual components to develop programs, identify priorities, and aid decision makers

Race & Ethnicity

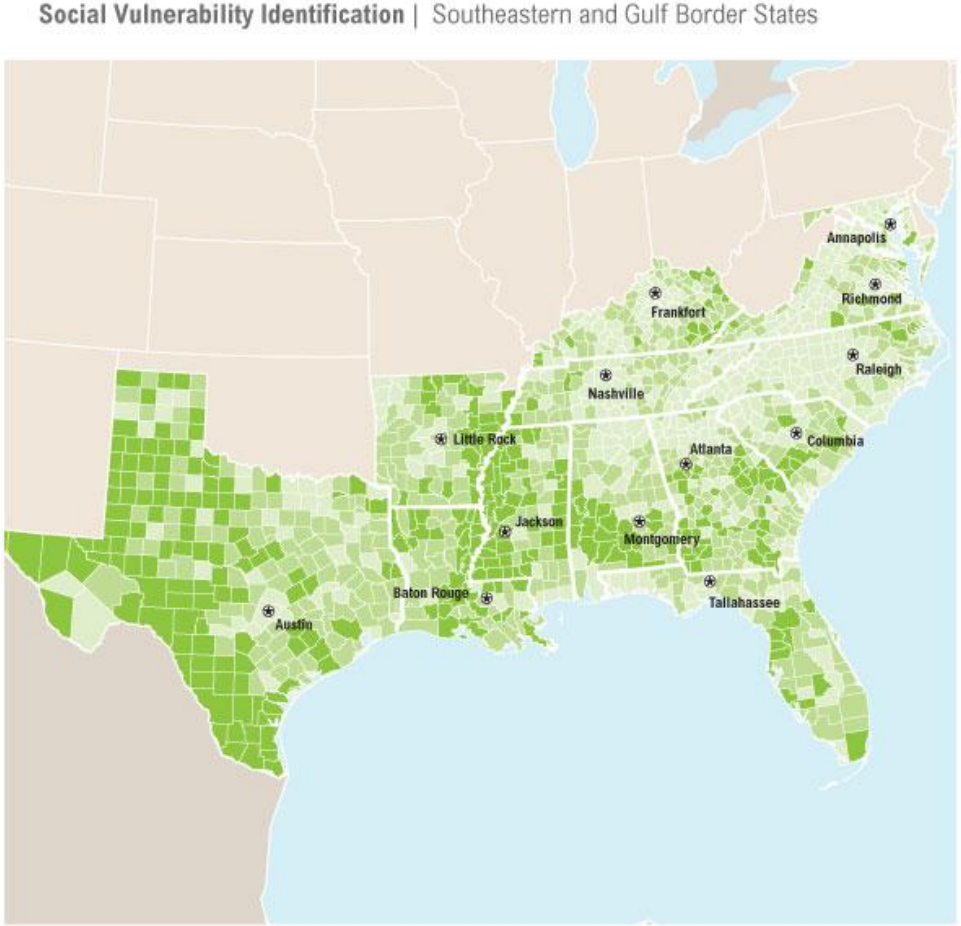
- Combined for more than 16% explanatory power
- Characterized by higher than average black and Hispanic populations, these two components provide unique insight which moves away from simple population identification as a means to determine adverse impact

- Focusing on these specific component parts of social vulnerability enables users to :
  - Better target programs focused on racial and ethnic disparities across the study area
  - Understand subtle racial and ethic differences between two or more places

Gender

- Gendered differences in disaster preparation, response, and recovery make female populations more vulnerable to natural hazards
  - This component highlights those areas with the greatest number of females as an indication of those places pre-disposed to adverse impacts
- It is important to note that the number of females within a population is not a direct indication of vulnerability
  - However, increased understanding the makeup of the population provides useful insight for planners, emergency managers, and other organizations interested in protecting lives

