**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Arizona – Tempe**

**Washoe County Urban Development**

*Utilizing NASA Earth Observations to Assess Urban Heat Island Reduction Strategies in Washoe County, Nevada*

**Project Overview**

***Project Synopsis:*** This project utilizes NASA Earth observations to aid decision-makers in the reduction of the urban heat island (UHI) impacts in the Truckee Meadows region of southern Washoe County, Nevada, including the cities Reno and Sparks. Reducing the UHI through targeted changes to urban infrastructure can improve health and air quality by reducing summertime energy consumption, create cool active transportation corridors for biking and walking, and reduce heat exposure to vulnerable populations. This project uses Landsat 5 TM, Landsat 8 OLI and TIRS, and Sentinel-2 MSI to assess trends in UHI indicators throughout the Truckee Meadows region. The end products will be processed and visualized in Google Earth Engine (GEE) and will include a tool to allow our local partners assess the impact of infrastructure and land cover change on the UHI.

***Community Concern:*** The UHI is a phenomena in which the urban core experiences higher temperatures than the surrounding rural areas. The magnitude and intensity of the UHI can be affected by urban landscape (vegetation prevalence, impervious surfaces, and building materials) and human activity (i.e. building/vehicle waste heat). Increases in urban temperatures can lead to an increase in exposure to extreme heat for vulnerable populations and elevate the risk of heat-related illness. Reducing the UHI could lower the risk of heat-related illness and improve air quality. The Washoe County Health District’s Air Quality Management Division (AQMD) has identified the need to assess the UHI and biophysical factors that influence the UHI throughout Truckee Meadows Region in order to provide targeted interventions.

***Source of Project Idea:*** This project idea originated from conversations between Lance Watkins (AZ Center Lead) and Daniel Inouye (Washoe County Health District, AQMD Branch Chief) at the 2017 NASA Applied Sciences Health and Air Quality Annual Meeting in Reno, NV. Daniel approached Lance with an interest in working with DEVELOP after seeing Lance give a presentation highlighting the Capacity Building Program.

***National Application Areas Addressed:*** Urban Development

***Study Location:*** Washoe County, NV

***Study Period:*** 2010 – 2018

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

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Washoe County Health District, Air Quality Management Division** | Daniel Inouye, Air Quality Management, Planning & Monitoring Chief | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:*** The AQMD participates in the Environmental Protection Agency’s Ozone Advance Program. The Advance Program engages with states, tribes, and local municipalities to promote local initiatives for reducing fine particulate and/or ozone pollution. A key goal of the Advance Program is to reduce the amount of the region’s hardscaped, impermeable, and heat absorbing surfaces, which amplify the UHI. The AQMD currently does not have any local tools to measure factors contributing to the region’s urban heat island. There is a need to estimate the biophysical factors (i.e. tree canopy, surface albedo, and percent impervious surface) that influence UHI. These factors are key performance indicators in the Health District’s Ozone Advance program and the City of Reno’s Master Plan Update.

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

*Washoe County Health District, Air Quality Management Division –* The AQMD have previously used NASA Earth observation products to demonstrate wildfire related ozone exceptional events demonstrations. This provided additional evidence for the Environmental Protection Agency that smoke from wildfires outside of Washoe County led to exceedances of particulate and ozone standards. However, they have not used NASA Earth observations to assess the UHI. This project builds their capacity to apply NASA Earth observations to achieve Goal 3, Strategy 1 (Decrease the amount of the region’s hardscaped, impermeable, and heat absorbing surfaces) of the Ozone Advance Program.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Arizona – Tempe Center Lead will establish bi-weekly meetings with the partners prior to the start of the term. The POC will be the team lead throughout the duration of the term.

