Choosing a Resilience Partner: A Comparative Study of U.S. Regional Natural Hazard Preparedness

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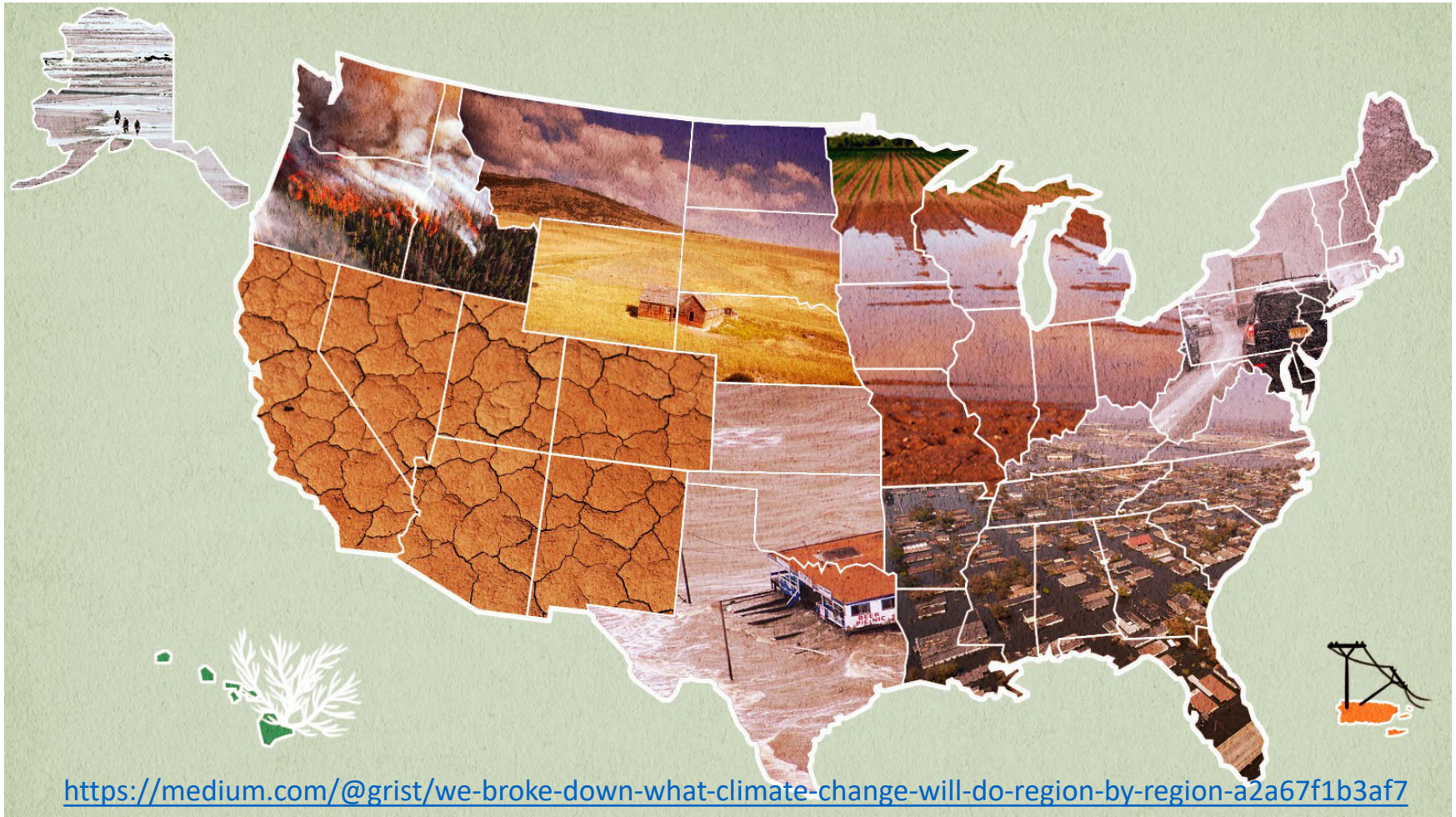
Christina M. Danis, AICP

Ph.D. Candidate (year 5)