Regional Social Vulnerability Map

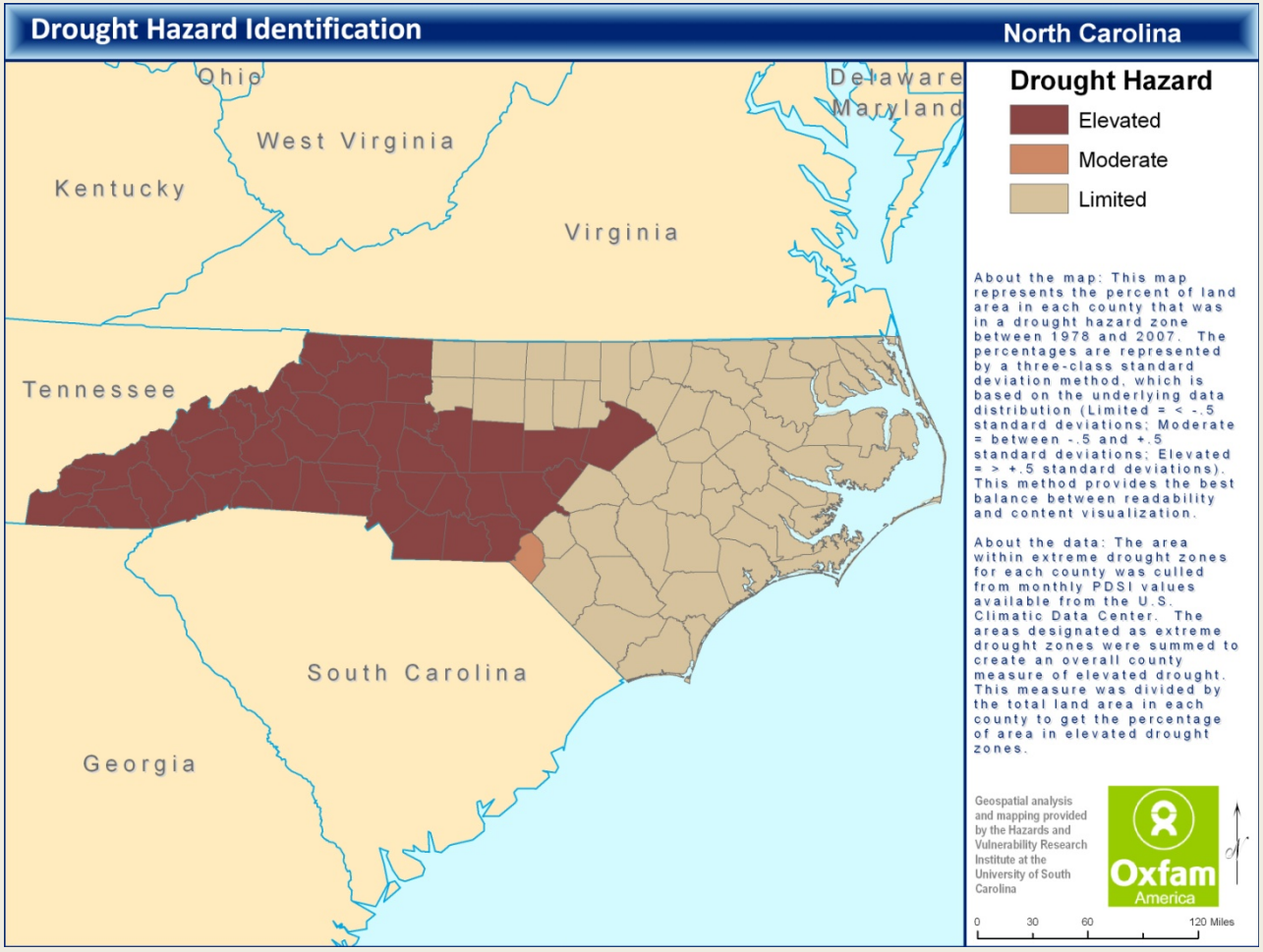


Climate Related Hazards

- The report created by the HVRI is an improvement on previous vulnerability work
  - Uses a robust algorithm to determine SoVI
  - Utilizes current science related to hazards identification
    - 30 years of drought information to create a historical extreme drought climatology
    - NFIP flood insurance information to create reliable flood zone areas
    - 30 years of hurricane information create a hurricane climatology
    - Peer reviewed sea-level rise estimation methodologies to create a useful measure of potential sea-level rise impacts
  - Covers a broad geographic area rather than a specific narrow focus

