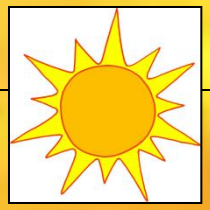
Heat Related Illness and North Carolina: Linking Variations in Heat Related Illness to Land Cover and Socioeconomic Patterns



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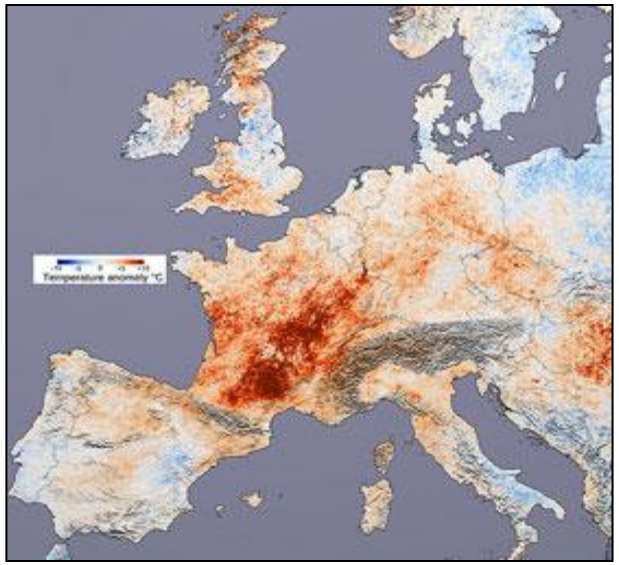
Rationale

- **<u>What is heat-related illness?</u>**
- **<u>Why is it important?</u>**
- **<u>Who is at risk for heat-related illness and death?</u>**
  - Urban areas
  - Poor, minorities, socially isolated, elderly, lack of fan or air conditioning

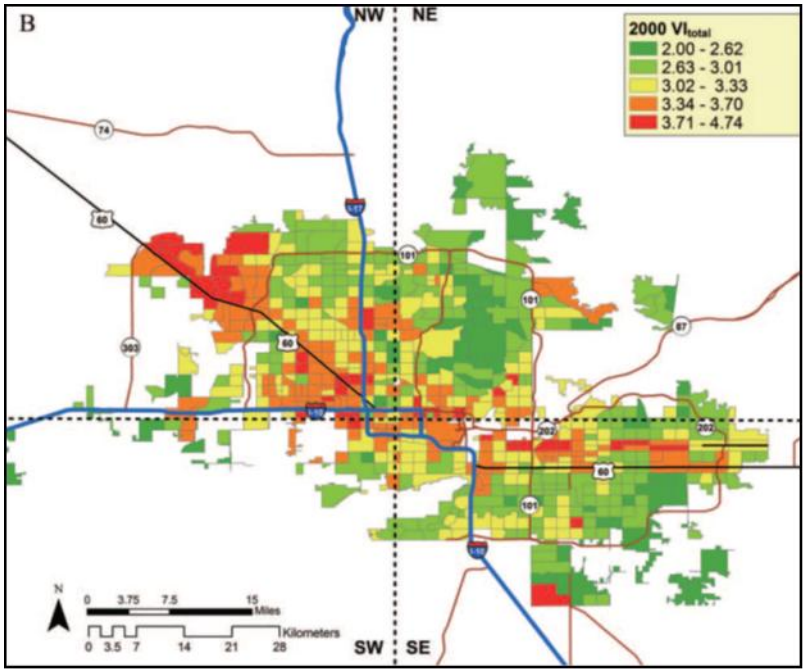
dailykos.com



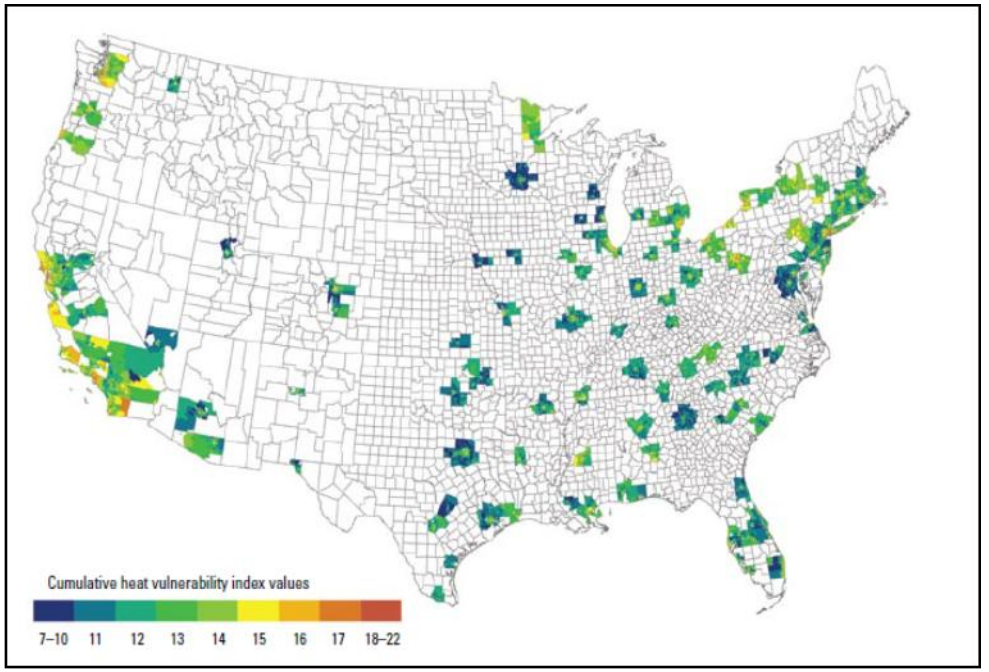
<u>Information adapted from</u>: Meehl and Tebaldi 2004, McGeehin and Mirabelli 2001Whitman *et al.* 1997, Semenza *et al.* 1999, Naughton *et al.* 2002, Jones *et al.* 1982, Kilbourne *et al.* 1982, Smoyer *et al.* 1998, Johnson *et al.* 2009, CDC 2004

Rationale

- **<u>What geographic locations are at greater risk for heat-related illness?</u>**
  - Measure the co-location of areas with greater physical exposure to extreme heat with locations with poor social vulnerability.
  - A main limitation – results not validated with actual counts to heat morbidity and mortality



Chow et al. 2012



Reid et al. 2009

Rationale

- **<u>Are agricultural workers at greater risk for HRI?</u>**
  - In the US, North Carolina accounts for 57% of all heat related deaths among all reported heat deaths among crop workers heat-crop workers from 1992 to 2006 (Luginbuhl *et al.* 2008)
  - African Americans, Latino workers (Richardson and Gregory 1997, Richardson and Mirabelli 2002).

