# URBAN HEAT WAVE HAZARD ASSESSMENT

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## Introduction

Heat waves are the largest cause of environment-related deaths globally. On average, over 6,000 people in the United States alone are hospitalized each summer due to excessive heat. Key elements leading to these disasters are elevated humidity and the urban heat island effect, which act together to increase apparent temperature and amplify the effects of a heat wave. Urban demographics and socioeconomic factors also play a role in determining individual risk. Currently, advisories of impending heat waves are often too generalized, with limited or no spatial variability over urban regions. This frequently contributes to a lack of specific response on behalf of the population. A goal of this project is to develop a product that has the potential to provide more specific heat wave guidance invoking greater awareness and action.

## Objectives

- Analyze climate data from past heat waves to develop temperature thresholds for heat wave hazard maps.
- Use thermal data from NASA satellites to derive high spatial resolution estimates of apparent temperature over selected urban regions.
- Identify and obtain relevant demographic data that can be used to identify "at risk" populations.
- Combine temperature data with demographic data to create a daily heat wave risk/hazard map.

## Historical Heat Waves

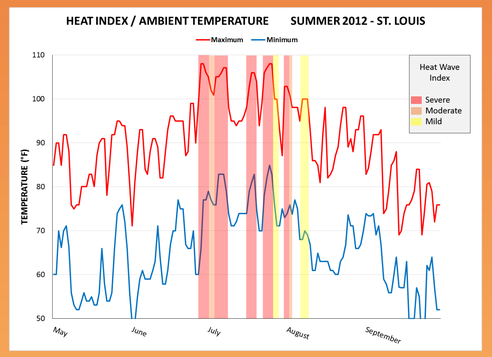


**Fig. 1:** The maximum and minimum ambient temperatures observed for St. Louis in the summer of 2012. The colored bars indicate the presence and severity of a heat wave.

Case studies of historical heat waves were used to develop "hot day" and heat wave criteria for the four selected cities. A "hot day" is defined as any day when the apparent temperature (a combination of ambient temperature and moisture) exceeds the 97th, 98th, or 99th percentile for high temperatures; it is considered a heat wave when two or more hot days occur consecutively. Over 20 years of summer temperature data from National Weather Service records was analyzed in order to determine these thresholds, which vary by city. The 97th, 98th, and 99th percentiles were used to identify mild, moderate, and severe heat waves (respectively) in past years, and can be useful for identifying and predicting future heat waves.

## Defining Parameters

Socioeconomic census tract data was collected and mapped in ArcGIS to help identify possible populations at risk. The figures below show the spatial variation of the three parameters selected for the initial map over Atlanta, GA. Each parameter was downscaled from the original Census tracts to 30 meters using the nearest neighbor technique. A weighted overlay combined the three parameters to determine the risk level on a 30 meter scale. Since the third parameter, age, is likely not as significant as the other two factors in determining overall risk, it was given a weight of 20% while the other two were both weighted 40%.

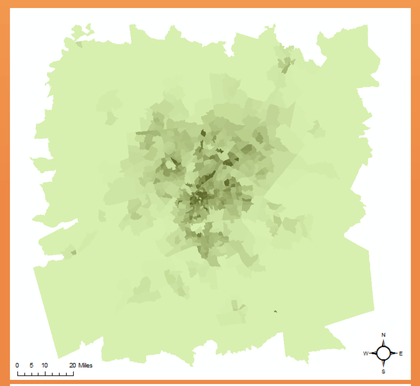


**Fig. 2:** Variation of population density in the city of Atlanta and the surrounding area. High population density correlates to higher urban development and potentially higher temperatures due to the urban heat island effect. The most darkly shaded regions have the highest density, making them most at risk.

Low density — High density

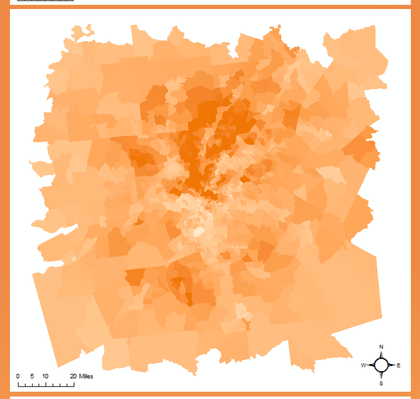


**Fig. 3:** Mean income (pictured left) is also an important factor in determining risk. Those most vulnerable to illness/death from a heat wave include the low-income/homeless, uninsured, elderly (or to a lesser extent, young children), and the disabled/chronically ill.

