**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

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

**Las Cruces Health & Air Quality**

*Utilizing NASA Earth Observations to Estimate Urban Heat Island Intensity and Vulnerability to Extreme Heat in Las Cruces, NM*

**Project Overview**

***Project Synopsis*:** The team will work alongside our partners at the Las Cruses Office of Sustainability, Arizona State University, and the Climate Assessment of the Southwest (CLIMAS) to estimate the magnitude, extent, and impacts of the urban heat island in Las Cruces, New Mexico. The team will utilize Landsat 8 Operational Land Imager (OLI), Landsat 5 Thematic Mapper (TM), and Terra Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) to assess changes to the urban heat island in Las Cruces. The project will also provide a customized heat vulnerability index for Las Cruces generated from socioeconomic and demographic data. The third objective is to explore how the urban heat island has changed with the development of Las Cruces. These three objectives will help our end users better layout and target appropriate adaptation and mitigation efforts to reduce the impact of the urban heat island on Las Cruces residents.

***Community Concern:*** 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. A substantial portion of single family and rental homes are over 30 years old. These homes often lack the resources to keep up with basic safety improvements such as insulation, water heating systems, and thermal windows. With expected increase in temperature, could leave residents unable to guard themselves against the effects of extreme heat. Additionally, shade canopy is limited to 4.5% of the city and many low-income neighborhoods have minimal green landscaping. Las Cruces is now taking a proactive approach to build adaptation capacity for extreme heat events in the city and mitigate thermal extremes in high-risk neighborhoods.

***Source of Project Idea:*** Las Cruces is one of three cities participating in the National Integrated Heat Health Information System (NIHHIS), coordinated by NOAA in partnership with the Centers for Disease Control and regional universities. Through the NIHHIS network Lisa LaRocque (City of Las Cruces Sustainability Officer), Dr. David Hondula, city staff, and community leaders identified major challenges and research needs of the City of Las Cruces to address the urban heat island. The inception of this DEVELOP project came from that discussion.

***National Application Area Addressed:*** Health & Air Quality

***Study Location:*** Las Cruces, NM

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

***Advisor:*** Dr. David Hondula (Arizona State University)

**Partner Overview**

***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 | Collaborator | No |
| Arizona State University, Urban Climate Research Center | Dr. David Sailor, UCRC Director | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision-Making Process:***

The City of Las Cruces is committed to developing a resiliency strategy, which requires an understanding 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 (e.g. CLIMAS) and academic institutions (e.g. University of Texas at El Paso) to incorporate remote sensing in their decision making.

***End-User’s Capacity to Use NASA Earth Observations:***

*City of Las Cruces, Sustainability Office* – Working through organizations like CLIMAS the Las Cruces Sustainability Office has incorporated NASA Earth observations into their efforts to increase its climate resiliency. However, the office is not properly staffed to work directly with NASA Earth observations and is largely reliant on such collaborations.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Climate Assessment for the Southwest (CLIMAS) –* Dr. Gregg Garfin is an associate professor in Climate, Natural Resources and Policy at the University of Arizona. He also leads the CLIMAS National Integrated Heat Health Information System (NIHHIS) effort for the El Paso region. The NIHHIS aims to understand the problem of extreme heat, its disproportionate impacts, and develop science-based services to reduce heat related morbidity and mortality. Dr. Garfin and his associates with CLIMAS will be providing scientific expertise to the team.

*Arizona State University, Urban Climate Research Center* – Dr. David Sailor is the director of the new Urban Climate Research Center (UCRC) at Arizona State University (ASU), which will serve as the physical and intellectual hub at ASU for ongoing and future projects related to urban heat and heat mitigation. Collaboration with the UCRC provides the DEVELOP node at ASU additional scientific expertise in urban heat island research and expands networking opportunities for participants.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will meet with the project partners every two weeks via teleconference. The team lead will be the main point of contact. The objective of these meetings is to keep partners updated on our progress and incorporate their expertise and needs into the final products.

