**NASA DEVELOP National Program**

**2018 Spring Project Proposal**

**California – Ames**

**Richmond Urban Development**

*Quantifying Changes in Urban Canopy Cover and Land Surface Temperature to Understand Their Impacts on the Neighborhoods throughout Richmond, California*

**Project Overview**

***Project Synopsis*:** There are over 35,000 trees planted in the city of Richmond and 12,000 to 15,000 tree planting opportunities. Groundwork Richmond is working alongside the city to increase tree canopies in different neighborhoods. This project will take a multi-resolution approach by leveraging Landsat and Sentinel-2 satellite imagery along with socioeconomic and demographic data to identify areas where Groundwork Richmond is achieving canopy coverage and areas that still need more trees. The end products will quantify changes in urban canopy cover and land surface temperature and will help identify canopy deficient neighborhoods. The team will also produce educational materials that can be used to inform volunteers and citizens about the benefits of trees.

***Community Concern:*** The city of Richmond sits within a ring or five major oil refineries, three chemical companies, two rail yards, highways, and is a port for tankers all of which affects air quality. Roughly 20% of young people (1 to 17) were diagnosed with asthma between 2009 and 2012. Over the past three years, Groundwork Richmond has planted 1,500 trees throughout the city in hopes of helping decrease air pollution in neighborhoods. Unfortunately, many residents especially in disadvantaged neighborhoods that are already under-treed don’t want to plant trees because of the effort and cost involved in planting, maintaining, and caring for the tree. Leveraging geospatial data to visually explain where planting efforts are effective and how they benefit communities will provide more information as to why trees should be planted in a neighborhood.

***Source of Project Idea:*** This project is a product of a broader engagement between DEVELOP and Groundwork USA. Sarah Calderon, Executive Director of Groundwork Richmond, met with DEVELOP to discuss the environmental issues the city of Richmond is facing, and this topic was identified as viable for Earth observations applications.

***National Application Area Addressed:*** Urban Development

***Study Location:*** Richmond, CA

***Study Period:*** 1985 – 2017 (June – August)

***Advisor:*** Dr. Juan Torres-Perez (Bay Area Environmental Research Institute)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Groundwork USA, Groundwork Richmond** | Sarah Calderon, Executive Director of Groundwork Richmond | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***Groundwork USA is a network of local trusts focused on urban greening and environmental justice. The Groundwork Richmond trust works with the city and other agencies on four main programs focused around improving green infrastructure throughout the city. In order to raise awareness about the benefits of these projects, Groundwork Richmond uses volunteers who have an interest in environmental stewardship. These individuals, many of them youth, speak at neighborhood meetings and schools and canvas neighborhoods with brochures that explain the positive results of these projects in hopes of finding new locations and volunteers for tree planting. Groundwork Richmond uses aerial imagery to better understand where there is a lack of greenery. However, the organization does not use remotely-sensed imagery to make decisions about where to place trees or to understand how trees may be reducing heat within the city.

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

*Groundwork USA, Groundwork Richmond* – Groundwork Richmond has very limited experience with NASA Earth observations and the analytical capabilities these observations provide.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** During the term, the team will have bi-weekly teleconferences with project partners. The DEVELOP Ames Center Lead, Jenna Williams, will be the liaison between the project partner and the DEVELOP team at Ames Research Center (ARC). ARC management will coordinate an in-person site visit with Groundwork Richmond where participants and partners can meet and give a presentation with preliminary results and collect project video footage.

***Transition Plan*:** A formal end-user handoff will take place at the end of the research term in the form of a WebEx teleconference. Results will be sent via NASA’s Large File Transfer (LFT). This project will not require a software release.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 TIRS** | Land surface temperature | Land surface temperature will be used to estimate the changes in magnitude and temporal extent of urban heat in the city of Richmond from 2013 to present. |
| **Landsat 8 OLI** | NDVI, MNDISI | NDVI will be used to assess vegetation changes from 2013 to present. The Modified Normalized Difference Impervious Surface Index (MNDISI) will be used to produce an impervious service layer. |
| **Landsat 5 TM** | NDVI, Land surface temperature | NDVI will be used to assess vegetation changes. Land surface temperature will be used estimate the changes in to the magnitude and temporal extent of urban heat throughout the city of Richmond from 1985 to 2013. |
| **Sentinel-2 MSI** | NDVI, MNDISI | NDVI will be used to assess vegetation changes from 2015, 2016 and 2017. The Modified Normalized Difference Impervious Surface Index (MNDISI) algorithm will be used to produce an impervious service layer. |

***Ancillary Datasets:***

USDA National Agriculture Imagery Program (NAIP) – Spectral vegetation indices will be used for the supervised classification of a land cover layer that will be fed into the Current Urban Canopy Three Year Analysis end product.