EPA

Agricultural Worker Health Project
: David Bacon

ers.usda.gov

Research Question

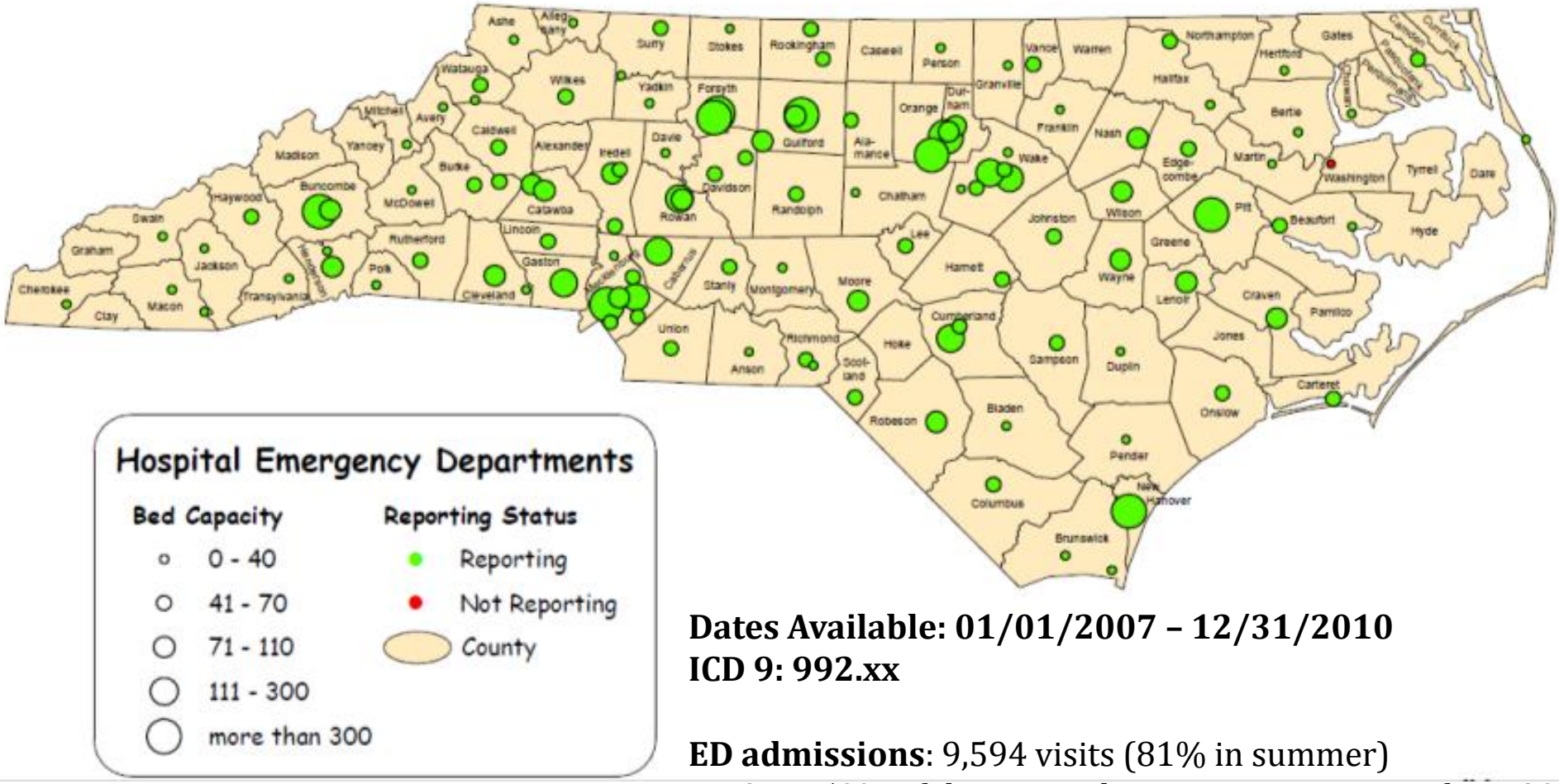
What is the spatial pattern of HRI across the study region? How does this pattern relate to socioeconomic, demographic, and land cover patterns?

www.healthspablog.org

joepaduda.com

OSHA

North Carolina Disease Event Tracking and Epidemiologic Tool (NC DETECT)



Dates Available: 01/01/2007 – 12/31/2010
ICD 9: 992.xx

ED admissions: 9,594 visits (81% in summer)

- Over 50% of these ED admissions are patients from 20 to 50 years old
- Males comprised 73% of the HRI ED admissions.