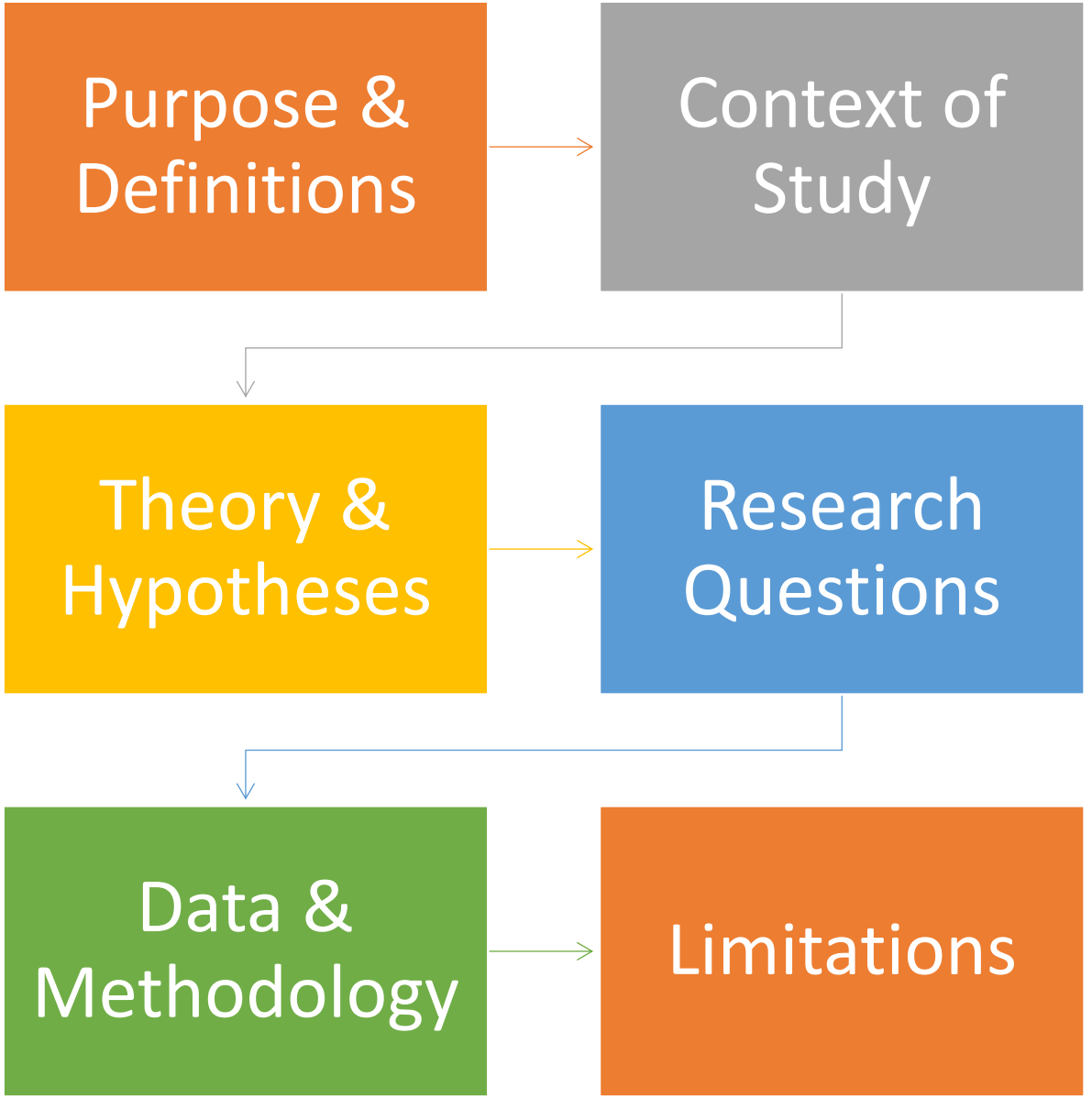
Public Policy

UNC CHARLOTTE



https://medium.com/@grist/we-broke-down-what-climate-change-will-do-region-by-region-a2a67f1b3af7

Overview of Research



Purpose

- When natural hazards become disasters, governments are accountable for minimizing death, injury, and property damage and ensuring rapid restoration of community functions.
- The U.S. Federal Emergency Management Agency (FEMA) affirms "individual and community preparedness is fundamental to natural disaster resilience."
- FEMA Community = "a geographically bound location that functions within a governance structure for example a town, city, or county."
- Resilient Community = "a group of individuals and organizations bound together by geography and perceived self- interest to carry out common functions."
- The **tension** between community being defined as "being within a governance structure" versus "shared perceived self-interest" informs why sound regional resilience partnerships matter.

Definitions

Resilience to natural disasters means intentionally guiding a system's process of adaptation to preserve some qualities and allow others to fade away, all while retaining the identity of the system (Post Carbon Institute, 2017).

Vulnerability is the characteristics of a person, group or place in terms of the capacity to anticipate, cope with, resist, and recover from the impact of a natural or man-made hazard (IFRC, 1999).

Community natural hazard preparedness

reflects the **union** of adaptation and guidance in support of resilience and addressing the characteristics of vulnerability at times, they may be reverse conditions

(Miller and Dabson, 2015).

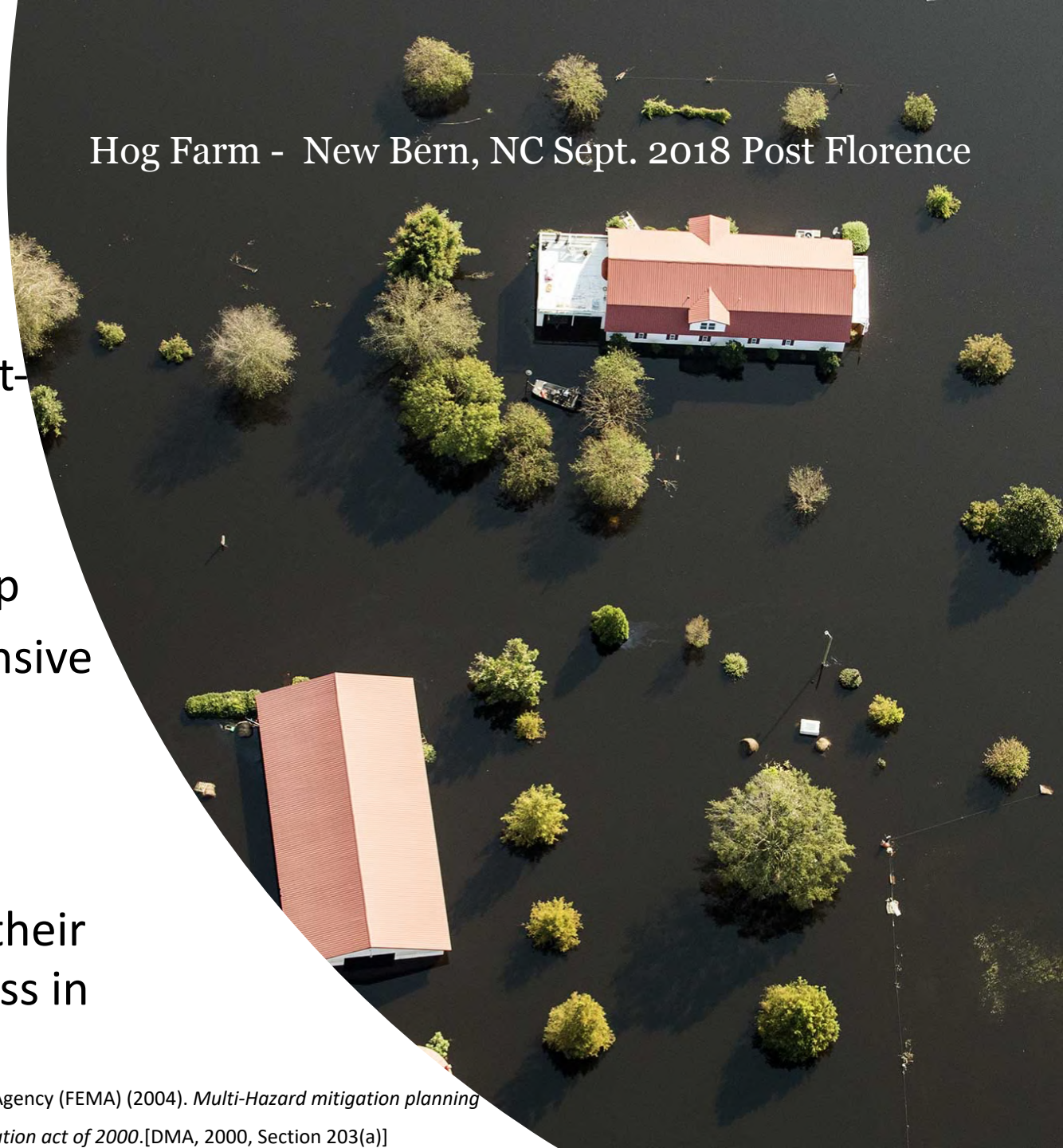
Context:

WHY MEASURE COUNTY/COMMUNITY PREPAREDNESS?

Federal - FEMA requires states to develop mitigation plans to be eligible for pre- and post-disaster funding .

State- states have control of how they develop and implement the FEMA required comprehensive plans.