TIGER & Line with Selected Demographic and Economic Data – Population, block, track, block groups, urban areas, roads and address data will be used for socioeconomic analysis to help identify under-treed areas and their characteristics.

City of Richmond GIS Viewer – This data set includes the city’s major data layers (roads, parcels, parks), which will be used to help validate the impervious service raster used in the Urban Canopy Cover Time Series and Urban Heat Assessment analysis.

City of Richmond Property Information – This data will aid in validating the land classification raster by identifying parcels and land use.

City of Richmond Crime View Community – This data will be used in the socioeconomic comparison to better understand if there is a correlation between Groundwork Richmond’s community efforts and crime reduction.

City of Richmond Zoning Information – This data will be used to isolate areas of interest into public spaces and neighborhoods.

Center for International Earth Science Information Newtork (CIESIN) Global Urban Heat Island (UHI) Data Set – These data will be used to validate the Landsat-based urban heat results

***Modeling:***

Imager/Object Based Classification (POC: Jenna Williams, NASA DEVELOP)

***Software & Scripting:***

TerrSet – This software will be used to derive spectral indices as well as to run classification tree analysis.

Esri ArcGIS – This software package will be used for all vector-based analysis.

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Canopy Cover Time Series** | This product will help the partner understand whether they are gaining or losing tree coverage at a neighborhood scale. The product will identify areas that are currently under-treed and provide more information on how the Urban Forestry and Adopt-A-Tree initiatives are impacting the community. | Using Landsat’s historic catalog, NDVI and MNDISI will be combined with a supervised classification layer to identify trees and conduct a decadal analysis of urban tree canopy from 1985 to present. | I |
| **Urban Heat Assessment** | Partners will use the assessment to better understand how urban heat in Richmond has changed over time and to determine if heat is affected by canopy cover. This will help them identify areas that are at increased risk for heat, so they can plan future tree-planting efforts. | Landsat’s historic catalog will be used to estimate the extent, magnitude, and temporal changes in surface urban heat throughout Richmond one decade at a time. Correlation analysis will be performed with the above end-product to see if there has been a reduction in heat vulnerably where urban canopy exist. | I |
| **Canopy Cover and Socioeconomic Analysis** | Currently, project partners are looking into societal benefits of trees, such as lowered crime rates or increased property values. Adding in socioeconomic data into the analysis will provide more information for community engagement. It will also aid in identifying underserved populations. | Once the decadal end products are produced, this product will incorporate socioeconomic data (property values, population, age ranges, and crime rates) at decadal intervals. Plotting the increase in tree canopy over time against socioeconomic variables will allow partners to see if trees are actually an indicator of improved quality-of-life. | I |
| **Current Urban Canopy Three Year Analysis** | This product will help partners quantify their impact and assess whether they are achieving canopy coverage where it is most needed. This will support upcoming urban forest and tree canopy campaigns and document the effects of the past three years of tree-planting efforts. | Sentinel-2 will be used to assess the impact of 15,000 trees planted between 2015 and 2017. NDVI and MNDISI will be combined with a supervised classification layer identifying trees. Canopy density will be calculated. | I |
| **Methods Tutorial** | Strong documentation of how these products were created, data utilized, and a step by step guide to recreation will allow our partners to reproduce this analysis into the future. This will allow them to continually update the information they decimate to the public and asses how their initiatives are improving the greater Richmond community. | This product will outline the process of analysis for each of the above end products. | I |

***End-User Benefit*:** This project will benefit Groundwork Richmond in many ways. It will introduce them to the capabilities of NASA Earth observations and how they can be used to track the progress of their urban greening initiatives. It will also aid the trust in understanding how current efforts are impacting urban heat and help identify areas that are lacking in green infrastructure. The products produced will provide additional educational materials that will help the partners when talking with the public about benefits of trees and introduce the young leaders who work with Groundwork to other STEM opportunities within the environmental field.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2018

***Related DEVELOP Work:***

2017 Summer (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:**

***References:***

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