**NASA DEVELOP National Program**

****NASA Langley Research Center

**Spring 2016**

**Short Title: Arizona Health and Air Quality II**

**Subtitle:** Enhancing Extreme Heat Intervention and Preparedness Activities in Maricopa County, Arizona with NASA Earth Observations

**VPS Title:** Phoenix Rising: Urban Heat Island in Maricopa County

**Project Team & Partners**

**Project Team:**

Daniel Finnell (Project Lead), Daniel.r.finnell@nasa.gov

Teresa Fenn

Richard Muench

Ashley Brodie

Derrick Hunter

**Advisors & Mentors:**

Kate Goodin (Maricopa County Department of Public Health)

Dr. Kenton Ross (NASA Develop National Program)

Dr. Dave Hondula (Arizona State University)

Lance Watkins (Arizona State University)

**Past or Other Contributors:**

Amy Stuyvesant (Team Lead)

Geordi Alm

Rocky Garcia

Emma Baghel

April Rascon

Bernardo Garcia

**Partner Organizations:**

Arizona Department of Health Services (ADHS) (End-user), POC: Matthew Roach; Boundary Organization

Phoenix Heat Relief Network (End-user), POC: Celina Brun

National Weather Service Phoenix Forecast Office (End-user), POC: Paul Iniguez

Environmental Remote Sensing and Informatics Lab (ERSL) at Arizona State University (Collaborator), POC: Billie L. Turner II

Center for Policy Informatics (CPI) at Arizona State University (Collaborator), POC: Erik W. Johnston

**Project Details**

**Applied Sciences National Applications Addressed:** Health & Air Quality, Disasters, Climate

**Study Area:** Maricopa County, AZ

**Study Period:** April 2006 - October 2015

**Earth Observations & Parameters:**

Aqua – MODIS will be used to determine land surface temperatures and a climatology for the region. This climatology will allow the team to identify areas of extreme heat and urban heat islands.

Terra – ASTER DEM data will be added to visualize the spatial variation in heat with elevation.

Landsat 7 - ETM+ will be used as a higher spatial resolution alternative to land surface temperature

Landsat 8 - OLI will be used as a higher spatial resolution alternative to land surface temperature

Suomi NPP - VIIRS will be used as a proxy for population through the use of the Day/Night Band reflectance.

**Ancillary Datasets Utilized:**

* Arizona Meteorological Network (AZMet) - ground-based meteorological observations
* Weather Underground - ground-based meteorological observations
* Maricopa County Health Department - locations of Heat Relief Network cooling centers
* ASU-GIS - census tract shapefiles
* US Census/TIGER - census tract shapefiles
* ASU Urban Vulnerability to Cliimate Change project - Maricopa County heat vulnerability maps
* Maricopa County Department of Health (MCDPH) - maps of spatial variability in heat health outcomes
* MCDPH, ASU, and ADHS - responses from 2014 cooling center evaluation
* MCDPH - community public health evaluation (CASPER) survey responses
* NOAA NCEI - teleconnection indices
* USGS National Land Cover Dataset - impervious surface estimates

**Software Utilized:**

ArcGIS - Raster manipulation/analysis, image enhancement & map creation of Landsat 7 ETM+, Landsat 8 OLI, spatial statistics, Aqua MODIS, Terra MODIS/ASTER

Qualtrics - Survey and interview development and response recording

R - Statistical analysis of teleconnection indices and heat wave magnitudes and duration

Python 2.7 - Programming language to build the tool

Google Earth Engine - Web based Geospatial research tool

**Project Overview**

**80-100 Word Objectives Overview:**

To automate the creation of heat vulnerability maps of Maricopa Co., Arizona, and to create a tool that the end-users can use to monitor heat severity. Potentially develop a case study with the Atmospheric Science Data center (ASDC) using OpENDAP data collection methods to allow for near real-time processing of MODIS imagery. These products will be used to manage response to extreme heat events.