Low income — High income

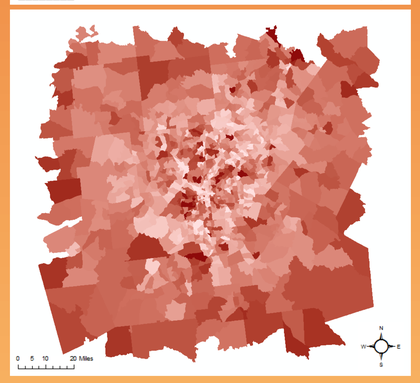


**Fig. 4:** The third parameter used was the percentage of the population (per Census tract) aged 65 and older. Though only three parameters were used initially, more can be added later to better specify at-risk areas.

Low percentage — High percentage

## Acknowledgements

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## Creating a Risk Map

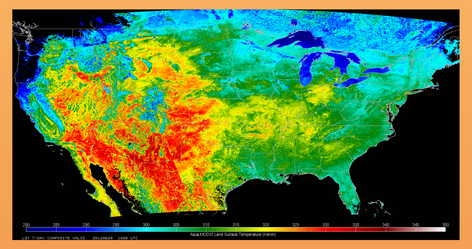

**Fig. 5:** Variation in land surface temperatures across the continental United States, as recorded by NASA's Aqua-MODIS satellite on June 29th, 2012.

Though risk varies over urban regions, there is ultimately no threat if there is no heat wave present. Land surface temperature data, mapped in ArcGIS at a 30 meter scale, identifies the hottest regions. The thresholds created from historical data can be used to identify heat waves.

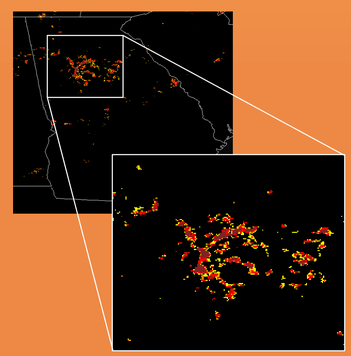

**Fig. 6:** LST data from Aqua-MODIS indicating whether a mild, moderate, or severe heat waves are occurring.

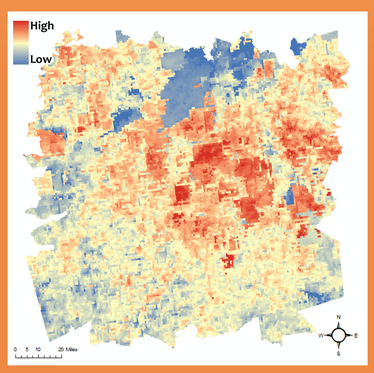


**Fig. 7:** Temperature variation over Atlanta, GA. As expected, the hottest temperatures occur over the most developed parts of the city.

## Conclusions/Future Work

- This risk map, overlaid with LST data, serves as a prototype tool for identifying high-risk areas at a high spatial resolution.
- Development of a real-time product will alter the map based on daily temperature fluctuations.
- Eventual use by public health officials and the general public will allow for better monitoring of public health risk in extreme heat events over urban regions.
- Refinement of this approach may lead to global applications.

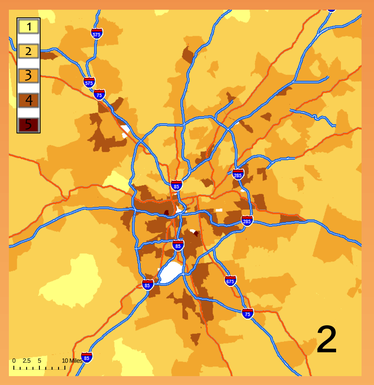


**Fig. 8:** The risk map of Atlanta combining the three demographic parameters, with major highways overlaid. 1 is least risk, 5 is most risk.