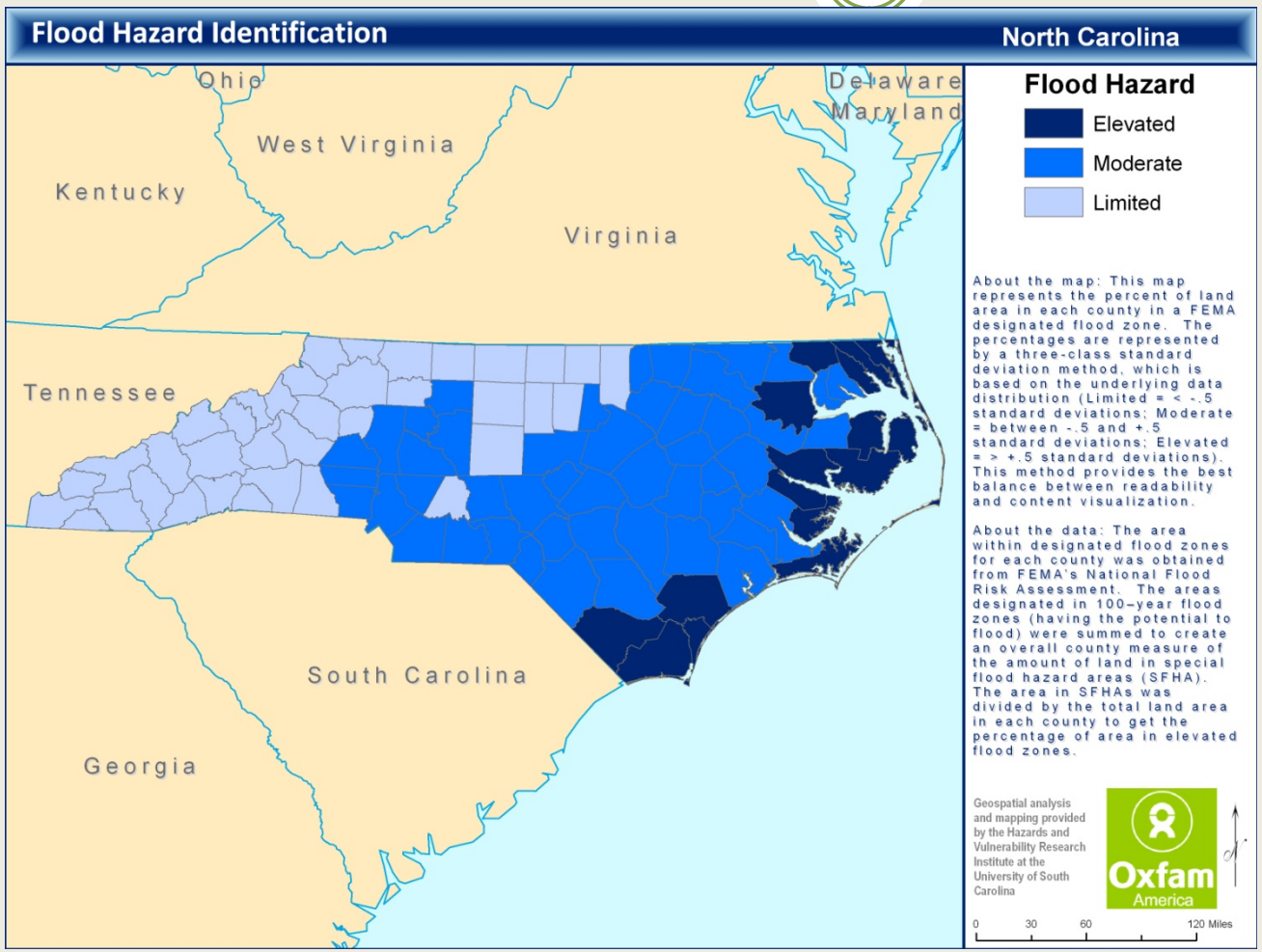
Drought (1978 – 2007)

- Difficult to measure due to diverse geographical and temporal climate zone distribution
  - Monthly extreme PDSI values* for each county were obtained from NOAA Earth Systems Rsearch Laboratory's Physical Science Division
  - These values were used to create a frequency of extreme drought for each county



*Palmer Drought Severity of -4 or below (severe to extreme drought conditions)

