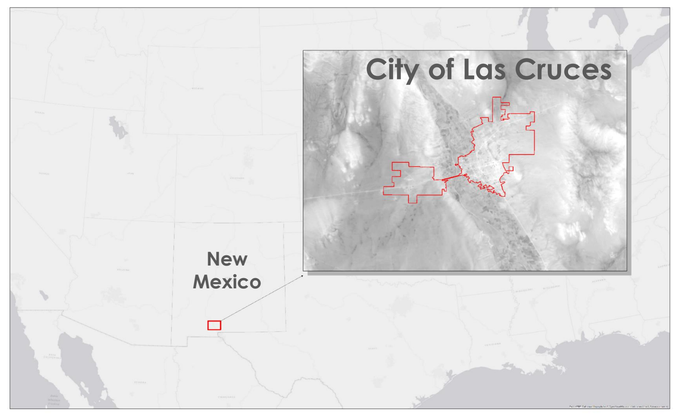
Assessing Urban Heat as it Relates to Social Vulnerability and Land Use Changes in Las Cruces, New Mexico

Abstract

Extreme heat during the summer months is a major public health issue in many cities worldwide. Local governments are increasing efforts to mitigate heat in cities through the implementation of infrastructure adaptations, including expansion of the urban tree canopy and white roofing, as well as revising design guidelines and principles for new construction. These strategies will be most beneficial for public health if they are deployed in places where risks of heat exposure are elevated as a result of higher temperatures and higher social vulnerability. Spatial variability in heat in the city arises because of the different ways in which the built environment impacts energy exchange between the surface and atmosphere. Social vulnerability is also unevenly distributed across urban areas and previous research demonstrates that socially disadvantaged populations often live in the hottest parts of the city. In this project, we used Landsat and Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) data to construct a time series of Las Cruces' urban heat patterns and assess the influence that urban morphology has on those patterns. Extreme heat vulnerability indicators were developed utilizing census and health records and aerial imagery from the National Agriculture Imagery Program (NAIP). These heat vulnerability indicators describe the sensitivity of the population to extreme heat and identify where vulnerable populations reside. The Las Cruces Sustainability Office will use the heat vulnerability indicators, urban heat island assessment, and urban heat island morphology comparison to improve the city's resilience and mitigation efforts.

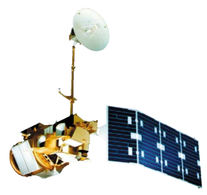
Study Area



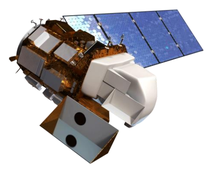
Objectives

- **Define** the urban heat island in Las Cruces
- **Assess** patterns of social vulnerability and land cover
- **Compare** land cover, social vulnerability, and land surface temperature
- **Locate** areas of concern
- **Inform** heat mitigation strategies