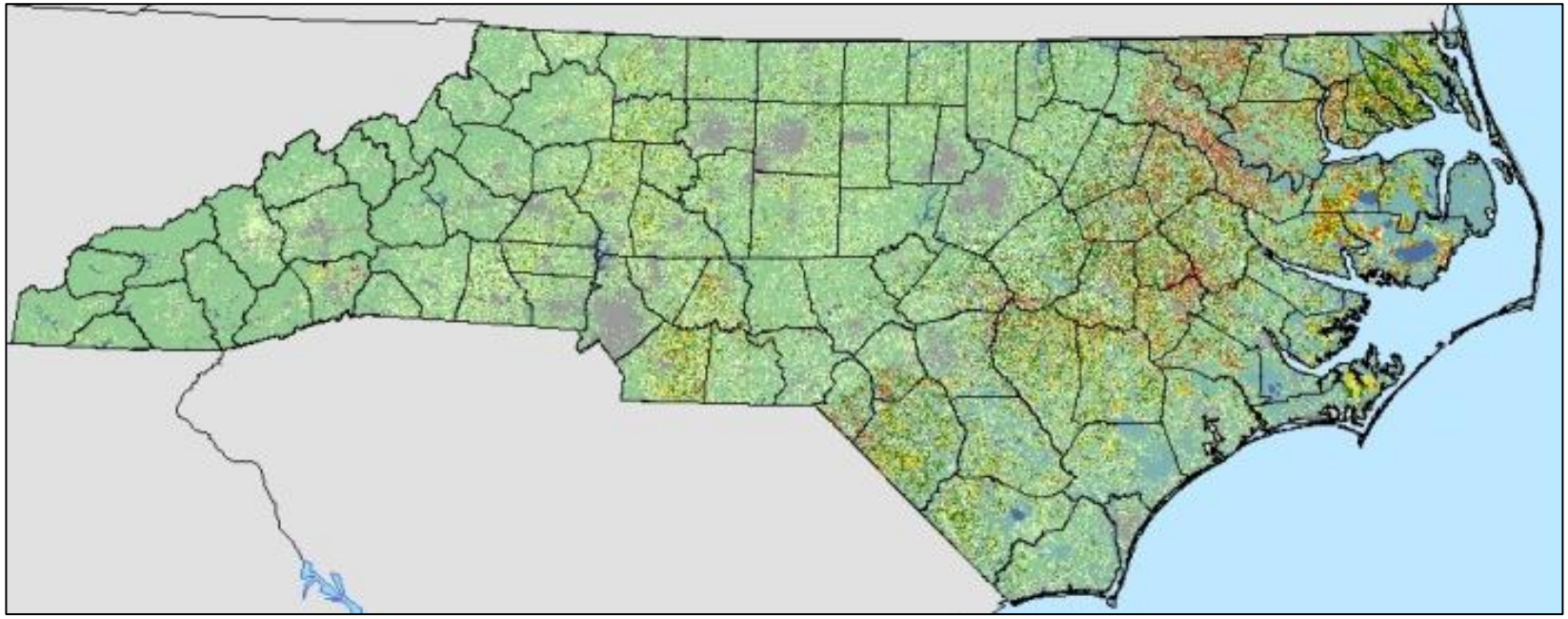
Data Sources

ACS 2006-2010 Survey	Potential Relationship to HRI
Race: (Hispanic, Black, White)	Populations most vulnerable to heat
Citizenship: (Naturalized, Non-Citizen, Spanish speakers)	Agricultural workers/social isolation
Income: (food stamps, below $20,000, median household income)	Wealth or poverty
Housing Type: (Mobile home, multihouse, rental occupancy)	Wealth or poverty/Social isolation
Electricity source:(LPG, natural gas, electricity, heating oil)	Rural or Urban/Poverty
National Land Cover Database (2008)	**Potential Relationship to HRI**
Developed Land: High intensity, medium intensity, Low intensity	Rural or Urban/Geographic Locations
Cultivated Crops: 30 total crops (e.g. tobacco, corn, apples, oats, peanuts)	Agriculture workers/Microclimate of fields
Forest: Evergreen, Mixed forest, deciduous forest, woodland	Cooling potential from vegetation

Methodology

1.) Transform data to a similar spatial scale

National Land Cover Database (2008)

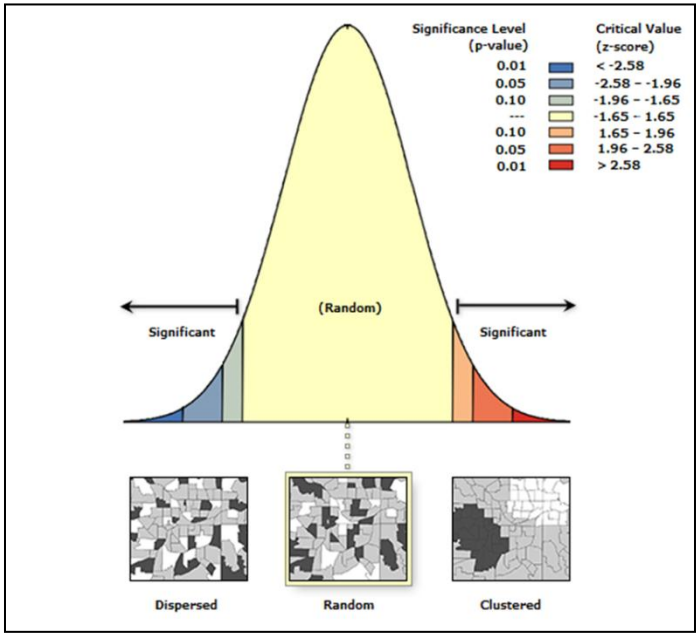


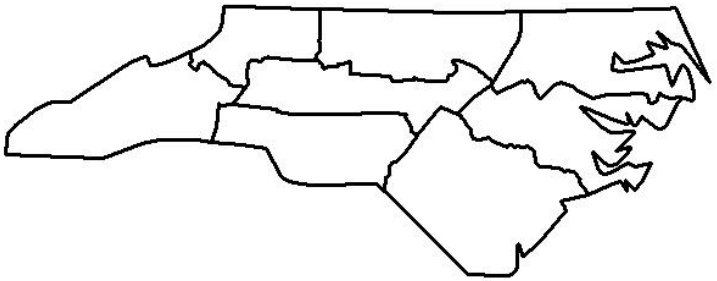
Methodology

2.) Map the spatial distribution and descriptive cluster analysis to analyze patterns of HRI

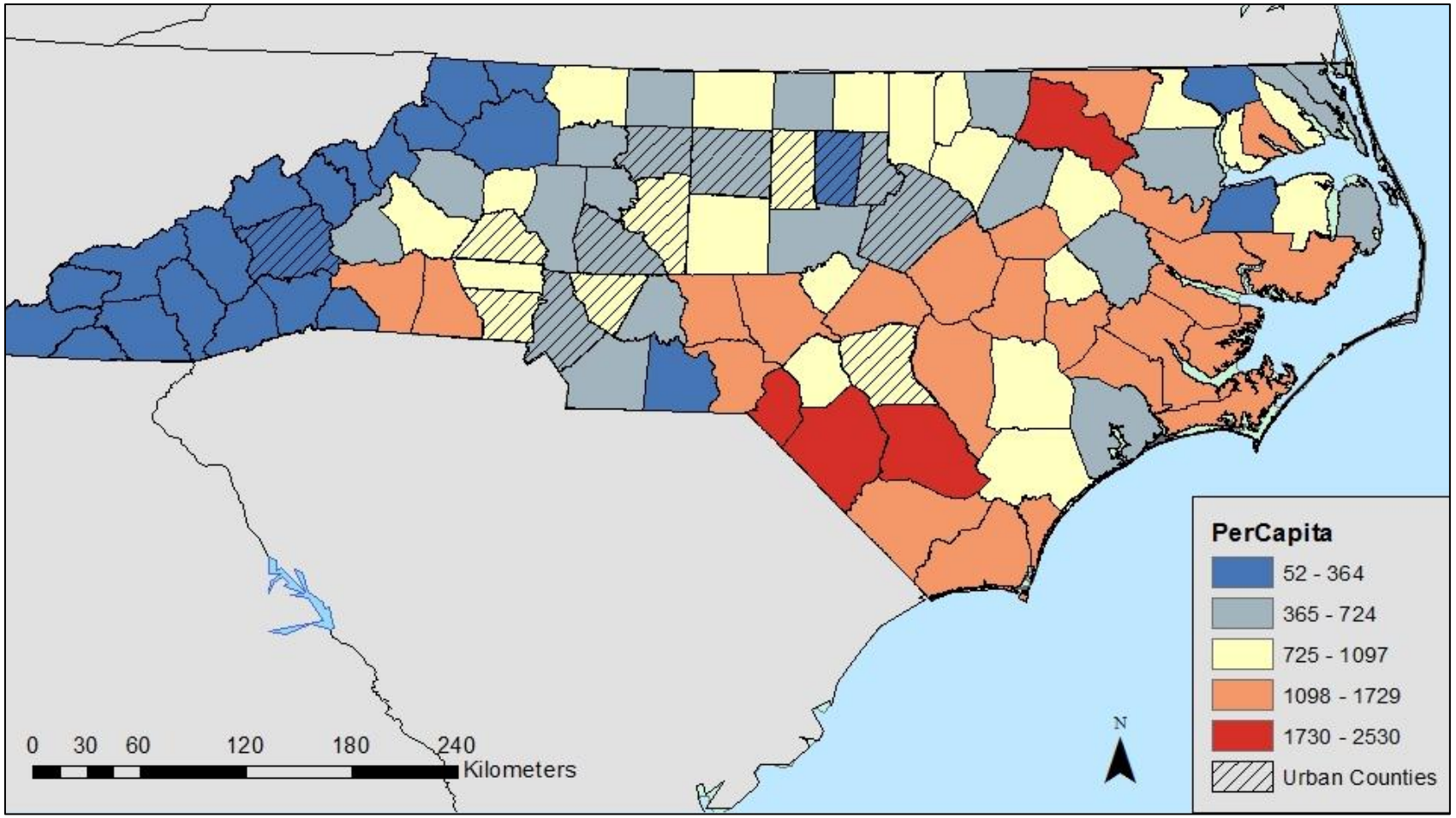
3.) Perform GWR on each physiographic region (coastal plain, piedmont and mountains)