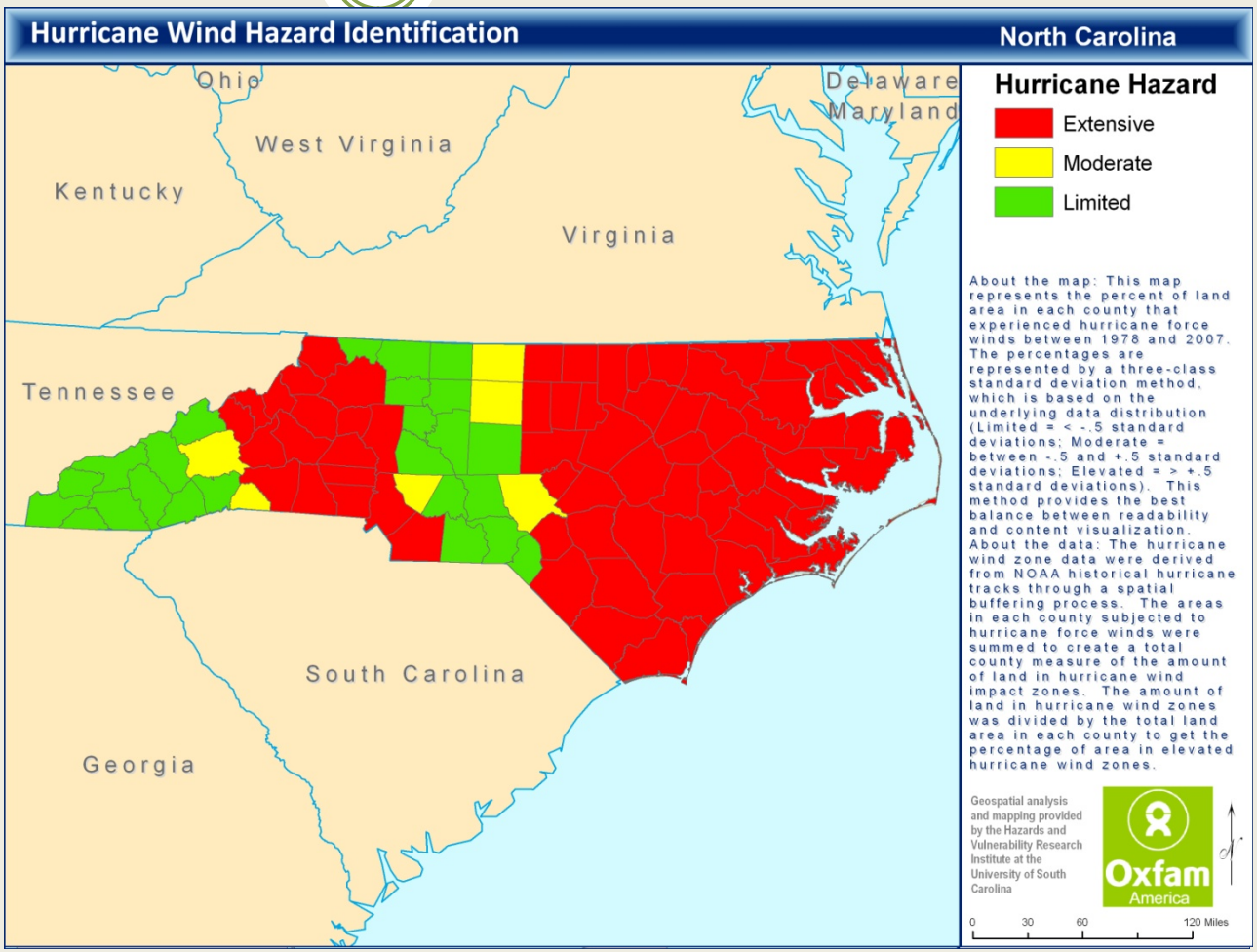
Floods



- Created using FEMA's National Flood Risk Report
  - Sum of the areas associated with SFHA , specifically – A and V zones (100 Year Flood Zones)
  - Sum was then dived by total land area in each county to create a ratio

