**NASA DEVELOP National Program**

**2017 Spring Project Proposal**

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

**Phoenix Health & Air Quality**

*Utilizing NASA EOs to assess the impact of extreme heat on transit riders in Phoenix, Arizona*

**Project Overview**

***Project Synopsis*:** This project aims to utilize NASA’s MODIS, ASTER, Landsat, and VIIRS to characterize the thermal environment of the thousands of bus stops that support the Valley Metro transit network in greater metropolitan Phoenix, Arizona. Working alongside partners at Phoenix Transit Department, Maricopa County Department of Public Health, and Arizona State University’s Center of Policy informatics the team will combine NASA EOs with transportation and socioeconomic data to help quantify the impact of thermal conditions and bus stop amenities on transit riders. This analysis will also help the city prioritize the installation of shade structures at currently unshaded stops over the next five years and identify other opportunities to improve stop amenities and shading features to reduce the health impact of extreme heat on riders.

***Community Concern:*** Over the next five years the City of Phoenix is investing $1,000,000 in the installation of shade structures at public bus stops to reduce heat exposure and thermal discomfort among transit riders. Thermal comfort at bus stops is a concern for community members who use the transit system; 2016 survey data indicate that a high percentage of riders report being too hot at bus stops during the summer. Thermal comfort is also a concern for the long-term sustainability of the transit network, as sufficiently hot conditions deter ridership in the absence of adequate cooling resources. NASA EO-based estimates of land surface temperature, impervious surface cover, and vegetation will characterize the thermal environment of bus stops. An understanding of the thermal environment will be incorporated into current prioritization criteria to provide a more comprehensive assessment of the need for bus stops improvements and shading.

***Source of Project Idea:*** ASU’s Center for Policy Informatics has been supporting the T2050 transportation initiative in Phoenix for the past 24 months. After the T2050 bill was passed, CPI researcher John Harlow facilitated an introductory meeting between transit staff and the AZ node science advisor (David Hondula) in 2015, from which the idea of a project evaluating the impact of shade structures emerged. Subsequent conversations motivated a site-specific categorization of the thermal environment at bus stops using in situ and remotely sensed data.

***National Application Area(s) Addressed:*** Health & Air Quality

***Study Location:*** Phoenix Metropolitan Area, AZ

***Study Period:*** May - October2015 – 2016

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

**Partner Overview**

***Partner Organization(s):***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Phoenix Transit Department | Bernard Venegas, Engineer | End-User | No |
| ASU Center for Policy Informatics | Dr. Erik Johnston, CPI Director and Associate Professor | Collaborator | No |
| Maricopa County Department of Public Health | Kate Goodin, Epidemiology and Data Services Program Manager | Collaborator | No |
| Vitalyst Health Foundation | CJ Hager, Director of Healthy Community Policies for Vitalyst Health Foundation.  | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision-Making Process:***The current prioritization criteria for selecting bus stops for shade structure implementation is the daily count of riders—stops that have more riders are to receive new structures ahead of stops with fewer riders. While this is a logical and suitable metric, it may not most accurately reflect ridership needs related to mitigating heat exposure. The transit department is interested in alternative metrics by which stops could be prioritized, and very interested in any quantitative information regarding the impact of shade structure deployment at bus stops. Bus stop shade structure deployment is supported by the T2050 transit tax passed in Phoenix in 2015.

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

*Phoenix Transit Department* – Phoenix Transit Department staff most closely related to shade structure deployment have not used NASA EOs previously. The department maintains multiple full-time GIS personnel with adequate computational resources and thus may be able to integrate EOs into future decision-making and reporting.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

Kate Goodin– As program manager of Epidemiology and Data Services Kate will be able to provide expertise as it relates to thermal comfort, heat related illness. Kate will also facilitate connections between the DEVELOP team and other MCDPH personnel focusing on active transportation and healthy community design initiatives.

Erik Johnston – Dr. Johnston expertise in policy informatics and CPI’s current efforts with the Phoenix Department of Transportation will help the team ensure a product useful to policy level decision making.

CJ Hager – Director Hager leads the Vitalyst Health Foundation based in Phoenix, AZ. One focus of her organization includes supporting policy that addresses the impact of transportation, which includes non-motorized travel and public transit, on community health. Her experience would ensure the teams work is connected to other interested parties across the Phoenix Metropolitan area.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will meet with project partners every two weeks via teleconference. The team lead will be the main point of contact. These meetings will help to incorporate end-user needs and perspective into the project.