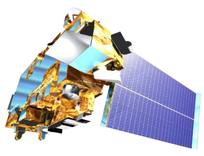
Earth Observations



Landsat 5



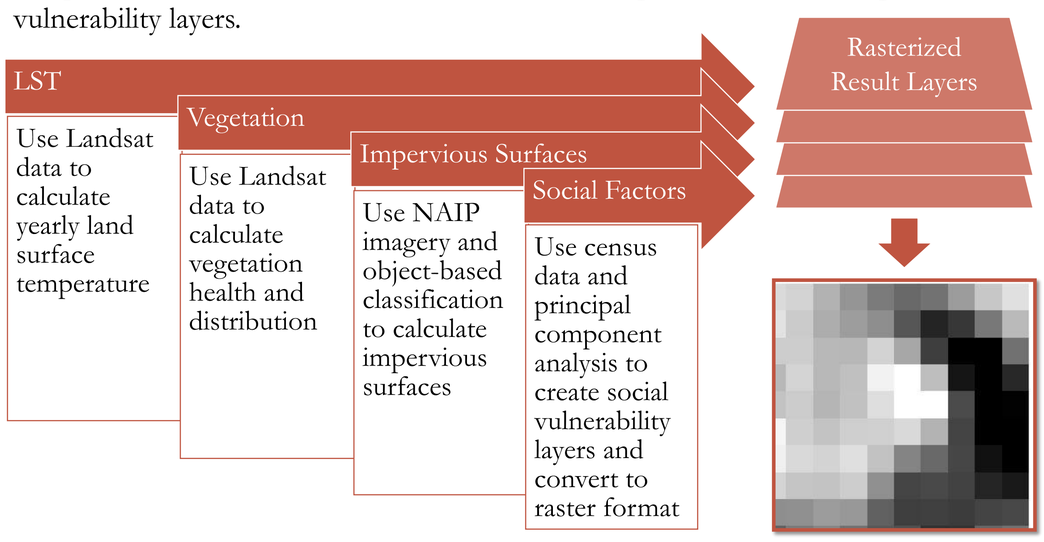
Landsat 8



Terra ASTER

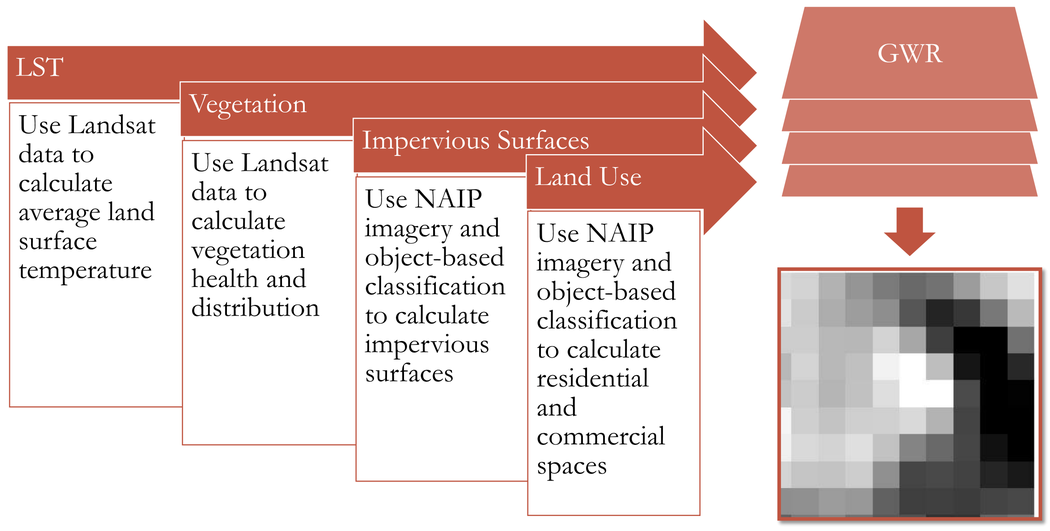
Methodology

Social factors were grouped into 5 categories, Household Composition, Economic Stability, Minority Status, Housing & Transportation, and Health. Vulnerability categories were combined with LST, NDVI, and Impervious Surface to produce heat vulnerability layers.



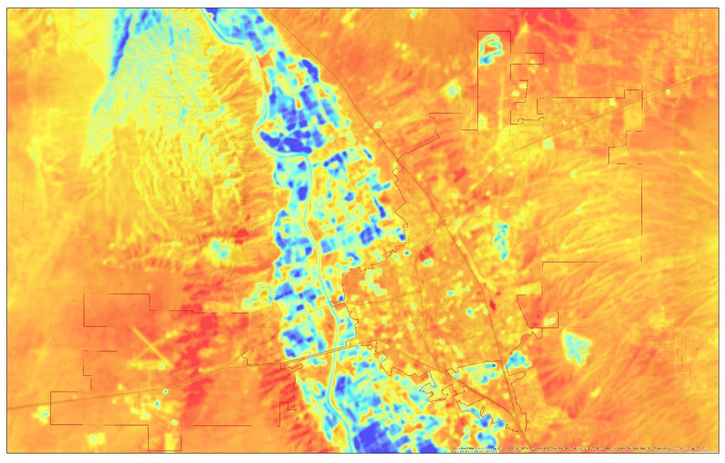
Heat Vulnerability Layer

Geographically weighted regression was used to relate NDVI, density of impervious surfaces, and density of residential and commercial space to LST for the year of 2016.

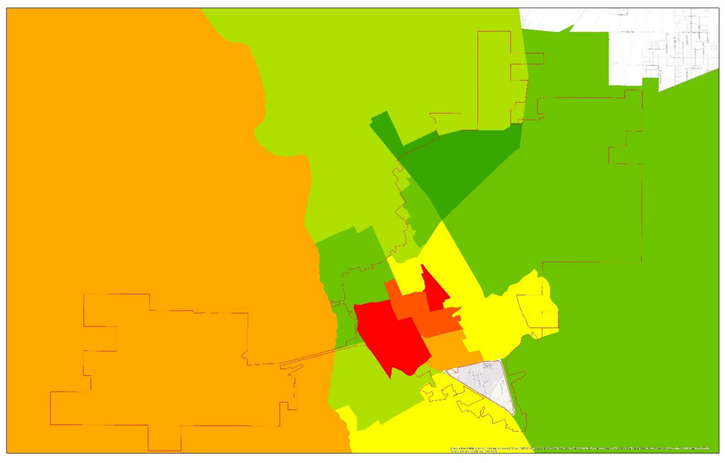


Geographically Weighted Regression

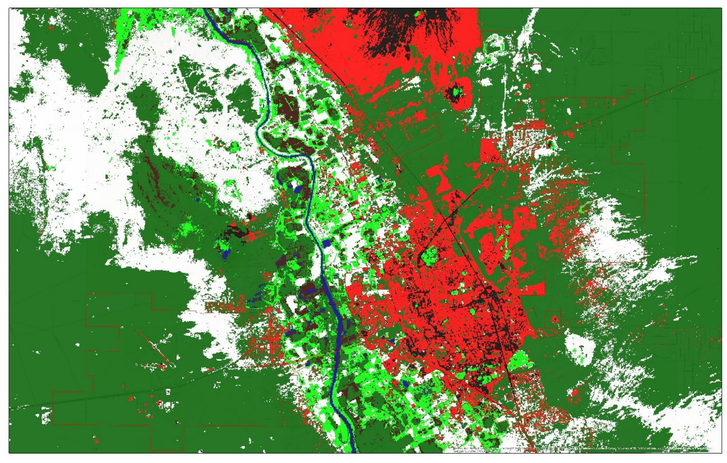
Results



Yearly land surface temperature was estimated from 1999 to 2016.



Social vulnerability index: darker regions indicated areas of higher social vulnerability and lighter tones indicate areas of lower social vulnerability.



Land cover land use classification was performed to discern impervious areas from vegetated areas.

Conclusions

- Areas with more impervious surfaces, fewer trees, and less vegetation experienced higher land surface temperature.
- Vulnerability analysis revealed that the central and southwest regions of the historical "Infill District" have the highest levels of social vulnerability.

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