4.) Perform basic correlations within physiographic regions to identify any at risk agricultural land cover





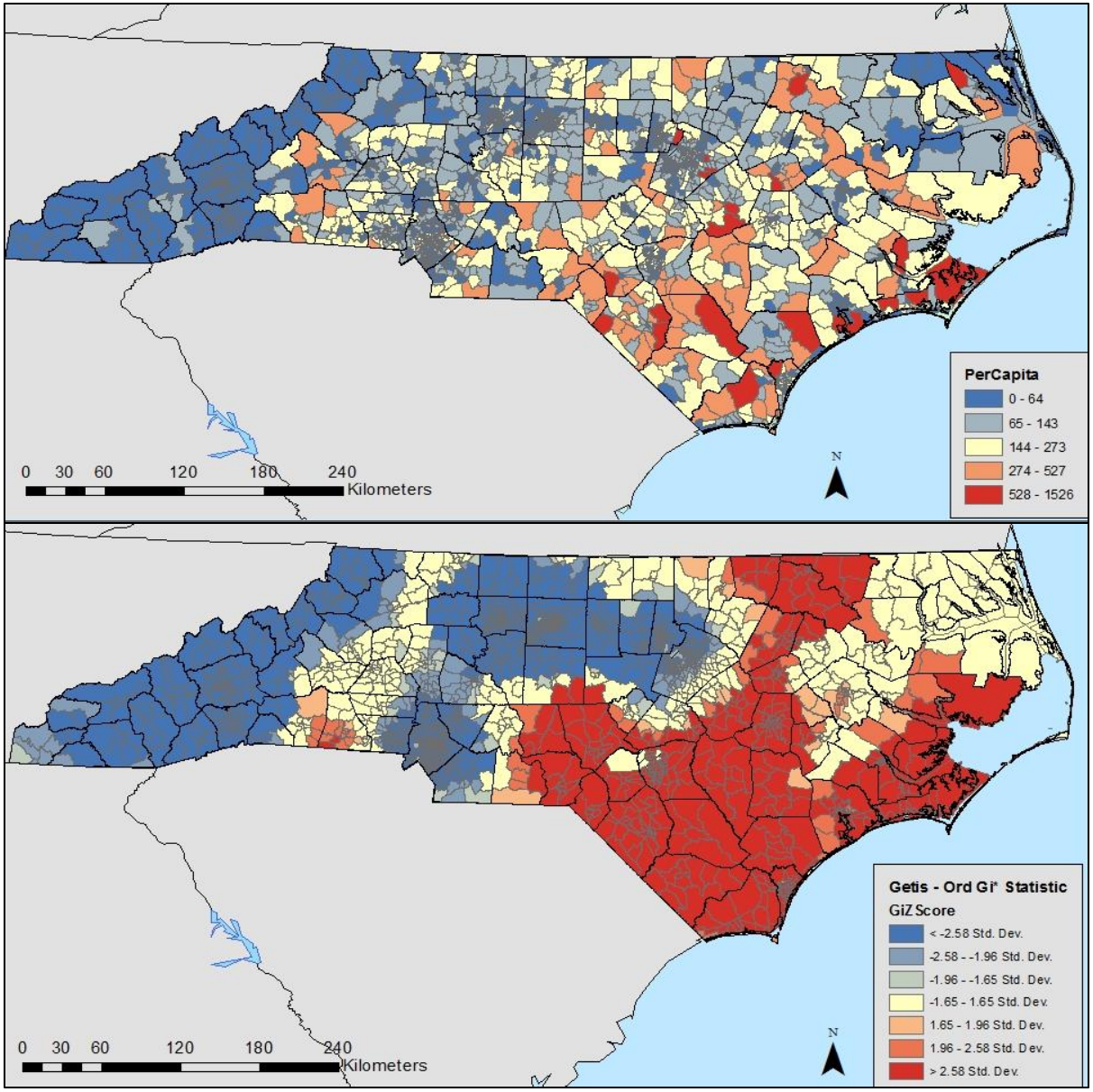
ED Admissions By County



N = 9, 594 ED Admissions
Rural Admissions = 6, 035 (82, 084 Per 100,000)
Urban Admissions = 3, 559 (9,985 Per 100,000)

*as defined by the NC Rural Economic Development Center

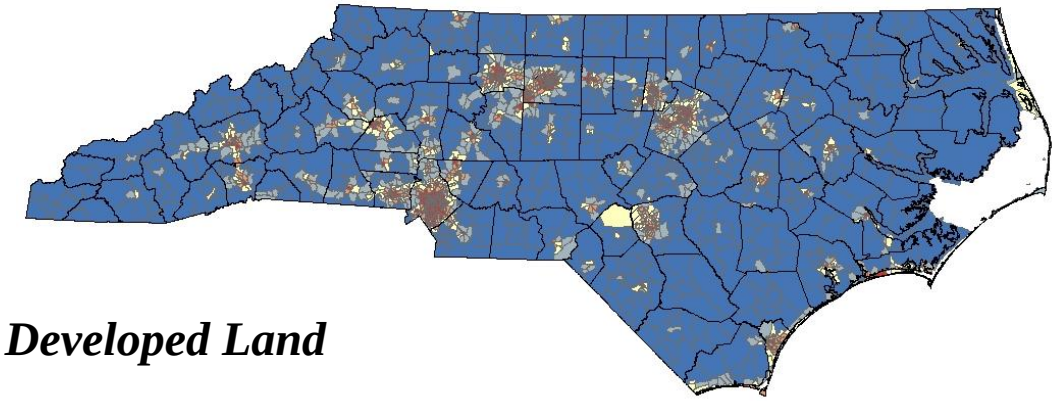
ED Admissions By Census Tract



State – Wide Analysis

Variables	R
Mobile Home	0.45
Cropland	0.34
Developed	-0.40

*p-values < 0.05

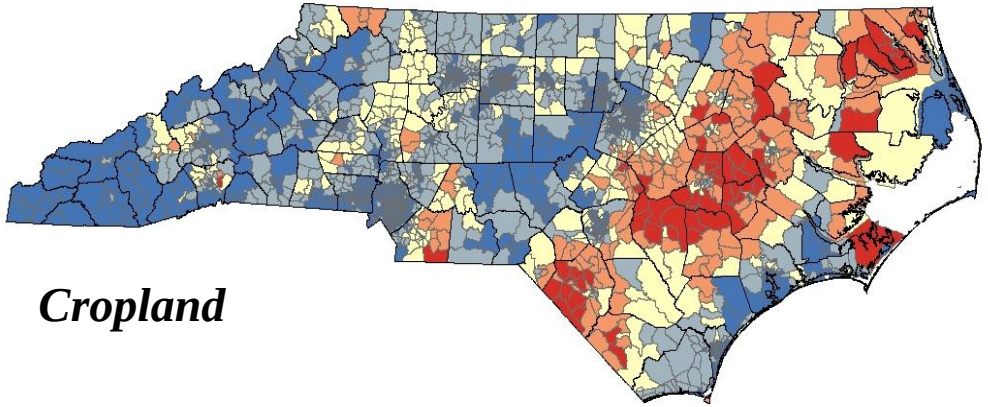


Developed Land

Stepwise Regression (in descending effect):

