**NASA DEVELOP National Program**

****Maricopa County Department of Public Health and Arizona State University

*Summer 2017*

**Short Title: Las Cruces Health & Air Quality**

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

**VPS Title:** Taking the Heat Off - Guiding Urban Heat Mitigation in the New Mexican Desert

**Project Team**

**Project Team:**

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**Advisors & Mentors:**

Dr. David Hondula (Arizona State University)

**Past or Other Contributors:**

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**Project Overview**

**80-100 Word Objectives Overview:**

This project will use satellite data to define the morphology of the urban heat island in Las Cruces, assess patterns of social vulnerability and land use within the city, and compare land use and social vulnerability to the urban heat profile in an effort to locate intersections of social vulnerability and extreme heat. The resulting data will be presented to our partners in the form of processed data, maps, and time series, and used to inform heat mitigation strategies and green infrastructure implementation.

**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 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.

**Keywords:**

Urban Heat Island (UHI), Landsat, Land Surface Temperature (LST), Las Cruces

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| City of Las Cruces, Sustainability Office | Lisa LaRocque, Sustainability Officer | End User | No |
| Climate Assessment for the Southwest (CLIMAS) | Dr. Gregg Garfin, Associate Professor  Sarah Leroy, Research Staff | Collaborator | No |
| Arizona State University, Urban Climate Research Center | Dr. David Sailor, UCRC Director | Collaborator | No |

**Community Concerns:**

* Climate scenarios indicate that Las Cruces, like many other places around the country, will experience increasingly high temperatures during the summer months (2014 National Climate Assessment).
* There are several areas in Las Cruces with concentrations (greater than 40%) of poverty in which residents are living in buildings over 30 years of age. These homes often lack the resources to keep up with basic safety improvements such as insulation, water heating systems, and thermal windows.
* Additionally, shade canopy is limited to 4.5% of the city and many low-income neighborhoods have minimal green landscaping for shade.

**Current Decision-Making Practices & Policies**:

The City of Las Cruces is committed to developing a resiliency strategy, which requires an understanding of the impact of the urban heat island on its population. The city has several ongoing initiatives aimed to reduce the impact of extreme heat and the urban heat island. First, the design and implementation of green infrastructure in low-income communities most impacted by the urban heat island. Second, the development and installation of rain-water harvesting systems to collect water that can be used to irrigate green infrastructure. Finally, the city has plans for a Participatory Mapping Project in low and moderate income neighborhoods, in which residents will gather narratives and pictures describing problem areas they want addressed. Currently, the Sustainability Office does not directly use NASA Earth observations. They have partnered with different governmental and academic institutions (e.g. University of Texas at El Paso) to incorporate remote sensing in their decision making.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software**  **Release** |
| Las Cruces Social Vulnerability Index | N/A | This index will help the partners understand which parts of the city experience greater vulnerability as a result of the prevalence of certain socioeconomic conditions. Our end users will use this analysis to better target adaptation and mitigation efforts to reduce vulnerability to extreme heat. | I |
| Surface Urban Heat Island Assessment | Landsat 8  Landsat 5 | This product will be a time series of the Las Cruces Surface Urban Heat Island. Partners will use this to better understand how the City of Las Cruces’ urban heat island has changed over time and better target adaptation and mitigation efforts in areas with higher temperatures so that they can improve the city’s resiliency strategy. | I |
| Urban Heat Island Urban Morphology Comparison | Landsat 8  Landsat 5 | This product will relate changes to Las Cruses’ urban heat island with changes in land use land cover and zoning in Las Cruces. The goal is to understand how changes to the development and changes to the urban landscape has influenced the urban heat island. From here the city will be able to better direct development to reduce the overall intensity of the urban heat island effect. | I |
| Las Cruces Urban Heat Island and Vulnerability Web Map | N/A | Utilizing ArcGIS Online supported by ASU, the team created a web map that contains end products created during the term. This will serve as the interface between the partners and the results. Additionally, it will allow our partners to use our products outside of the term with minimal technical requirements. This product can also be tied into current initiatives like the Participatory Mapping Project. | N/A |

**Project Benefit to End User**:

The proposed end products will help advance our partners current efforts to curtail heat related health impacts and prepare for future impacts of extreme heat. An updated map of the Las Cruces urban heat island along with a customized heat vulnerability index will allow our partners to better identify where vulnerable communities reside and examine how different land uses and characteristics influence the urban heat island. This will enable our end users to justify decisions with long-term implications for regional climate (e.g., codes, zoning, and infrastructure) as well as identify target areas for immediate intervention activities such as cooling centers and water distribution sites. The scientific literature indicates that vulnerability mapping often leads to institutional learning and perspective-shaping. We anticipate that city staff may also identify new opportunities for intervention through the course of this project as well as new community partners to include in efforts to address heat and its impacts.

**Project Details**

**Applied Sciences National Application Addressed:** Health & Air Quality

**Study Area:** Las Cruces, NM

**Study Period:** 2009 –2016 (May – September)

**Earth Observations & Parameters:**

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| Landsat 8 TIRS | Land Surface Temperature | This will be incorporated in the heat vulnerability assessment. Land surface temperature will be used to estimate the extent and magnitude and temporal changes of the surface urban heat island in Las Cruces. Land surface temperature will also inform the heat vulnerability assessment. |
| Landsat 8 OLI | NDVI | NDVI will be used to assess vegetation prevalence throughout Las Cruces. Bands 3 and 4 of the Landsat 8 OLI can be used to calculate NDVI throughout the duration of our study period. |
| Landsat 5 TM | Land Surface Temperature | Land surface temperature will be used to estimate the extent and magnitude and temporal changes of the surface urban heat island in Las Cruces. Land surface temperature will also inform the heat vulnerability assessment. |

**Ancillary Datasets Utilized:**

* Socioeconomic Data and Applications Center (SEDAC) – Global Urban Heat Island Dataset
* Socioeconomic Data and Applications Center (SEDAC) – SEDAC Gridded Population of the World (GPW)
* CDC Behavioral Risk Factors, 206 Census Tracts, 4 NM Cities, 2013-2014 – health data
* US Census American Community Survey – socioeconomic data
* National Agriculture Imagery Program (NAIP) – calculating NDVI and land cover

**Software Utilized:**

* R – processing Landsat 5 and Landsat 8 data, statistical processing for Las Cruces Social Vulnerability Index
* Esri ArcGIS – map creation
* Python – ASTER, Landsat 5, and Landsat 8 data processing

**Project Handoff Package**

**Transition Plan:**

The team will meet with the partners on August 7th, 2017 at the University of Arizona in Tucson. The meeting will consist of a team presentation of the project and results, a follow up discussion with partners and attendees, and a final handoff of materials. During the follow up discussion, partners will have a chance to address any last minute questions or issues about the project, results, or usage of the material. The partners will maintain a point of contact to which they can direct any questions or comments after handoff is complete.

**Team POC:** Jonathan O’Brien, jmobrie@g.clemson.edu

**Handoff Package:**

* Las Cruces Surface Urban Heat Island Assessment
* Urban Heat Island Urban Morphology Comparison
* Las Cruces Social Vulnerability Index
* Las Cruces Vegetation and Tree Canopy Cover maps
* Any processed data associated with the maps
* Project Video
* Technical Paper
* Project Poster
* Project Presentation