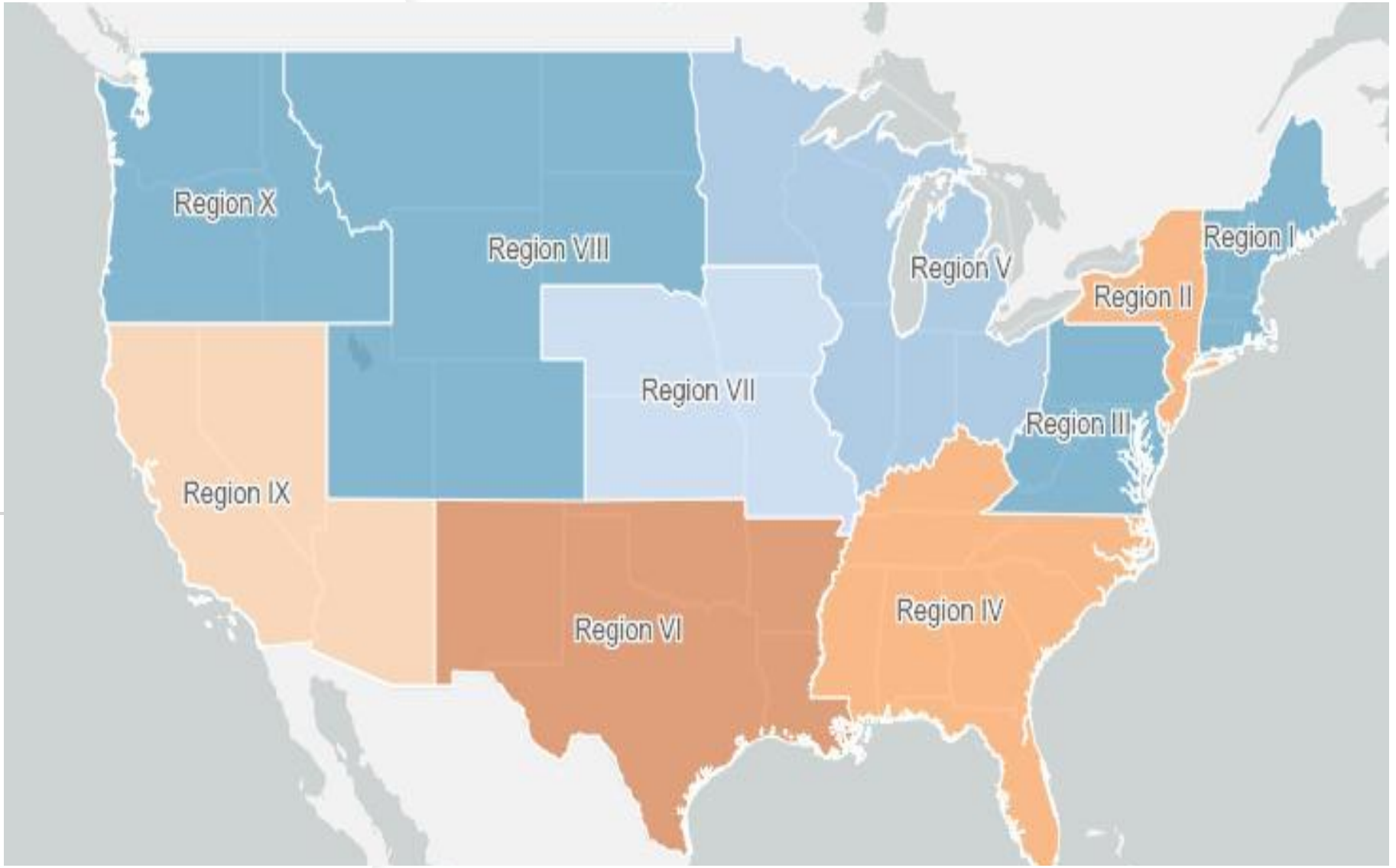
Local - to be eligible for funding, counties/communities must regularly update their plans, monitor performance, and show progress in achieving goals.



Federal Emergency Management Agency (FEMA) (2004). *Multi-Hazard mitigation planning guidance under the disaster mitigation act of 2000*.[DMA, 2000, Section 203(a)]

FEMA Region Federal Share of Obligations for Hazard Mitigation Grant Programs

(1989 to 2018)



Source: FEMA, 2019

Geographical Context (Urban-Rural dynamic)

U.S. = **90% rural land area** populated less than 20% of entire U.S. population (HAC, 2018).

<u>Study area counties (Isserman, 2005):</u>

Urban = 158, Mixed Urban = 156

Rural = 1,189, Mixed Rural = 886

Rural areas vs. urban are:

- Growing in diversity
- Have higher rates of homeownership
- Increasing in age
- Have higher credit needs (wage stagnation continues)

Theory

Regulation Theory

- Indicates regulation expresses itself locally. (Painter, 1997)
- Regulationist posit that in order to address an environmental crisis, such as the increased frequency of natural disaster events, the response needs to consider the socially constructed nature of the issue.

Center-Periphery Theory

- Indicates a “steady weakening of the peripheral economy by a net-transfer of natural, human, and capital resources to the core (Friedmann, 1972, pp. 94-95).
- In order to overcome this disparity government intervention is necessary (Friedmann 1966, 1972).

Hypotheses

H1: **Rural counties are less prepared** despite government intervention and investment.

H2: The **10 FEMA regions do not inform** the predictability of natural hazard preparedness conditions.

H3: The extent **of state hazard regulations influence** the probability of increased urban, suburban, and rural, natural hazard preparedness.

H4: Rural counties are less prepared if their neighbors are also rural counties - **spatial neighbor relationships matter**.

H5: The **10 FEMA regions are concerned** about their ability to ensure context sensitive 'whole community' approaches in rural or impoverished areas, and a **visually available community planning tool** that incorporates a state, regional, county boundaries with urban-rural population details would be of value.

Research Question

Does state-level hazard planning inform urban, suburban, and rural county & FEMA region natural hazard preparedness?

Mixed Methods - Research Approach

- Adjacent category logistic regression model and spatial cluster/hotspot analysis (LISA, Local Moran's I) tell the story of place and space.

- FEMA community preparedness leads provide insight about the value of my research design and DV - University of Missouri, Missouri Transect Project (MTP) community resilience tool.

So What?

What happens when the natural hazard preparedness conditions are **different**?

Despite enhanced guidelines, funding and technical assistance there is a difference in urban-rural communities' resilience.

Do these differences highlight state and regional hazard plan partnership opportunities across the 10 FEMA regions?