**Abstract:**

Extreme heat causes and exacerbates a number of health problems,especially for the elderly, leading to hospitalization and death in severe cases. The problem of severe heat is especially felt in Maricopa County, Arizona. Maricopa County contains the city of Phoenix, where an urban heat island (UHI) effect has elevated temperatures, particularly at night. Without nightly relief from the high temperatures, the citizens of Maricopa County are at risk of developing heat related illnesses and heat related mortality is on the rise. Several organizations, including the Arizona department of Health Services and the Phoenix Heat Relief Network, are working to create more effectively placed cooling centers and heat warning systems to aid those with the highest risk of exposure. This project created a tool using ArcGIS Online whichcreated heat maps of Maricopa County in near real-time to aid the partners in providing spatially distributed relief during extreme heat events.

**Community Concerns:**

* Extreme heat is a chronic health hazard in central Arizona
* The aging population of Maricopa County is more susceptible to heat-related health risks
* Maricopa County experiences an Urban Heat Island Effect
* From 2006 to 2013 there were 632 confirmed heat related deaths in Maricopa County

**Current Management Practices & Policies**:

The National Weather Service issues heat warning products to the service region based on meteorological observations at Phoenix Sky Harbor airport and forecaster opinion on the conditions that are dangerous for human health. There is one message for the entire region, which typically covers multiple Arizona counties, and there are no remotely sensed data used to customize the warnings based on spatial variability. The Phoenix Heat Relief Network places their heat relief centers based on the location of existing resources (e.g., food banks) and willing participants without explicit consideration of spatial risk patterns.

**Decision Support Tools & Benefits:**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Teleconnection Indices Correlation Maps | Aqua MODIS, Terra ASTER, Landsat 7 ETM+, Landsat 8 OLI | Allows for seasonal heat preparedness. Improve research on drivers of local temperature change. |
| Revised Heat Vulnerability Map | Aqua MODIS, Terra ASTER, Landsat 7 ETM+, Landsat 8 OLI, Suomi NPP VIIRS | Improve end-user ability to identify vulnerable communities. |
| Extreme Heat Vulnerability Tool | Aqua MODIS, Terra ASTER, Landsat 7 ETM+, Landsat 8 OLI, Suomi NPP VIIRS | Allows end-users to monitor land surface temperature and identify vulnerable neighborhoods in near-real time. |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements**

Category III

*If your decision support tools fall within Category IV, fill out this section:*

**Software Title:** Insert here (ex. DEVELOP National Program Python Package)

**Software Abbreviation:** Insert here (ex. dnppy)

**Technical Point of Contact:** Insert full name, permanent email, and node here. Also include whether employed through SSAI or Wise County. (Team member who knows the most about the software.)

**Brief Description of the Software:** Insert here (ex. The dnppy package will be used to functionalize common programming tasks in the geospatial community, specifically for working with NASA data products. It will include functions for processing satellite data and assist in structuring analysis to reduce the startup time for DEVELOP teams to learn programming and create tools for end users.)

**Type of Code:** *Executable Code* and/or *Source Code* (Select one or both)

**Will the software include any embedded computer databases?** *Yes* or *No* (Select one)

**Does the software use or call any open software or libraries?** *Open Source* and/or *Proprietary/Commercial* (Select one or both)

**List the software or libraries used, under what license they were obtained, and the URL for the license in the table below:**

|  |  |  |
| --- | --- | --- |
| **Name** | **License** | **License URL** |
| Ex. Arcpy module | Ex. group license through ArcGIS | http://www.esri.com/software/arcgis |
| Ex. Python | Ex. Open source license | http://opensource.org/licenses/Python-2.0 |
|  |  |  |

**Full Software Description and Plan**

**Introduction/Objective:**

What motivated the creation of this software, what problem does it address?

**Applications and Scope:**

Where and how will this software be used to influence decisions?

**Capabilities:**

What can it do better than what was previously available?

**Interfaces:**

How is one expected to use the software? For example, command line, GUI, script execution, etc.

**Assumptions, limitations, & Errors:**

What areas that the software could be improved upon in the future? This is where limitations of the theory, model, science, etc should be briefly documented. If the tools only work for a specific scenario, say so.

**Testing:**

What validation techniques and testing strategy will be used to build confidence in the software?