Vulnerability Index For Heat-Related Mortality in Georgia, U.S.

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Introduction

Heat is a natural hazard, and heat-related mortality is a matter of great public health concern. Exposure to extreme heat has been associated with both increased mortality and morbidity, especially for vulnerable populations. Particular population subgroups are at increased risk of heat-related mortality, including the elder people, people who live alone, people of lower income, people of lower socioeconomic status, people of races other than white, people with less education, people with poor hosing, people without access to cooling devices such as air conditioning, and people with pre-existing health conditions.

Objectives

(1) Summary statistics for maximum daily temperature, minimum daily temperature, and daily number of death in summer season (May-September) Georgia, during 1995-2004. (2) quantify and map vulnerability index on county level over the state of Georgia, and (3) determine if greater number of deaths occur on oppressive hot days than non-oppressive hot days, and investigate whether higher vulnerability index levels will see greater mortality increase than lower vulnerability index values.

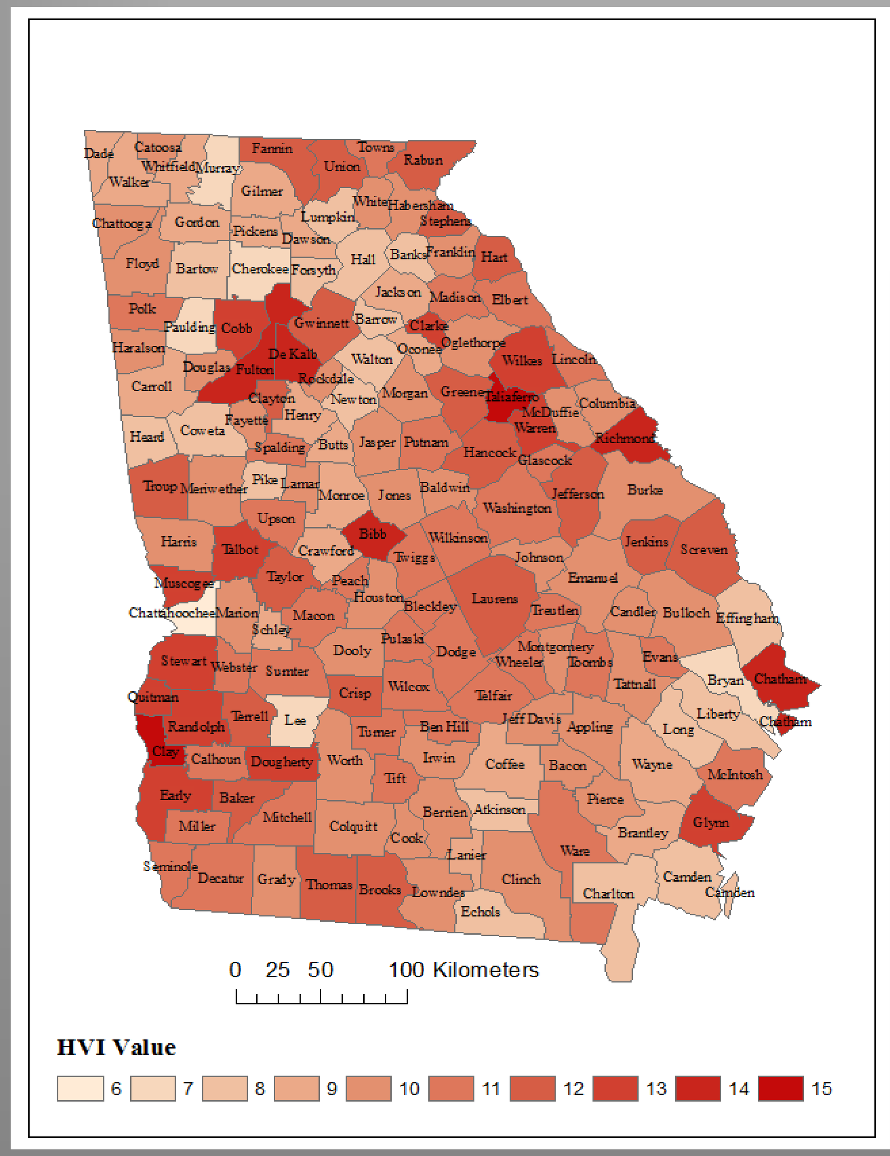
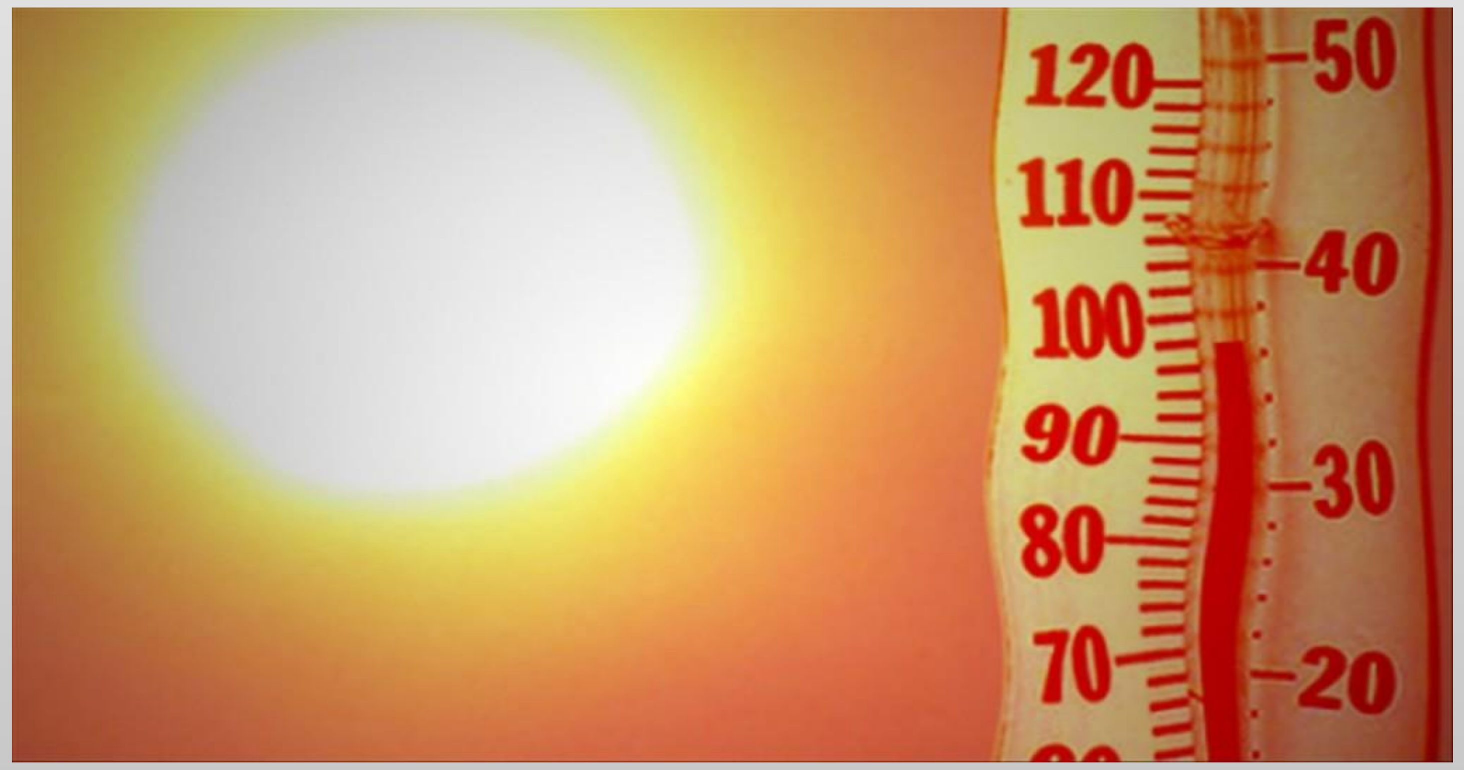