Methodology – Mixed Methods Comparative Study

Quantitative

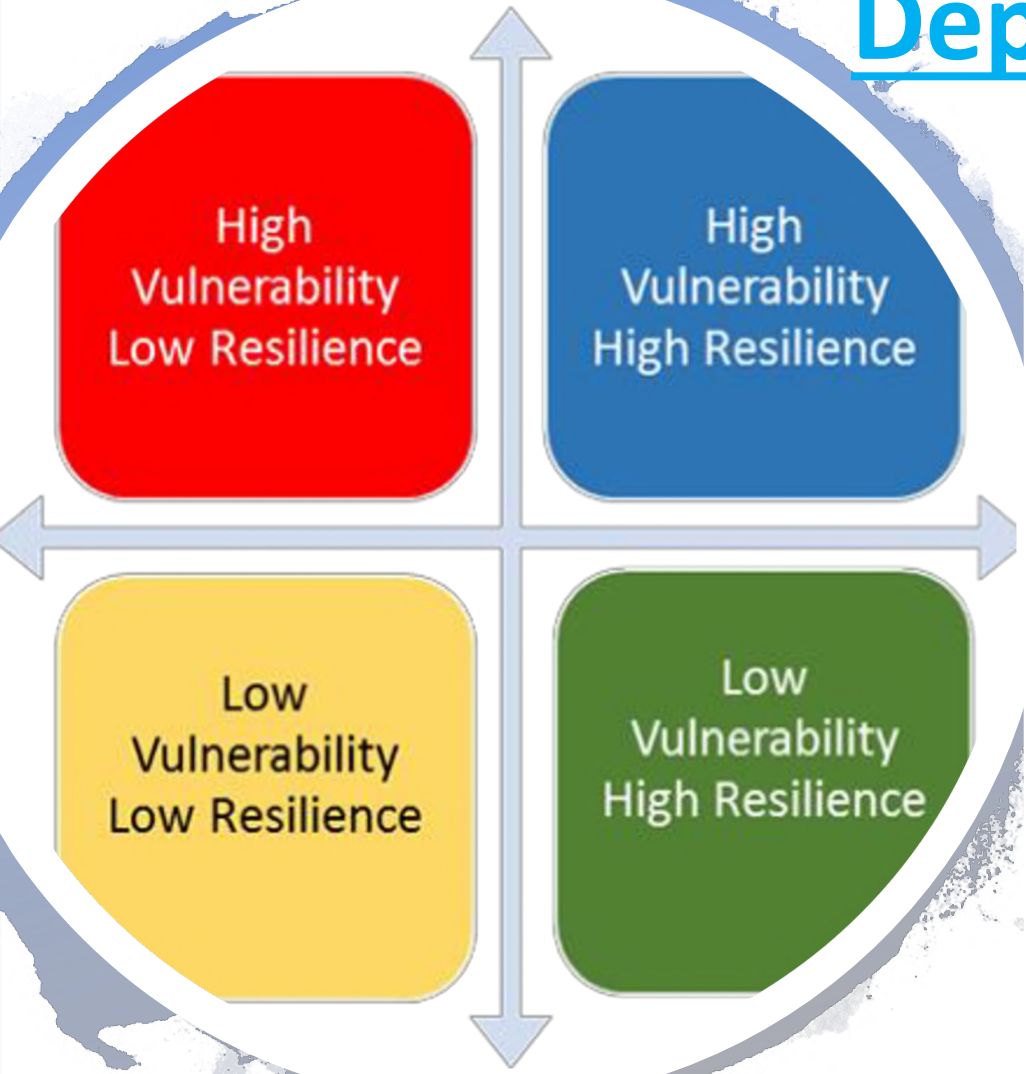
Regression model identifies urban, suburban, rural county-level natural hazard preparedness using resilience and vulnerable MTP components for 2,389 counties

Spatial auto-correlation identifies hotspot/cluster outlier counties across the continental U.S. and in each of the 10 FEMA regions.

Qualitative

Semi-structured elite interviews highlights how urban, suburban, and rural natural hazard preparedness conditions inform the work of the FEMA region community preparedness leads.

Categorical Ordinal Dependent Variable (4 DV's)



N= 2,389 counties

Missouri Transect Project (MTP), 2017 (ACS 2011-2015)

MTP Variable	Least Prepared (LR/HV)	Somewhat Prepared (LR/LV)	Moderately Prepared (HR/HV)	Most Prepared (HR/LV)
Economic	671	485	525	708
Environment	647	411	555	776
Infrastructure	574	597	634	584
Social	827	338	360	864
Total # of counties	2719	1831	2074	2932

Adjacent category logistic regression model

(Goodman, 1983)

4 DV's = Natural Hazard Preparedness (MTP Economic, Environmental, Infrastructure, Social R/V categories) =

4 EV's = (urban/mixed urban/mixed rural/rural county population density) + (# of adopted state hazard regulations) + (FEMA Region counties) + (county disaster incident/frequency value) +

3 CV's = (county ATTOM building risk factor) + (county 2016 presidential political preference) + (total county HMGP federal & local match grant award value)