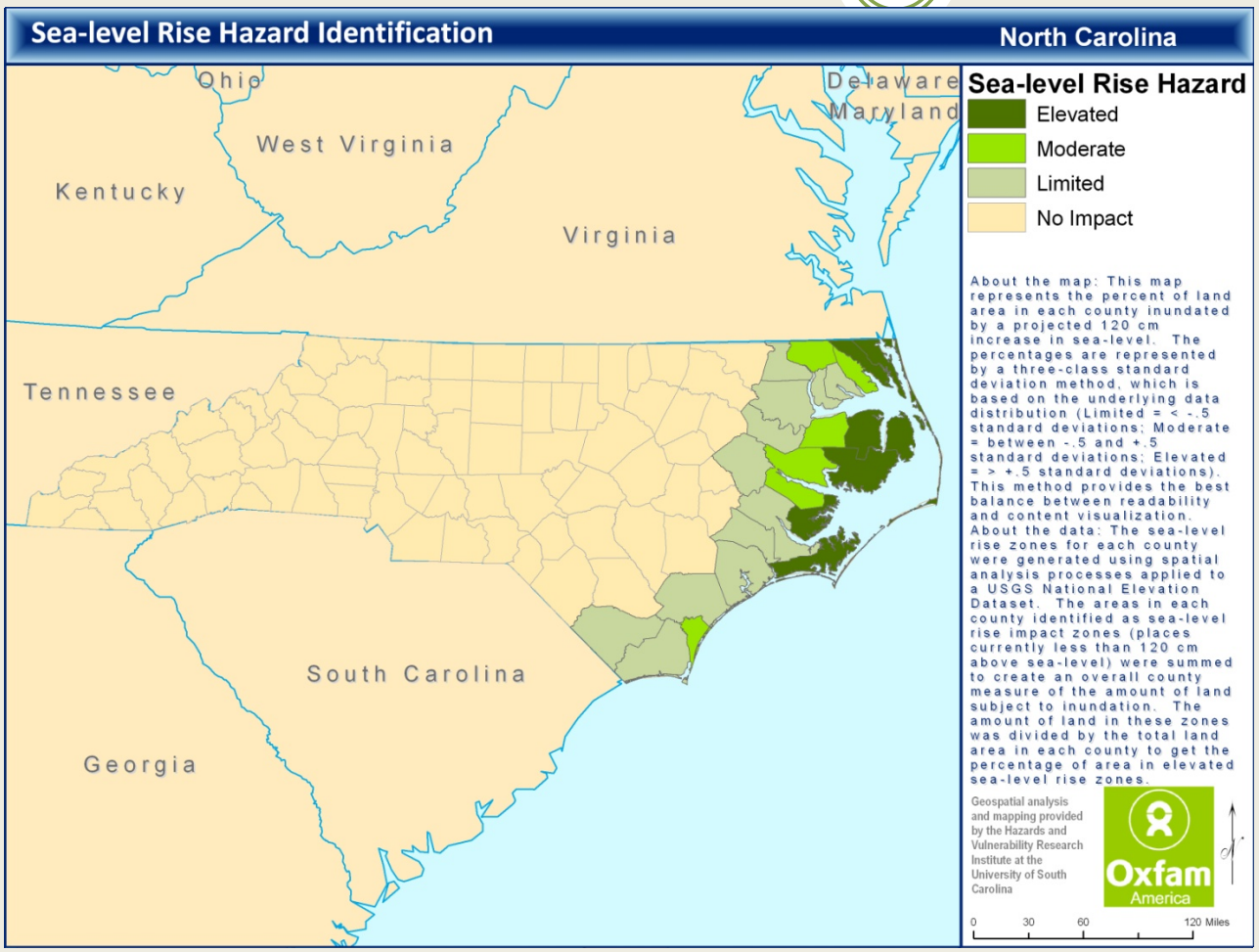
Hurricane Winds (1978 – 2007)

- Created using GIS to identify those storms which tracked within 100 miles of the state
  - Storm tracts were buffered using a 100 mile literature based designation*
  - A hurricane wind ratio was calculated by dividing land area of wind zones in each county by total county land area



* Willoughby, H.E., Rappaport, E.N., and F.D. Marks. 2007. Hurricane Forecasting: The State of the Art. Natural Hazards Review 8(3) 45-49.

Sea Level Rise (2100 forecast)



*Titus, J. G. and V. Narayanan, 1995. The Probability of Sea Level Rise. Washington D.C.: US Environmental Protection Agency, EPA 230-R95-008.