***Transition Plan*:** The team will present their results and end products to our partners and other interested parties through a web video conference. The processed datasets, end products, and supporting documentation will be sent to partners through NASA Large File Transfer. The end products may include a python or GEE script, which will require software release.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 5 TM** | Top-of-atmosphere reflectance/radiance | This dataset will be used to calculate vegetation indices. |
| **Landsat 8 OLI** | Top-of-atmosphere reflectance/radiance | This dataset will be used to calculate vegetation indices. |
| **Landsat 8 TIRS** | Brightness temperature/radiance | This dataset will be used to calculate land surface temperature. |
| **Sentinel-2 MSI** | Top-of-atmosphere reflectance | This dataset will be used to produce yearly estimates of tree coverage and roof top albedo.  |

***Ancillary Datasets:***

National Land Cover Dataset (NLCD) – national estimates of land cover, percent tree cover and percent impervious surface

USDA National Agriculture Imagery Program (NAIP) – high-resolution imagery for more accurate estimates of tree canopy coverage and percent impervious surface

Desert Research Institute & UC Davis TahoeClim – dataset will be used to assess air temperature throughout the study area

***Software & Scripting:***

Esri ArcGIS – object based land cover classification, map generation, vector data management

Google Earth Engine API – raster data processing, time-series analysis, tool development

GWR4 – local and global regression analysis

R – data management

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Urban Tree Cover Canopy Time Series** | An assessment of urban tree canopy percent cover will allow partners to track the progress and impact of tree planting initiatives.  | Object-based classification using NAIP areal imagery to classify trees, grass, and built features. A subpixel analysis will be conducted using Landsat 5 TM and Landsat 8 OLI to estimate tree canopy coverage. National Land Cover Database Percent Tree cover will also be used to validate subpixel analysis. Together these products will provide a time-series of tree canopy cover. | I |
| **Roof Top Albedo Time Series** | Partners can use this to examine how changes to roof top albedo influences UHI. This would be useful to assess the influence of white roofing policy.  | A combination of Sentinel-2 MSI, Landsat 5 TM, and Landsat 8 OLI will be used to assess roof top albedo or reflectivity. | I |
| **Urban Heat Island Index Map Collection/Series** | Identify the extent and magnitude of the surface UHI. The end users will be able to display these data with the previous end products to better identify exposure of vulnerability communities and the effectiveness of urban infrastructure changes.  | Land surface temperature will be calculated from Landsat 5 TM and Landsat 8 TIRS. | I |
| **Percent Impervious Surface Time Series** | The high spatial resolution impervious layer will be used to identify area with higher concentrations of impervious surface that could be replaced with green space.  | Object based classification of NAIP areal imagery will be used to calculate a high spatial resolution percent of impervious area. Landsat 5 TM and Landsat 8 OLI will be used to produce moderate resolution impervious area.  | I |
| **Google Earth Engine UHI Indicator Tool** | This tool will allow our partners to produce, visualize, and examine trends in the previously mentioned end products. This will allow our partners to quickly examine the UHI indicators together to better inform their policy for reducing UHI and near surface ozone. | The previously mentioned end products will be produced using Google Earth Engine and housed in this UHI Indicator Tool.  | IV |
| **UHI Biophysical Regression**  | Through this analysis partners will be able to identify which of the biophysical factors have the greatest impact to reduce the UHI | The previously mentioned end products will be incorporated into a regression analysis to identify which biophysical factors have the greatest influence on the UHI. This will be a global and local regression analysis. | I |

***End-User Benefit*:** This project will support the Health District’s Ozone Advance Program and the City of Reno’s Master Plan Update by allowing more frequent and robust benchmarking of factors contributing to the UHI. With a tool in hand that provides more data and information related to the UHI and its indicators, the AQMD and other partners can make timely and informed policy decisions to reduce UHI impacts and improve air quality.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Summer

***Related DEVELOP Work:***

Spring 2018 (AZ) – Ajax Urban Development: Utilizing NASA Earth Observations to Assess Urban Forests as an Adaptation Strategy for Extreme Heat in Ajax, ON, Canada

Spring 2018 (ARC) – Richmond Urban Development: Quantifying Changes in Urban Tree Canopy Cover and Land Surface Temperature to Understand Their Impacts on Neighborhoods throughout Richmond, California

Summer 2017 (AZ) – Las Cruces Health & Air Quality: Assessing Urban Heat as it Relates to Social Vulnerability and Land Use Changes in Las Cruces, New Mexico

**Notes & References:**

***Notes*:** We are currently looking into the possibility of utilizing other NASA Earth observations, like OMI, to estimate near surface ozone throughout the study area. This product would enhance current monitoring efforts and allow for a more detailed regression analysis.

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