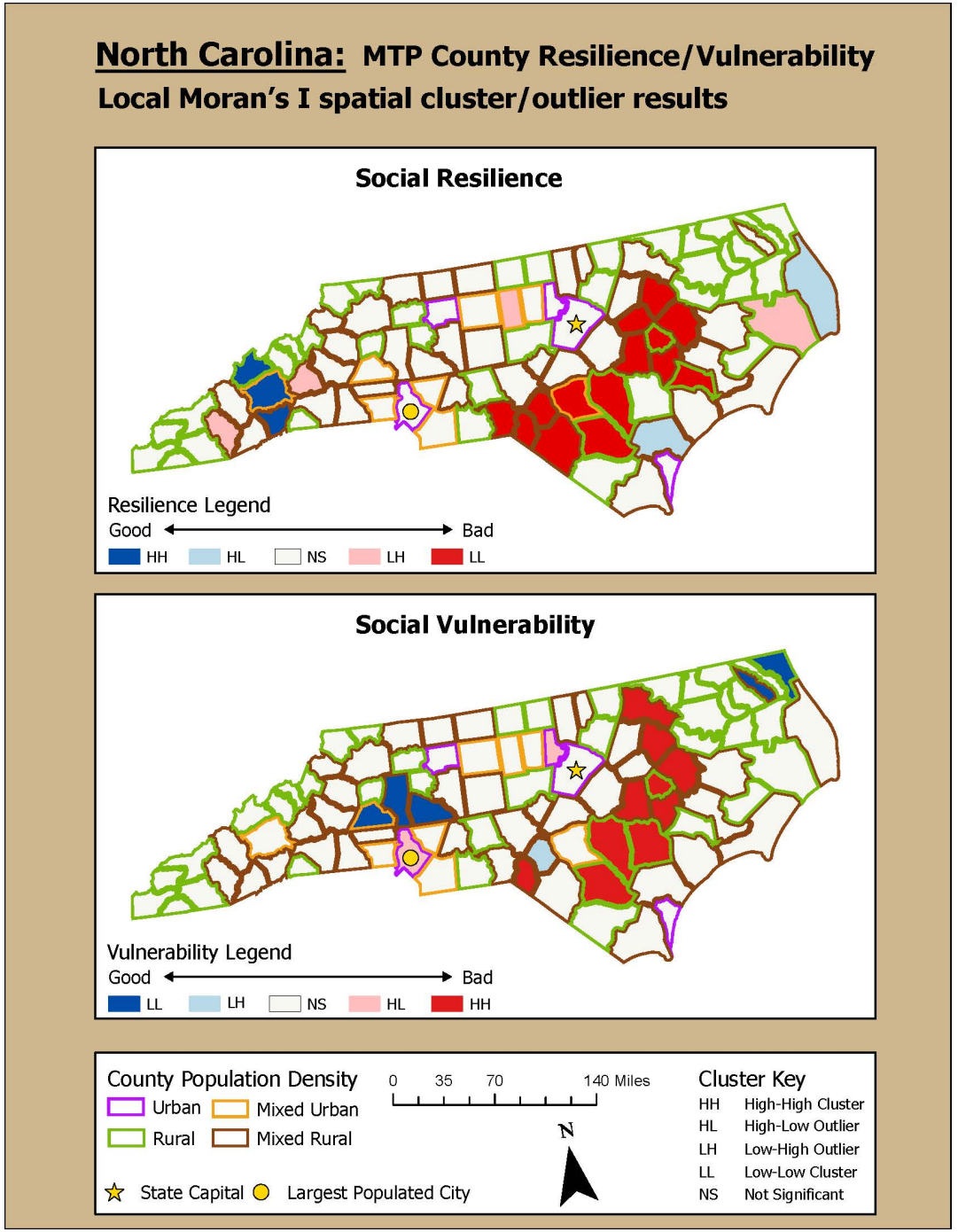
MTP Social R/V sources

Table 1. Social Resilience Index: Concepts, Variables, and Data Sources		
Concept	**Variable**	**Data Source**
Place attachment	Percentage of population living in same county as one year prior	U.S. Census Bureau, American Community Survey, 2011-2015
Place attachment	Percentage of housing units that are owner occupied	U.S. Census Bureau, American Community Survey, 2011-2015
Highly educated population	Percentage of population with a BS degree or higher	U.S. Census Bureau, American Community Survey, 2011-2015
Civic engagement	Voter participation rate	2016 Presidential Election, County-Level Open Data from Townhall.com and U.S. Census Bureau, American Community Survey, 2011-2015
Social capital	Number of 501(c)3 organizations per capita	Internal Revenue Service, April 2016, and U.S. Census Bureau, 2010
Social capital	Number of associations per 10,000 population	U.S. Census Bureau, County Business Patterns, 2014, and U.S. Census Bureau, 2010
Healthy population	Life expectancy	Institute of Health Metrics and Evaluation, 2014

Table 3. Social Vulnerability Index: Concepts, Variables, and Data Sources		
Vulnerable population	Percentage of population with a disability	U.S. Census Bureau, American Community Survey, 2011-2015
Vulnerable population	Percentage of population without health insurance	U.S. Census Bureau, American Community Survey, 2011-2015
Vulnerable population	Percentage of population age 65 and over	U.S. Census Bureau, American Community Survey, 2011-2015
Vulnerable population	Percentage of population under age 18	U.S. Census Bureau, American Community Survey, 2011-2015
Community erosion	FBI violent crime rate	U.S. Department of Justice, 2010-2012
Vulnerable population	County poverty rate	U.S. Census Bureau, American Community Survey, 2011-2015
Political fragmentation	Number of jurisdictions	U.S. Census Bureau, Census of Governments, 2012; 2013 Census Tiger/LINE Tribal Lands Boundary File; USGS National Map, 2006 Federal Lands

MTP Regression Significant Variables

Social Preparedness	Odds Ratio	P>|z|	95% Confidence Interval
Mixed Rural vs. Rural	1.51	0.005	1.13 - 2.02
FEMA Region vs. Region 4			
1	14.52	0.005	2.22 - 94.84
2	5.44	0.000	2.30 - 12.87
3	2.94	0.000	1.71 - 5.06
5	3.13	0.000	1.93 - 5.10
6	0.361	0.000	0.23 - 0.56
8	2.07	0.024	1.10 - 3.90
Presidential 2016 Majority Vote			
Rebublican vs. Democrat	4.1	0.000	2.40 - 7.03
Natural Disaster Incident Frequency	0.990	0.002	0.983 - 0.996
Psuedo R2 = 0.2006			



MTP Infrastructure R/V sources

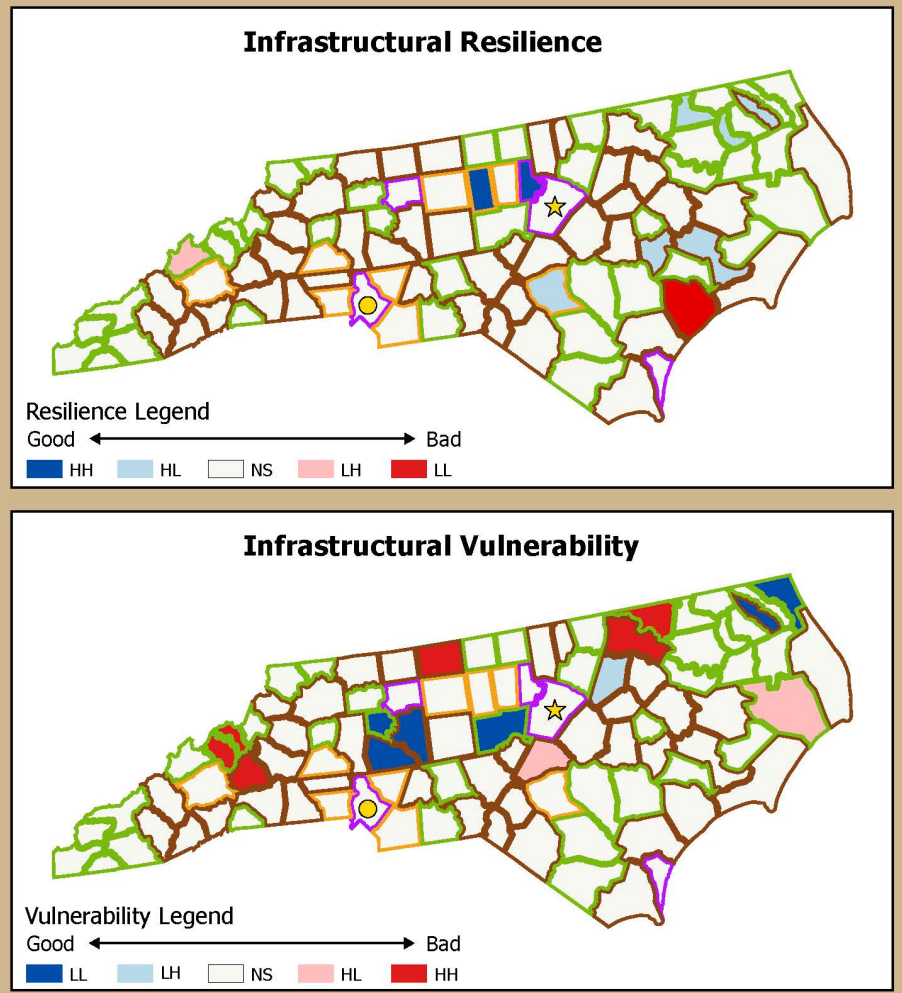
Table 6. Infrastructure Resilience Index: Concepts, Variables, and Data Sources		
Concept	**Variable**	**Data Source**
Medical Capacity	Percentage of population within 10 miles of a hospital with an emergency room	Centers for Medicare and Medicaid Services Provides of Service File, 2014; U.S. Census Bureau, 2010.
Medical Capacity	Primary care physicians per capita	Health Resources and Services Administration, Area Health Resource File, 2014-15
Adequacy of roadways	Lane miles of interstates, principal arterial and minor arterial roads per 1,000 population	Federal Highway Administration, Highway Performance Monitoring System, 2012; U.S. Census Bureau, 2010.
Potential First Responders	Persons in emergency response occupations as a percentage of total county population	U.S. Census Bureau, American Community Survey, 2011-2015
Investment in emergency response system	Per capita expenditures on police and fire	U.S. Census Bureau, Census of Governments, County Area Expenditures, 2012
Access to food	Percentage of population within 1 mile of a grocery store	U.S. Department of Agriculture Food Access Research Atlas, 2015