***Transition Plan*:** There will be an in-person meeting with end users in which the team will showcase the end products and discuss future work for the second term. The end-product will demonstrate the utility of NASA EOs to identify hotter thermal conditions of bus stops throughout the city. The end products produced at the end of this term directly incorporated into producing the end products of term II, which will be used to help determine where shade structures should be installed.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat** | NDVI | NDVI will be used to characterized that presence of vegetation at bus stops |
| **Suomi NPP VIIRS** | Land surface temperature | Land surface temperature will be used to estimate the average temperature of each bus station  |
| **Terra ASTER** | Land surface temperature | Land surface temperature will be used to estimate the average temperature of each bus station |

***Ancillary Datasets:***

Oak Ridge National Laboratory – Daymet – daily maximum, minimum, and mean dew point and air temperature data will complement information about the radiative and vegetative environments sourced from NASA EOs.

Phoenix Valley Metro – Ridership Data –The team has access to bus fare system data from summer 2015 to generate hourly/daily/monthly ridership statistics. Exploratory work suggests a relationship between warm-season temperature and daily ridership.

Arizona State University – Transit Survey – This is a survey of riders conducted in the summer of 2015 by ASU students. This survey could help understand rider demographics and other factors to consider in bus stop shading prioritization

Arizona Meteorological Network – Weather Data – This dataset contains meteorological data for stations throughout Arizona and will be used to ground truth Daymet data.

National Centers for Environmental Information – Integrated Surface Database – This dataset provides hourly meteorological data for stations throughout the world. Data for our study area will be combined with the Arizona Meteorological Network to ground truth Daymet data.

US Census - 2010 Census and American Community Survey – The team will use this data to categorize populations accessing the transit system based on demographic and socioeconomic indicators

***Software & Scripting:***

ArcGIS – data processing and map creation

Python – data processing

R-Statistical Programming – data processing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| ASTER LST Time Series | A 10 year Summer (May – October Time series of land surface temperature would allow end users to understand how the variable has varied throughout time. Additionally, an ASTER LST thermal indicator will be created from this product and used in the regression analysis. | ASTER LST will be collected and processed for the study period and area. A spatially explicit average of the time series will be create and cells corresponding to the bus route and stops will be extracted. | none |
| VIIRS LST Time Series | A 10 year Summer (May – October) Time series of land surface temperature would allow end users to understand how the variable has varied throughout time. Additionally, a VIIRS LST thermal indicator will be created from this product and used in the regression analysis. | VIIRS LST will be collected and processed for the study period and area. A spatially explicit average of the time series will be create and cells corresponding to the bus route and stops will be extracted.  | none |
| Landsat NDVI Time Series | A Time series of vegetation prevalence for May – October 2015 – 2016. This would allow end users to understand how the variable has varied throughout time. Additionally, a Landsat NDVI thermal indicator will be created from this product and used in the regression analysis. | Landsat NDVI will be collected and processed for the study period and area. A spatially explicit average of the time series will be create and cells corresponding to the bus route and stops will be extracted. | none |
| Thermal Indicator Ridership Regression Model  | This product will perform a regression analysis between the thermal indicators and air temperature for each bus stop and ridership, with the goal of predicting ridership. This model will help our end user better understand who each variable, e.g. surface temperature and NDVI, impact ridership. Additionally, this model will help inform the suitability model, which will be created in term II.  | ASTER LST, VIIRS LST, and Landsat NDVI thermal indicators will be used to predict ridership in a regression analysis.  | none |

***End-User Benefit*:** The end products produced in this term will allow our end-users to better understand the spatial and temporal thermal conditions of the bus stops throughout the city. Communicating the impact of shade structures on thermal comfort and overall rider satisfaction is a goal of the transit department. Additionally, the analysis will allow our end-users to incorporate this information into the decision-making process regarding the prioritization of installing shade structures at bus stops. These shade structures will help reduce the likelihood of riders experience thermal discomfort and/or heat-relates illness while using the transit system.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2017 Spring (Start) to 2017 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1(Proposed Term):** 2017 Spring (AZ) – Phoenix Health & Air Quality I
	+ The primary objective of this term is to processes the ASTER LST, VIIRS LST, and Landsat NDVI to create monthly time series and create thermal indicators for each bus stop. A secondary objective will be to create a regression model for predicting ridership based on thermal indicators and air temperature. This will help us understand if these thermal indicators are useful in predicting ridership.
* **Term 2:** 2017 Summer (AZ) – Phoenix Health & Air Quality II
	+ The summer team will construct take the data and results from the previous term to develop a suitability model to identify which stops should be prioritized over others for shade improvements. The team will also utilize socioeconomic data to assess neighborhood demographics that are served by each stop. Additional ground trothing will be done using Arizona Meteorological Network and National Centers for Environmental Information data. Finally, the results from the Spring 2017 term and Summer 2017 term will be compiled into an ArcGIS Online Web Map, which will enhance end user decision making regarding shade structure installation.