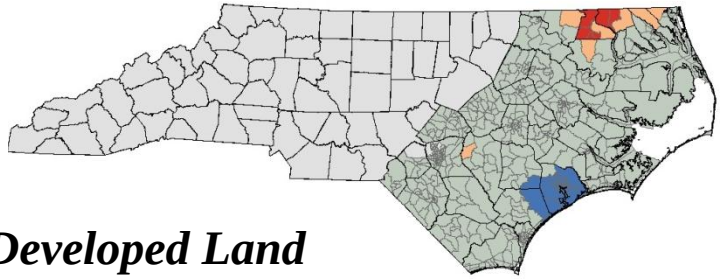
- Mobile home density
- Developed land
- Cropland

Together the variables in this model accounted for 23% of the variance in HRI admissions.



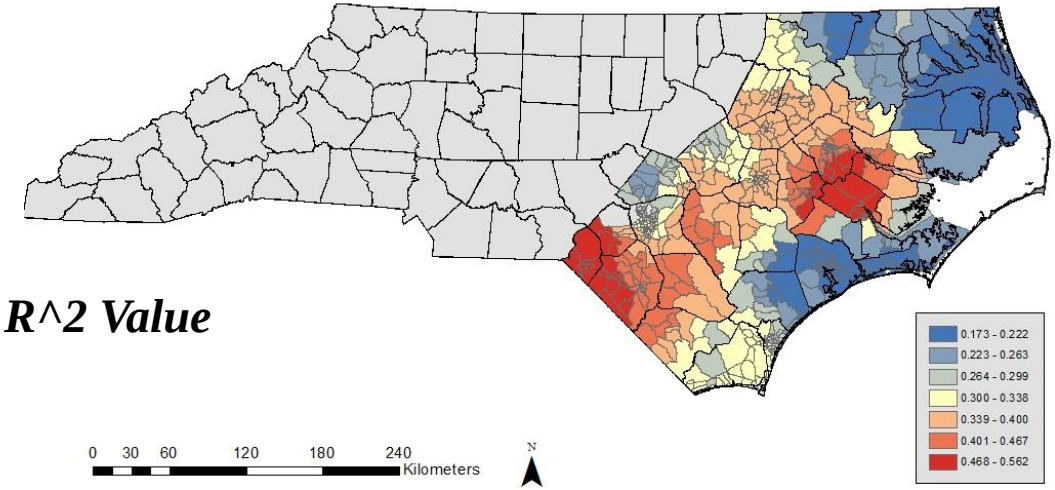
Cropland

Coastal Plain

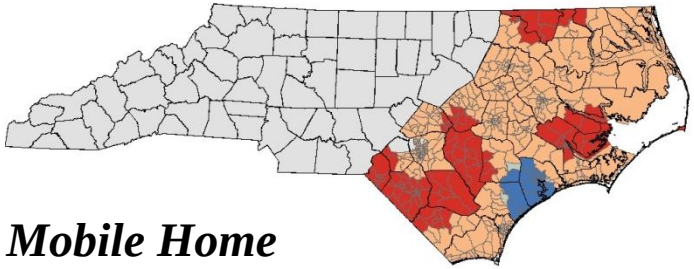


Developed Land

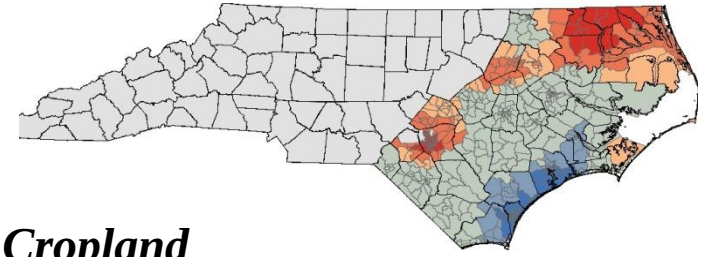
Geographically Weighted Regression



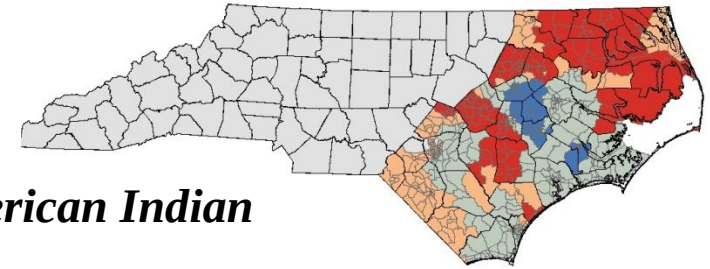
R^2 Value



Mobile Home



Cropland



American Indian

N = 3,753ED Admissions

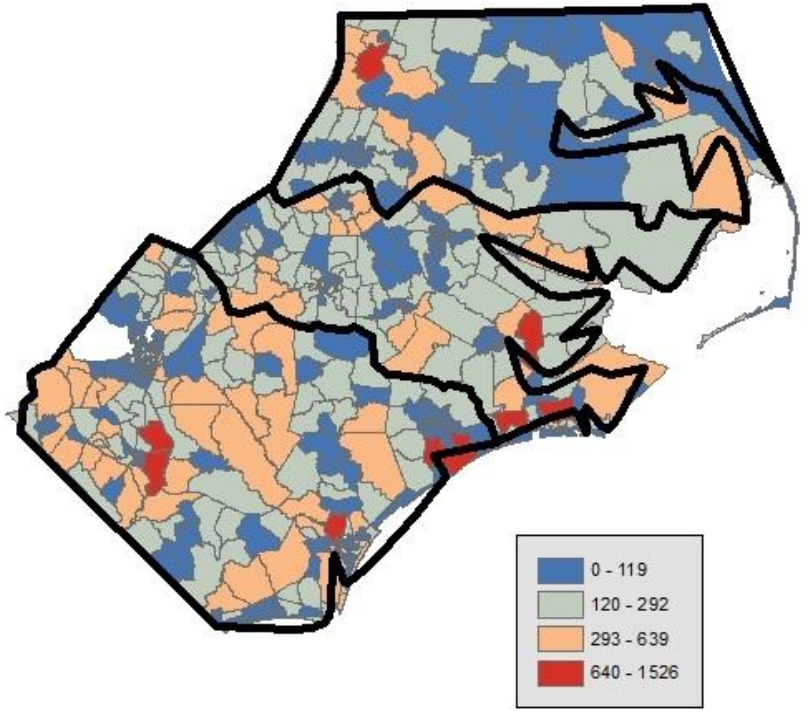
Coastal Plain

Land Cover Analysis

Coastal Plain	Land Cover Type	R - Value
Southern	Forest Vegetation	0.48
2078 ED visits	Soybean	0.25
48389 Per Capita	Corn	0.24
	Developed	-0.44
Middle	Forest Vegetation	0.46
1149 ED visits	Corn	0.26
26421Per Capita	Tobacco	0.16
	Developed	-0.52
Northern	Cotton	0.54
536 ED Visits	Forest Vegetation	0.33
12476 Per Capita	Sunflower	0.22
	Developed	-0.36