Figure 1. Vulnerability index by county in Georgia on a scale of 6 (low) to 15 (high).



Methods

Collect vulnerability, atmospheric, and mortality data. Quantify vulnerability index on county level for the entire state of Georgia. Summary statistics for maximum daily temperature, minimum daily temperature, and daily number of death in summer season (May-September) Georgia, during 1995–2004. Use multiple Poisson regression to model the effect of the vulnerability index on deaths during extreme heat days.

$$Y_{it} \sim \text{Poisson}\,(\mu_{it})$$

$$\ln(\mu_{it}) = \beta_{0i} + \beta_1 x_{it} + \beta_2 v_i + \beta_3 x_{it} \cdot v_i + ns\,(year, df)$$

Y_{it} denote the total number of deaths on day t in county i, and assuming that Y_{it} follows a Poisson distribution with mean μ_{it}. x_{it} is the indicator of oppressive days in i county on day t, v_i is the vulnerability index value, ns ($year$, df = 3) is a natural cubic spline function of year with $df=3$.

All the analysis were performed using R software (version 2.15.0)

Variables	Mean	Min.	Median	Max.	SD*
Max Daily Temperature (°F)	88.96	55.00	90.01	110.20	6.63
Min Daily Temperature (°F)	71.47	38.00	73.48	87.00	6.86
No. of Daily Death	1.01	0.00	0.00	43.00	2.53
Vulnerability Index	10.42	6.00	10.00	15.00	1.74

Table 1. Summary statistics for maximum daily temperature, minimum daily temperature, daily number of death, and value of vulnerability index in summer season (May-September) Georgia, during 1995–2004
* SD is the standard deviation from the mean

Results

Counties with higher vulnerability index levels had higher daily death numbers on oppressive heat days compared to counties with lower vulnerability index levels. Days that met or exceeded the 95th percentile threshold of summer maximum temperature showed greater increases in No. of daily death than days that did not reach this threshold for counties vulnerability index value more than 10. The interaction term of oppressive heat days and vulnerability index is statistically significant (p-value=0.004).

Discussion

There are several limitations of this project. First, we only use all-cause daily number of death with no stratifications for cause of death, since there are few deaths per day in small populations in many rural counties and very few deaths are directly attributed to heat. Second, we didn't acquire air conditioning data, this data are only available in major metropolitan regions from the American Housing Survey, this issue limit us to find the relationship between air conditioning and heat mortality. Third, air quality data has been excluded as a confounding factor in the relationship between heat and mortality, many rural areas lack data on air quality and therefore a comprehensive study could not be completed.

Conclusions

Counties that have higher vulnerability levels have greater daily death numbers increase for oppressive heat days versus non-oppressive heat days, counties that have lower vulnerability levels have similar daily number of death on oppressive heat days as non-oppressive heat days.

	Vulnerability index									
Heat indicator	6	7	8	9	10	11	12	13	14	15
Non-oppressive	1	1.11	1.23	1.37	1.52	1.69	1.88	2.09	2.32	2.57
Oppressive	0.97	1.09	1.22	1.37	1.54	1.73	1.95	2.19	2.46	2.77

Table 2. Relative risk from the statistic model for vulnerability index values and 95th percentile summertime maximum temperature