***Transition Plan*:** The project results will be transferred to our partners at the end of the term via email. We are planning a closeout that will either be in person (preferred) or virtual to engage our partners in discussion about the results of the project.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI 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. |
| **National Agriculture Imagery Program (NAIP)** | NDVI | NDVI will be used to assess vegetation prevalence throughout Las Cruces. NAIP imagery provides a 1 m spatial resolution which will be helpful for detecting vegetation in neighborhoods of Las Cruces with very little vegetation.  |
| **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. |
| **Terra ASTER** | 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:***

Socioeconomic Data and Applications Center (SEDAC) – Global Urban Heat Island (UHI) Data Set – The team will use compare their Landsat and ASTER based UHI assessment with this dataset.

Socioeconomic Data and Applications Center (SEDAC) – SEDAC Gridded Population of the World (GPW) – The team will use the GPW products to address concerns of population density.

US Census – American Community Survey (2010) – The team will use these data to develop a city-specific heat vulnerability index based on demographic and socioeconomic indicators.

US Geological Survey – National Land Cover Database (2011 NLCD) – This dataset identifies different land cover and land use classes in the US.

***Software & Scripting:***

R – processing Landsat 5/8 data, statistical processing for Las Cruces Social Vulnerability Index

Esri ArcGIS – map creation

Python – ASTER and Landsat 8 data processing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Las Cruces Social Vulnerability Index (Las Cruces SoVI)** | This Index will help the partners understand which parts of the city experience great vulnerability as a result of the prevalence of certain socioeconomic conditions. Key socioeconomic indicators will be identified through a combination of literature review and communication with the end partners. Our end users will use this analysis to better target adaptation and mitigation efforts to reduce vulnerability to extreme heat.  | A principal component analysis approach outlined by Cutter et al. (2006) will be used to create the Social Vulnerability Index. This product will be produced with Census and American Survey data. | I |
| **Surface Urban Heat Island Assessment** | This product will be a time series of the Las Cruses Surface Urban Heat Island. Partners will use this to better understand how their 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.  | ASTER LST and Landsat based LST data will be used to estimate the extent and magnitude of the Las Cruces Urban Heat Island from 2006 to 2017. | I |
| **Urban Heat Island Urban Morphology Comparison** | This product will relate changes to Las Cruses’ urban heat island with changes in land use land cover and configuration of buildings 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 as to reduce the overall intensity of the urban heat island. | ASTER LST, Land Use Land Cover, and other landscape metrics will be incorporated in an analysis to determine how the Urban Heat Island has changed with changes in urban landscape. | I |
| **Las Cruces Urban Heat Island and Vulnerability Web Map** | Utilizing ArcGIS Online supported by ASU, the team will create a web map will contain 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. | This product will contain the Urban Heat Island Urban Morphology Comparison, Las Cruces Social Vulnerability Index, and Las Cruces Urban Heat Island Assessment and allow users to overlay these two products (along with additional ancillary data sets) to prioritize new projects and initiatives in the city. | N/A |

***End-User Benefit*:**

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 vulnerable communities 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, infrastructure) as well as identify target areas for immediate intervention activities. 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 Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2017 Summer

***Related DEVELOP Work:***

2017 Spring (Maricopa County Department of Public Health & Arizona State University) – Phoenix Health & Air Quality: Utilizing NASA Earth Observations to Assess the Impact of Extreme Heat on Transit Riders in Phoenix, Arizona

2016 Spring (Langley Research Center) – Arizona Health & Air Quality: Enhancing Extreme Heat Intervention and Preparedness Activities in Maricopa County, Arizona with NASA Earth Observations

2015 Fall (International Research Institute for Climate and Society) – New Jersey Health & Air Quality: Modeling Near Surface Air Temperature Profile of Complex Urban Systems Based on Land Surface Properties and Correlating On-Site and Satellite Data to Better Understand Temperature Profiles in Urban Microclimates

**Notes & References:**

***References:***

<http://www.las-cruces.org/sustainabilityoffice>

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