- Created using USGS National Elevation Data (1/3 arc second)
  - Created a 120 cm inundation surface for study area based on extant literature*
  - Calculated an inundated area value for each county
  - Value was then dived by total land area in each county to create a ratio

SoVI = Who

- SoVI data outputs become part of a toolset used to identify underlying aspects of populations which influence hazard impacts
  - This information helps to identify populations based on the dynamic interplay between a broad array socio-economic and demographic characteristics
- Specifically, this work provides multiple perspectives of social vulnerability:
  - Macro level comparative visualizations
  - Tabluar sub-component characterization for a higher level understanding of drivers at more localized levels

Hazards = Where

- Hazard assessments (biophysical vulnerability) provide knowledge about potential threat levels for particular areas
  - Data identifies places based on historical incidence or modeled future impacts
  - Information enables users to understand threats specific to place
- Coupled with SoVI indicators, we can start to understand the spatial nature inherent in the southeastern US
  - Not every place has the same level of vulnerability
  - Hazardousness varies across space
  - Together, these provide an additional level of understanding

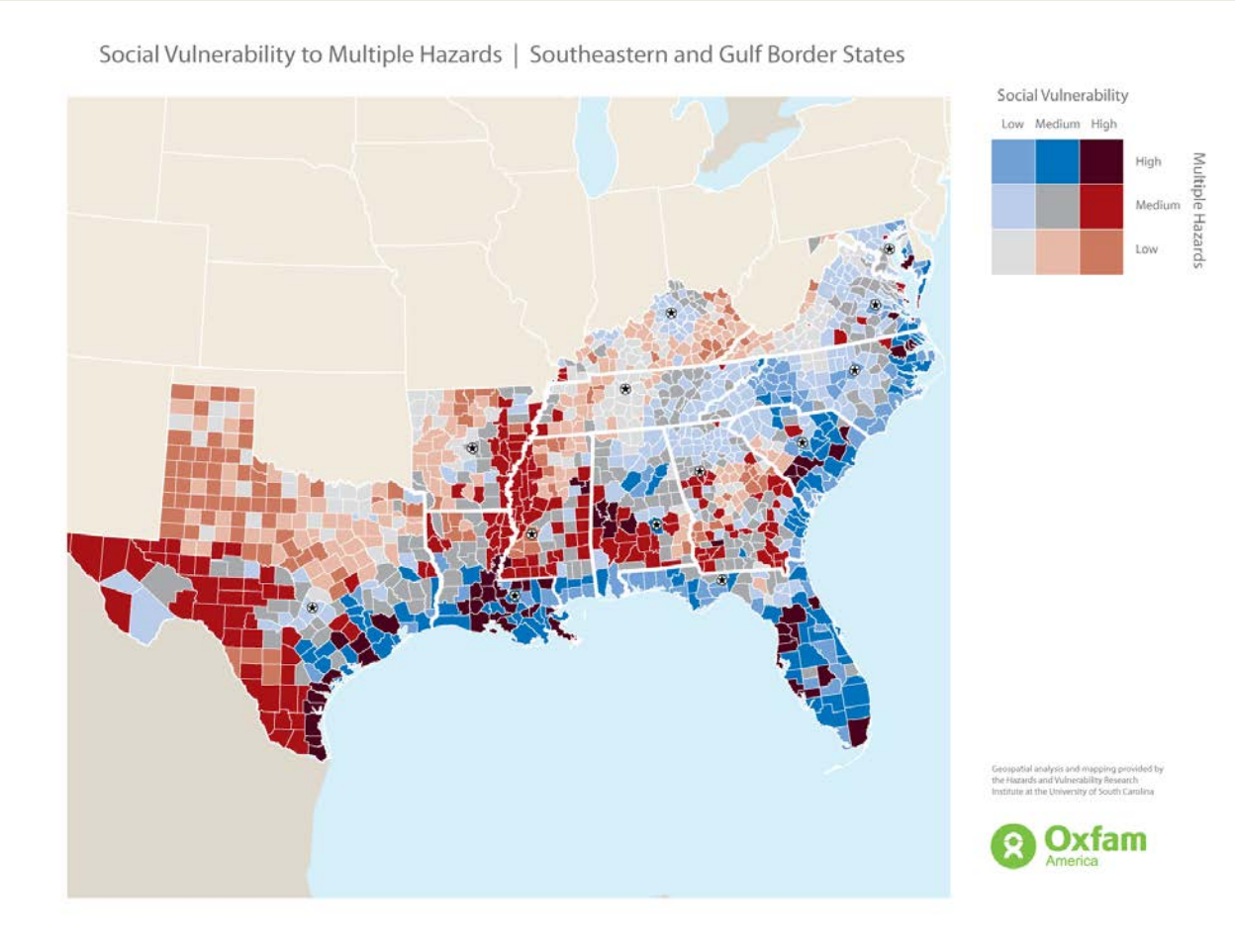
Intersectionality = Why

- Analyzing the underlying circumstances and situations (biophysically and socially) provides detail about the root causes and dynamic pressures that are present
  - In a certain place
  - In relation to individual or combined threats from climate change
- Once we grasp the reasons for increased vulnerability and identify specific threats to lives and livelihoods we can
  - Start to formulate focused action items
  - Foster a spirit of adaptation and community cohesion
  - Provide scientific support for policy decisions aimed at decreasing vulnerability