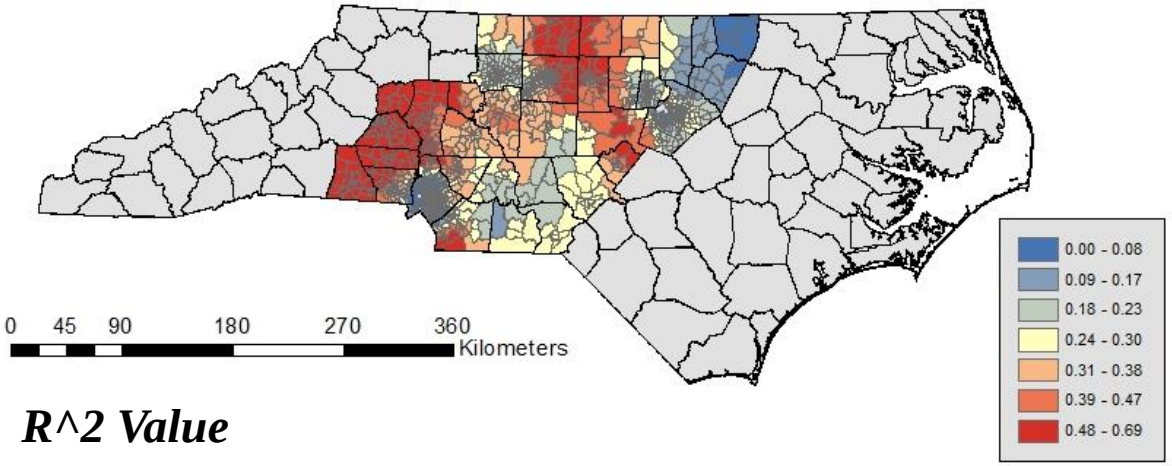
*p-values < 0.05

Per Capita HRI for Coastal Plain

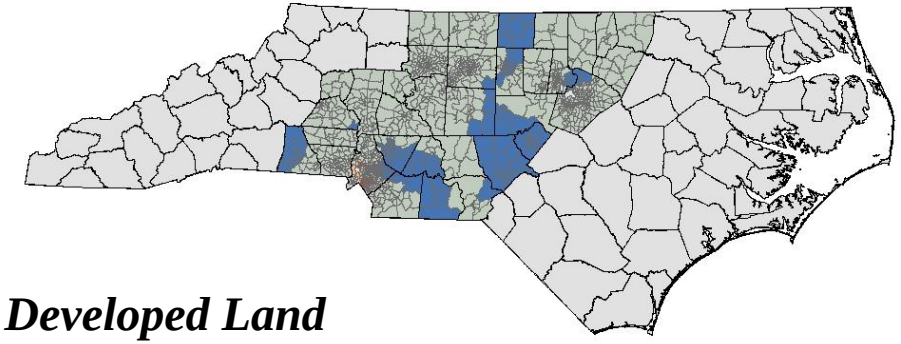


Piedmont

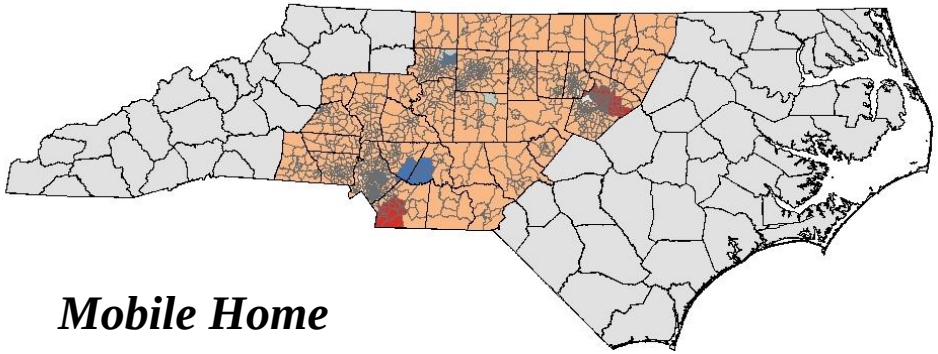
Geographically Weighted Regression



R^2 Value



Developed Land



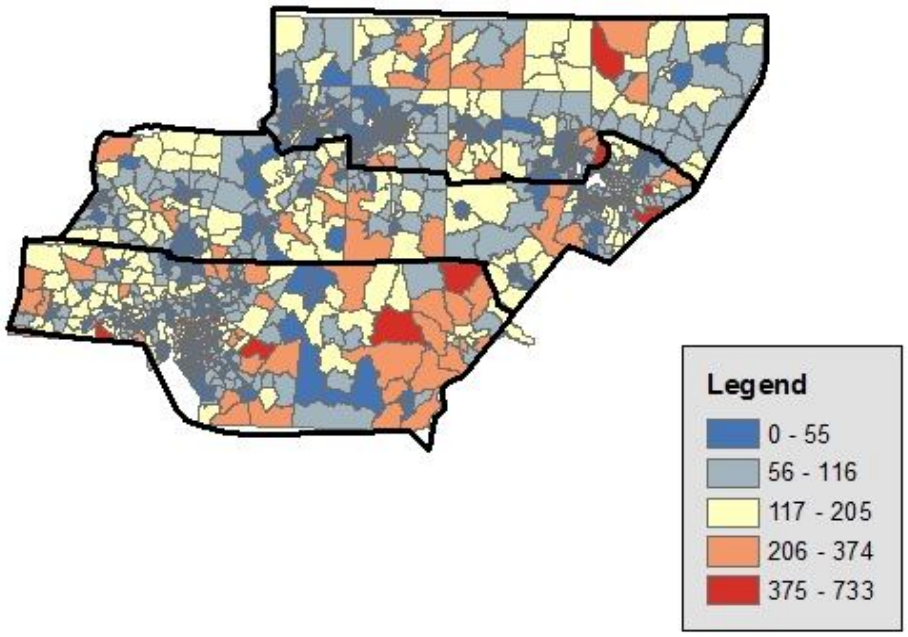
Mobile Home

Piedmont

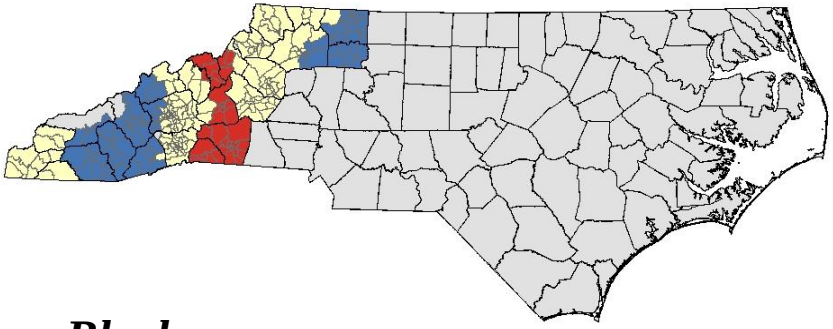
Land Cover Analysis

Piedmont	Land Cover Type	R - Value
Southern	Forest Vegetation	0.31
1644 ED visits	Peaches	0.26
42548 Per Capita	Soybean	0.2
	Developed	-0.47
Middle	Forest Vegetation	0.39
1473 ED visits	Corn	0.24
33153 Per Capita	Soybean	0.24
	Developed	-0.46
Northern	Forest Vegetation	0.49
1176 ED Visits	Tobacco	0.31
28329 Per Capita	Corn	0.28
	Developed	-0.54