Table 8. Infrastructure Vulnerability Index: Concepts, Variables, and Data Sources		
Concept	**Variable**	**Data Source**
At risk infrastructure	Percentage of housing units that are mobile homes	U.S. Census Bureau, American Community Survey, 2011-2015
Evacuation challenges	Percentage of population living in group quarters	U.S. Census Bureau, American Community Survey, 2011-2015
Evacuation challenges	Percentage of housing units with no vehicle available	U.S. Census Bureau, American Community Survey, 2011-2015
At risk infrastructure	Percentage of homes built before 1960	U.S. Census Bureau, American Community Survey, 2011-2015
Evacuation challenges	Count of high detour or high traffic bridges	U.S. Department of Transportation, 2013 National Bridge Inventory
High potential loss facilities	Percentage of population within 5 miles of a dam	2014 National Transportation Atlas, Dams Dataset
High potential loss facilities	Percentage of population within 10 miles of a nuclear facility	U.S. Geological Survey, Structures Dataset
Infrastructure quality	Percentage of population served by water systems with at least one health-based violation	U.S. Environmental Protection Agency Safe Drinking Water Information System

MTP Regression Significant Variables

Infrastructure Preparedness	Odds Ratio	P>|z|	95% Confidence Interval
Mixed Urban vs. Rural	4.59	0.025	1.21 - 17.45
FEMA Region vs. Region 4			
1	0.27	0.047	0.074 - 0.982
5	3.25	0.000	2.17 - 4.86
6	0.65	0.037	0.433 - 0.975
7	1.96	0.000	1.35 - 2.84
8	4.76	0.000	2.67 -8.48
Presidential 2016 Majority Vote			
Rebublican vs. Democrat	3.64	0.000	2.04 - 6.50
Psuedo R2 = 0.1780			

North Carolina: **MTP County Resilience/Vulnerability**
Local Moran's I spatial cluster/outlier results