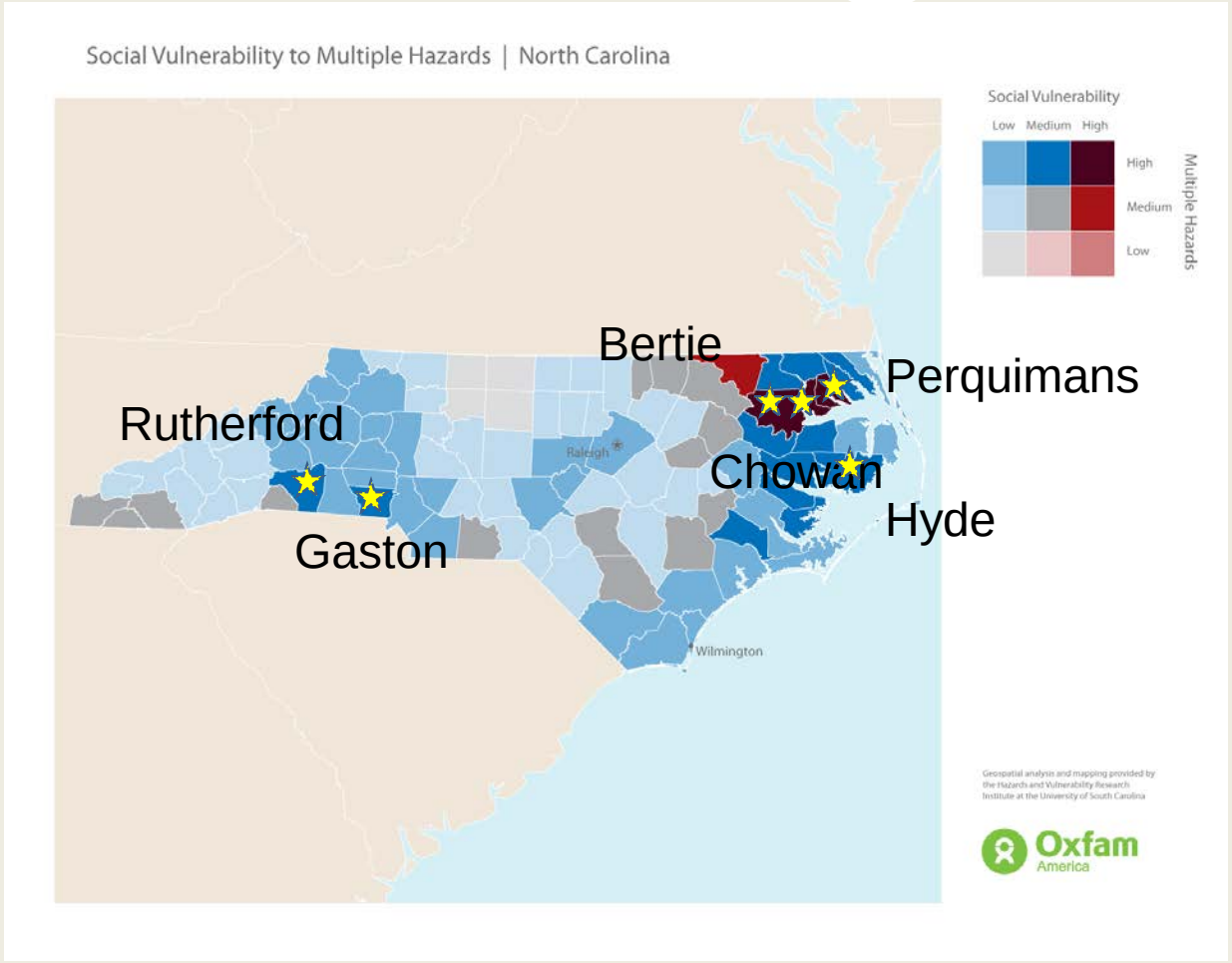
Regional SoVI by multihazard map

Areas of Interest

- West Texas
- Mississippi Delta Region
- Coastal Communities



NC SoVI by multihazard



Areas of Interest

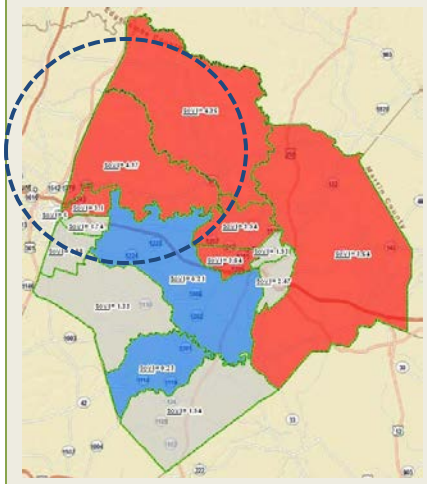
Northeastern

- High Hazard & High SoVI (HOTSPOTS)

Coastal & West Central

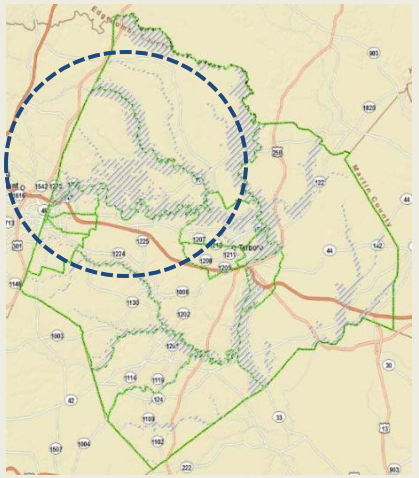
- High Hazard and Medium SoVI

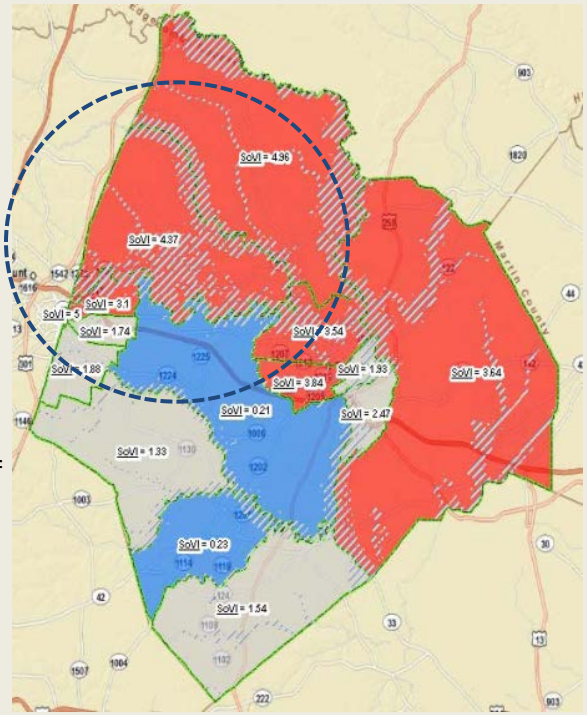
Scaling Down for Additional Detail



Vulnerable populations using the SoVI index downscaled to the census tract level (red symbolizes elevated levels of social vulnerability, dark blue equal low levels

1% chance flood zone (or more commonly called the 100-year floodplain).





The bottom map shows a detailed geospatial analysis of the intersection of the flood zones and vulnerable populations with the actual numbers of residents in a specific census tract provided in the chart.

Socioeconomic and Demographic Characteristics (2000)	Value in Tract
Total population	3,944
# of persons under 5	275
# persons over 65	318
Number living below poverty	666
Number of African Americans	2,830
Number of renters	365
Number of Female Headed Households	325

Recap

- Identifying socially vulnerable populations in relation to physical threats can provide insight for the following areas:
  - Research
    - Helps us to shift us from “business as normal” to developing real tools and solutions to influence policy decisions and planning
  - Advocates
    - Understanding specifics about who is threatened by which hazard enables more focused efforts at change
  - Governments
    - Detailed knowledge at the county level provides decision makers at all levels (federal, state, local) with a decision support tool

Contact information

Thank You

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