Per Capita HRI for Piedmont

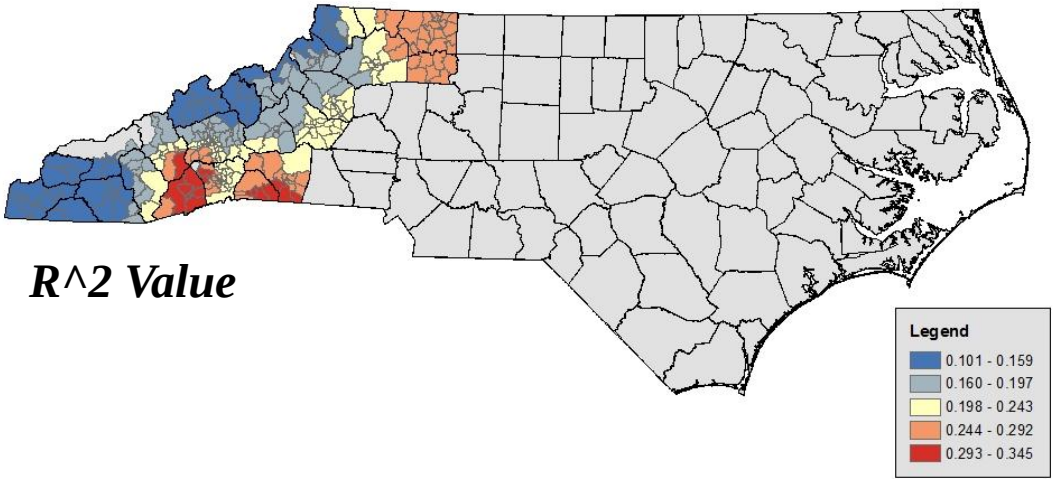


Mountains

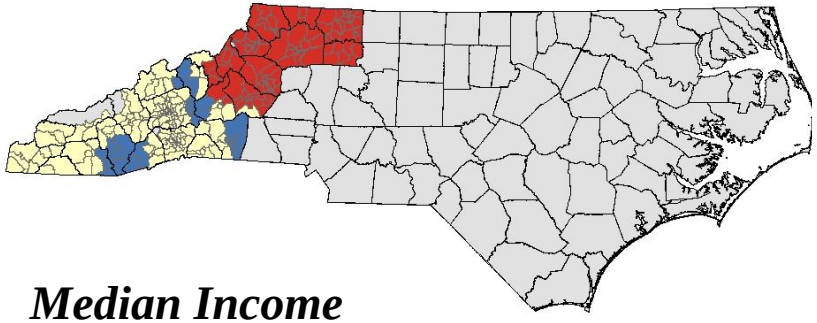


Black

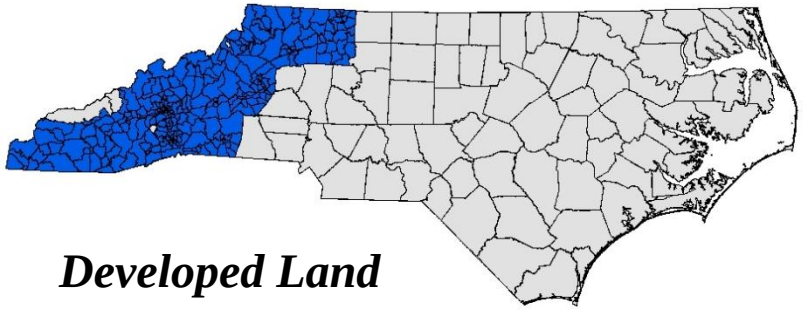
Geographically Weighted Regression



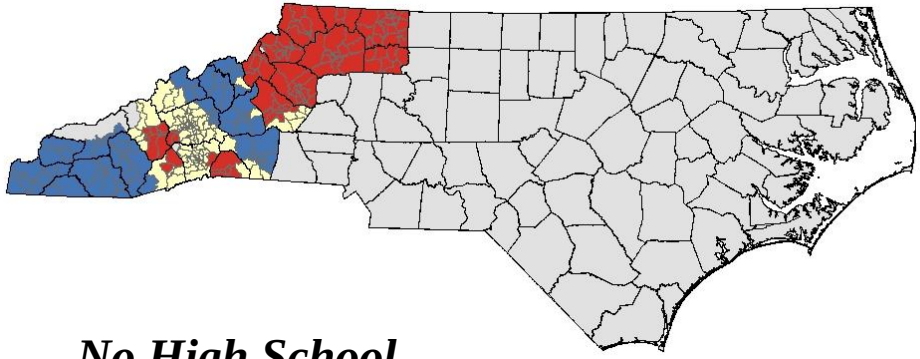
R^2 Value



Median Income



Developed Land



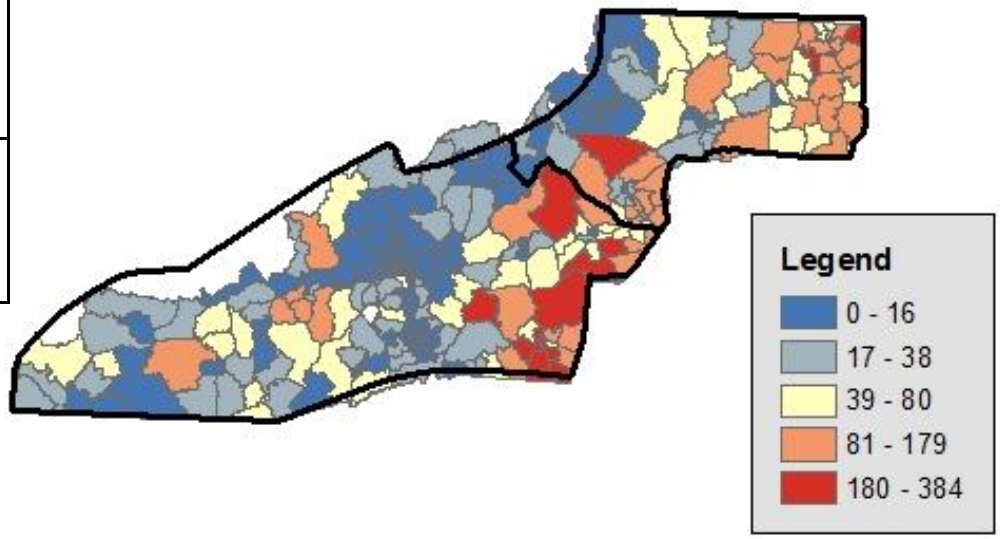
No High School

Mountains

Land Cover Analysis

Coastal Plain	Land Cover Type	R - Value
Southern	Forest Vegetation	0.4
	Soybean	0.25
	Corn	0.24
	Developed	-0.44
Northern	Forest Vegetation	0.62
	Watermelon	0.27
	Developed	-0.3

Per Capita HRI for Mountains



Rural vs. Urban

Stepwise Regression Results

Piedmont	Variables	R^2
Rural	(+)Mobile Home (+)Cropland (-) Developed (+) American Indian (+)Population 18 to 24	0.263
Urban	(-)Developed (+)Less than High School Education (+)Mobile Home (+)Black	0.191

Summary

- In North Carolina, heat related illness (HRI) is found predominately in rural areas. Since rural risk factors for heat have rarely been examined, these results highlight a need for additional study of rural population's vulnerability to heat.

- Mobile homes, a possible proxy for rural poverty, increase a community's risk for heat-related illness. Other indicators for poverty such as food stamps, income below $20,000 or home value below $10,000 have less influence on HRI.

- In the Coastal Plain, American Indians are a possible at-risk group. In the Northern Coastal Plain, agriculture is positively associated with HRI – particularly for cotton.

- In the Piedmont, no minority populations were associated with increased HRI. However, rural areas with high mobile home concentration were associated

- In the Mountains, particularly in the North blacks and residents with no high school are positively associated with HRI.

- ***Previously identified risk factors, such as cooling vegetation and an urban environment DO not apply to North Carolina residents. This research highlights how risk factors for other geographic regions cannot necessarily be applied to other regions to assess vulnerability.***