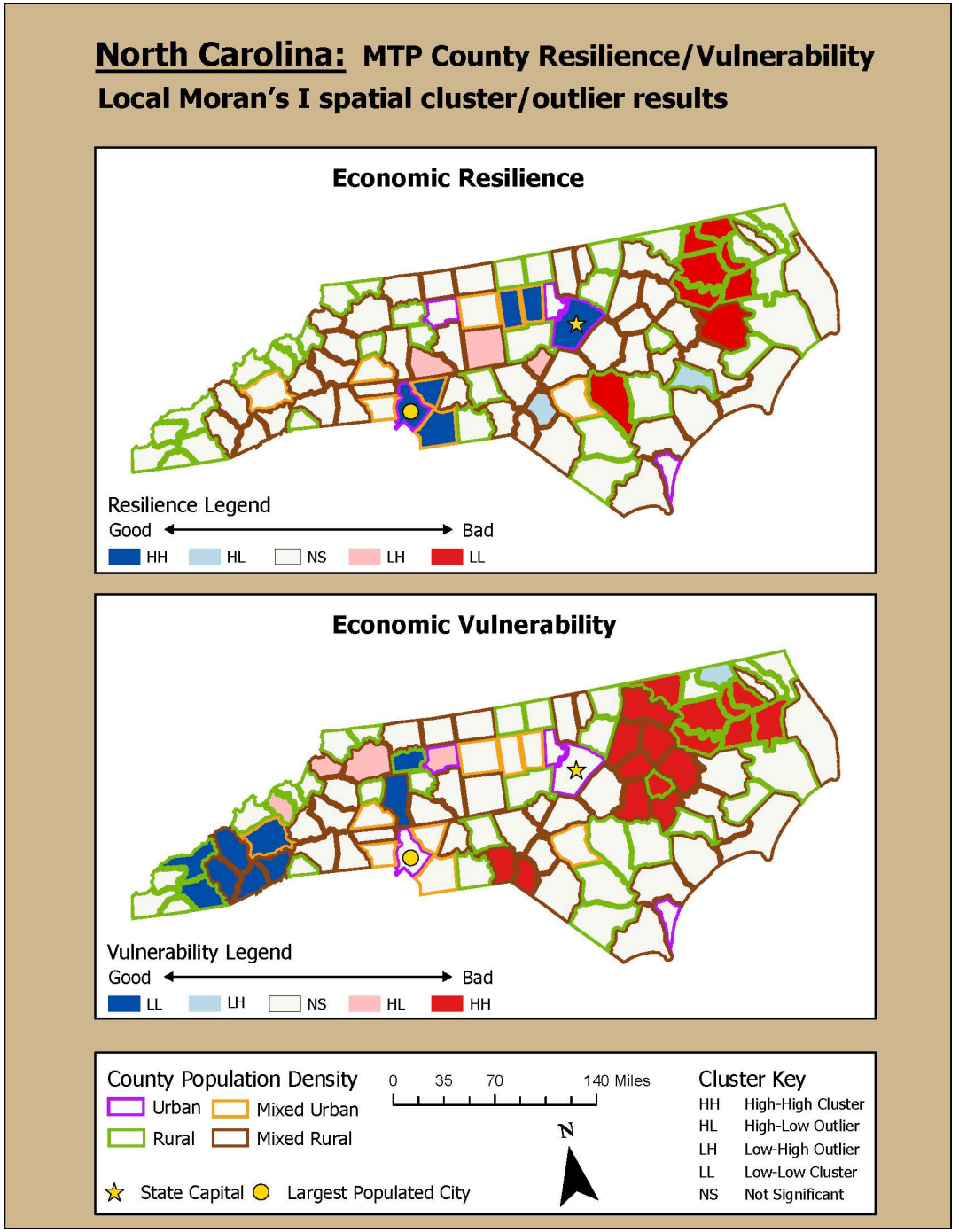
MTP Economic R/V sources

Table 11. Economic Resilience Index: Concepts, Variables, and Data Sources		
Concept	**Variable**	**Data Source**
Economic diversity	Employment sector diversity (relative to national average)	U.S. Census Bureau, American Community Survey, 2011-2015
Entrepreneurship	Proprietors as a percentage of total nonfarm employment	Bureau of Economic Analysis, 2014
Entrepreneurship	Average nonfarm proprietor income	Bureau of Economic Analysis, 2014
Active economy	Labor force participation rate	U.S. Census Bureau, American Community Survey, 2011-2015
Economic growth	Establishment birth rate	U.S. Census Bureau, Statistics of U.S. Businesses, 2014

Table 13. Economic Vulnerability Index: Concepts, Variables, and Data Sources		
Concept	**Variable**	**Data Source**
Reliance on natural resource sectors	Percentage of workers employed in agriculture, forestry, fishing, mining industries	U.S. Census Bureau, American Community Survey, 2011-2015
Cost burdened households	Percentage of households spending 30% or more of total income on housing costs (mortgage/rent and utilities)	U.S. Census Bureau, American Community Survey, 2011-2015
Economic hardship	Unemployment rate	U.S. Census Bureau, American Community Survey, 2011-2015
Potential tax shortfalls	Business vacancy rate	Department of Housing and Urban Development; U.S. Postal Services (2016, Quarter 4)

MTP Regression Significant Variables

Economic Preparedness	Odds Ratio	P>|z|	95% Confidence Interval
FEMA Region vs. Region 4			
3	8.00	0.000	4.55 - 14.06
5	4.38	0.000	2.94 - 6.53
6	2.67	0.000	1.75 - 4.08
7	7.03	0.000	4.59 - 10.78
8	6.69	0.000	4.14 - 18.82
Presidential 2016 Majority Vote			
Rebublican vs. Democrat	3.14	0.000	1.86 - 5.28
Natural Risk Building Code Rank	1.010	0.043	1.00 - 1.02
Psuedo R2 = 0.1521			



MTP

Environment

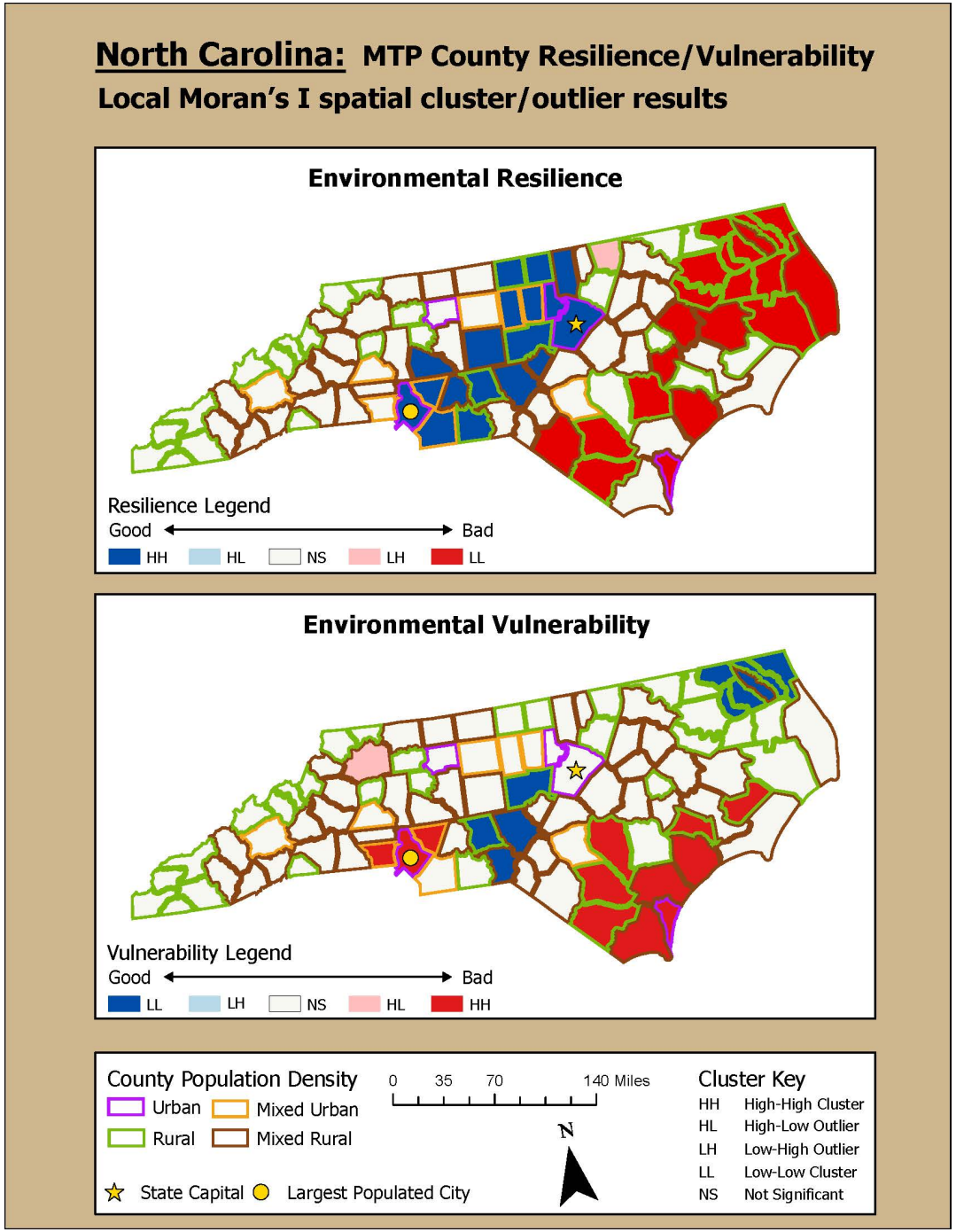
R/V sources

Table 16. Environmental Resilience Index: Concept, Variable, Data Source		
Concept	**Variable**	**Data Source**
Environmental resilience	Ecophysiographic Diversity Index Score	ESRI & USGS World Ecophysigraphic Diversity, 2015