Summary

- In North Carolina, heat related illness (HRI) is found predominately in rural areas. Since rural risk factors for heat have rarely been examined, these results highlight a need for additional study of rural population's vulnerability to heat.

- Mobile homes, a possible proxy for rural poverty, increase a community's risk for heat-related illness. Other indicators for poverty such as food stamps, income below $20,000 or home value below $10,000 have less influence on HRI.

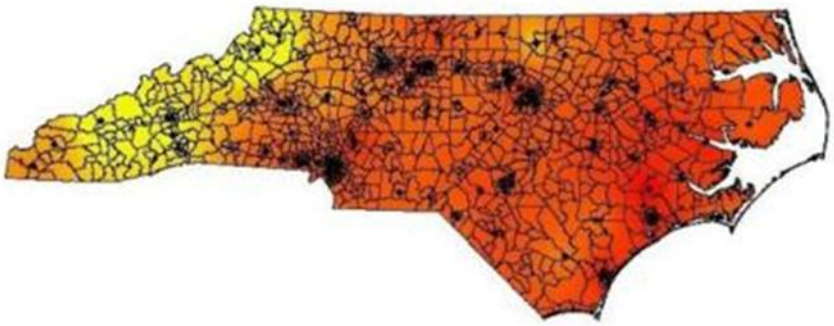
- Minorities such as American Indians are positively associated with HRI in rural counties of NC, particularly in the Northern and Southern Coastal Plain. Other Minorities such as Blacks are positively associated with HRI in urban counties and selected areas of the mountains.

- Cropland is postively associated with HRI, but crop type varies regionally. More analysis and data is needed to confirm any relationship.

- **Previously identified risk factors, such as cooling vegetation and an urban environment <u>DO not apply</u> to North Carolina residents. This research highlights how risk factors for other geographic regions cannot necessarily be applied to other regions to assess vulnerability.**

Future Directions

- Integrate weather data to explore climate thresholds.
- Incorporate into heat advisory, warnings
  - National Weather Service
  - Department of Public Health



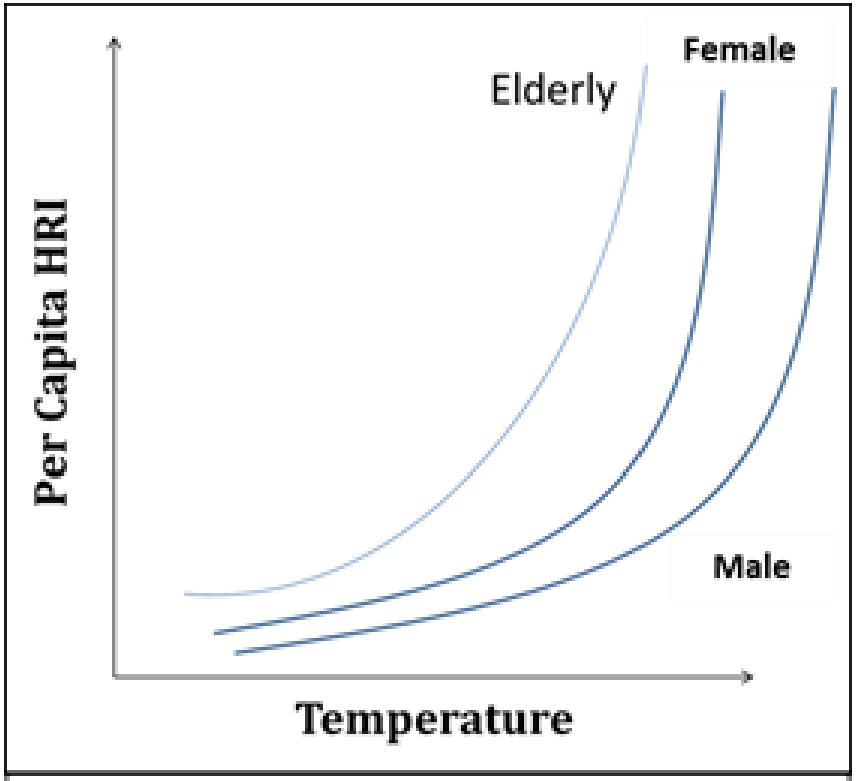


Figure 2: Conceptual example of a climate threshold for different genders and demographics; Thresholds shape and value change with different demographics, gender, spatial locations and time of year being examined.

Acknowledgements:

NC Division of Public Health
NC-DETECT
Southeast Regional Climate Center
Carolina Integrated Science & Assessments (CISA)

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