Table 18. Environmental Vulnerability Index: Concepts, Variables, and Data Sources		
Concept	**Variable**	**Data Source**
Flood risk	Percentage of population within 2 miles of a levee or within a levee zone	U.S. Army Corps of Engineers, National Levees Database, Dec. 2015
Storm severity	Number of storm events over 15 year period	National Oceanic and Atmospheric Administration, 2000-2014
Range of storm types	Diversity index of storms	National Oceanic and Atmospheric Administration, 2000-2014
Earthquake risk	Population weighted seismic hazard zone score	U.S. Geological Survey, National Seismic Hazard Maps, 2014, 2007, 1998
Drought risk	Percentage of weeks in drought	U.S. Drought Monitor, 2012-2014

MTP Regression Significant Variables

Environment Preparedness	Odds Ratio	P>|z|	95% Confidence Interval
Mixed Rural vs. Rural	0.560	0.001	0.402 - 0.782
FEMA Region vs. Region 4			
6	0.036	0	0.019 - 0.069
7	0.099	0.000	0.062 - 0.159
10	0.04	0.000	0.011 - 0.248
Presidential 2016 Majority Vote			
Rebublican vs. Democrat	2.14	0.005	1.26 - 3.62
Natural Disaster Incident Frequency	0.989	0.005	0.981 - 0.997
Psuedo R2 = 0.2771			



Qualitative Study

IRB Determination
Date: 12/12/2019
RE: Determination that Research or Research-Like Activity does not require IRB Approval
Study #: 19-0513

- I ask FEMA community preparedness leads to provide insight about what resilient measurement tools they see being implemented in their region by states.

- I question their perception of the value of the MTP map book approach for assisting community hazard planners with county-level urban-rural regional resilience and vulnerability conditions, and

- I ask about what they perceive affecting the nature of urban-rural resilience and vulnerability conditions within their region of the U.S.

Why does this matter?

The fairness and equity of resilience to natural hazards is not only important for improving our nations' regional resilience, but also for the protection of taxpayer investments, property and most importantly citizens.

Limitations

- Resilience is a **complex phenomenon** with multi-level geophysical, social, economic, and infrastructure parameters that influence the outcomes for community preparedness
- Study uses **cross-sectional** data (2011- 2018) vs. longitudinal data
- Regional resilience index (MTP) is in the **beta** testing phase
- The 10 FEMA region community planning leads or designees, limit **generalizability**

References

- American Planning Association (APA) 2019. Hazard Mitigation and Disaster Recovery Planning Division (HMDR), Survey of State Land-Use and Natural Hazards Planning Laws, accessed 8/4/2019 [50 State APA Survey Results]
- ATTOM (2016) 2016 RealtyTrac Natural Hazard Housing Index accessed 9/24/2018
- Federal Emergency Management Agency (FEMA) (2019). Hazard Mitigation Plan Status [https://www.fema.gov/hazard-mitigation-plan-status] Accessed 11/4/19.
- Federal Emergency Management Agency (FEMA) (2018). Hazard Mitigation Assistance Snapshot,accessed11/24/2019 [https://www.arcgis.com/apps/webappviewer/index.html?id=b9d25d1b3d8347aeb084fac9d30c3f0e&extent=-16595145.2901,431438.746,-6077410.198,7485659.2124,102100
- Federal Emergency Management Agency (FEMA) (2004). *Multi-Hazard mitigation planning guidance under the disaster mitigation act of 2000*. [http://www.fema.gov/library/viewRecord.do?id=3115] [DMA, 2000, Section 203(a)])
- Friedmann, J. (1972). A generalized theory of polarized development. In N. Hansen, ed., *Growth centers in regional economic development.* New York: free Press, 82 – 107.
- Friedmann, J. (1966). *Regional Development Policy: a case study of Venezuela*. Cambridge, Mass.: MIT Press.
- Housing Assistance Council. 2018. "CRA in Rural America Infographic." Accessed July 31, 2019. https://create.piktochart.com/output/39253704-cra-in-rural-america-infographic.
- International Federation of Red Cross (IFRC), 1999. World Disasters Report, Focus on Early Warning, Early Action. http://www.ifrc.org/en/publications-and-reports/world-disasters-report/wdr2009/
- Isserman, A.M. (2005). In the national interest: Defining rural and urban correctly in research and public policy. *International Regional Science Review,* 28(4), 465-499.
- Miller, K. K., Johnson, A., & Dabson, B. (2015). Resilience and Vulnerability Indexes for U.S. Counties. MO: Columbia: University of Missouri Institute of Public Policy.
- Miller, K. K., Johnson, A. and Dabson, B. (2015a). "County Level Resilience and Vulnerability Index" Institute of Public Policy Working Paper 01, Harry S Truman School of Public Affairs, University of Missouri. http://ipp.missouri.edu/wp-content/uploads/2015/01/Working-Paper-01-A-County-Level-Resilience-and Vulnerability-Index-Final-21.pdf
- Miller, K. K., Johnson, A. and Dabson, B. (2015b). "Resilience and Vulnerability Indexes for U.S. Counties." Institute of Public Policy Working Paper 04, Harry S Truman School of Public Affairs, University of Missouri.
- Missouri Transect Project (MTP*) Miller, K.K., Johnson, A., and Dabson, B. (2017). Research Methodology of Resilience and Vulnerability. University of Missouri, Institute of Public Policy, Harry S. Truman School of Public Affairs. https://www.communitycommons.org/wp-content/uploads/bp-attachments/156345/Methodology-Abbreviation.pdf
- Painter J. (1997). *Regulation, regime and practice in urban politics*, in Lauria M. (Ed.) Reconstructing Urban Regime Theory, pp. 122–143. Sage, London.
- Post Carbon Institute, (2017). *The Community Resilience Reader Essential Resources for an Era of Upheaval*, ed. Daniel Lerch. Island Press: Washington, DC. ISBN-13: 978-1-61091-861-9 (electronic)
- Pressman, J. L., Wildavsky, A. B., & Oakland Project. (1973). *Implementation: how great expectations in Washington are dashed in Oakland: Or, Why it's amazing that Federal programs work at all, this being a saga of the Economic Development Administration as told by two sympathetic observers who seek to build morals on a foundation of ruined hopes*. Berkeley: University of California Press.

Thank You!

Questions & Suggestions

cdanis1@uncc.edu

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