**NASA DEVELOP National Program**

**2019 Summer Project Proposal**

**Alabama – Mobile**

**Mobile Urban Development**

*Evaluating Urban Heat Islands and Flooding to Enhance Green Infrastructure Initiatives in Coastal Communities in Mobile*

**Project Overview**

***Project Synopsis*:** Partnering with Groundwork Mobile (GM), the team will investigate spatio-temporal relationships between flood vulnerability and socioeconomic status in Mobile, Alabama. In addition, vegetative canopies, impervious surfaces, and areas of extreme urban heat will be analyzed to identify neighborhoods viable for green infrastructure initiatives. This project will apply data from Landsat 8 OLI and Sentinel-2 MSI to produce time series products to indicate changes in green and gray infrastructure over time and utilize Landsat 8 TIRS and Terra MODIS land surface temperature and emissivity (LST&E) data to identify areas of extreme urban heat. The flood extent analysis will be created using Sentinel-1 C-SAR to identify areas at risk of flooding. By combining these products with census data, the socioeconomic and demographic risk evaluation will identify underserved areas most at risk of flooding and extreme heat, along with their potential for green infrastructure initiatives implemented by the partner organizations.

***Community Concern:*** Mobile, Alabama is situated on the western shores of Mobile Bay and along the Gulf of Mexico. Its low elevation, coastal geography, and subtropical climate contribute to flood events, especially in downtown neighborhoods. Tropical storm systems often batter this culturally rich city, which is home to nearly 200,000 people, increasing its likelihood to flood. During Hurricane Katrina in 2006, a storm surge of 12 feet inundated downtown Mobile leaving historic buildings and homes flooded and major transportation infrastructure like the Port of Mobile damaged. Flooding, along with extreme urban heat are growing concerns for community and government institutions in the region. Paved surfaces and grey infrastructure contribute to more intense Urban Heat Island (UHI) effects and can increase the temperature of urban areas significantly in contrast with surrounding, less developed areas. Green infrastructure initiatives can mitigate the risk of the UHI effect and flooding as organizations like GM and the DPC work to build, manage, and improve green spaces in Mobile.

***Source of Project Idea:*** This project idea emanated from discussions between the DEVELOP National Program Office and the Alabama – Mobile leadership team to build on methodologies developed during the Summer 2018 New Orleans Urban Development project but to focus on Mobile.

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

***Study Location:*** Mobile County, AL

***Study Period:*** January 2015 – May 2019

***Advisors:*** Joseph Spruce (Science System & Applications, Inc.), Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Groundwork USA, Groundwork Mobile** | Larissa Graham, Chair | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***Groundwork USA is a non-profit network comprised of twenty local trusts who seek to promote environmental, social, and economic well-being in the communities it serves. Their projects aim to transform the landscape of marginalized and underserved communities and implement risk-mitigation techniques such as the construction of rain gardens, urban gardens, coastal restoration, and tree plantings while teaching participants leadership and teamwork skills. Groundwork Mobile is in its infancy and hoping to develop strategies for identifying potential project areas.

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

*Groundwork USA, Groundwork Mobile* – The end user has no familiarity with NASA Earth observations and has not implemented remotely sensed data in its work before. This project will build Groundwork Mobile’s capacity in remote sensing applications and enhance its GIS skills.

***Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*Groundwork USA, Groundwork Mobile* – Groundwork partners with local communities to reverse environmental, economic, and social decline. Additionally, Groundwork Mobile collaborates with business owners, non-profit organizations and government officials to coordinate beautification and restoration initiatives. The end products will be shared with these partnerships. Additionally, these products can be used to produce public education materials for the Mobile community.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Communication between the DEVELOP team and the project partners will take place biweekly via teleconference or in-person meetings. These meetings will primarily involve project updates and high-level results. The Center Lead will coordinate an initial project meeting within the first two weeks of the term and will transition this responsibility to the Project Lead.

***Transition Plan*:** The project deliverables will be provided to the project partners via Google Drive at the end of the term. A hand-off presentation will be conducted via web conference, using either Google Hangouts or WebEx, with the option for local partners to attend the presentation in-person. During this meeting, the team will present the project results to the partners and field any questions they may have.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 8 OLI** | Land Cover | Landsat 8 OLI will be used to identify low urban tree coverage, calculate canopy changes over time and map municipal zones with higher exposure to surface runoff. |
| **Landsat 8 TIRS** | LST | The Landsat LST product will evaluate annual and seasonal changes in surface temperature to identify urban heat islands in Mobile county. |
| **Sentinel-2 MSI** | Land Cover | Sentinel-2 will be used to supplement Landsat products to identify low urban tree coverage, calculate canopy changes over time, and map municipal zones with higher exposure to surface runoff. |
| **Sentinel-1 C-SAR** | Normalized Difference Flood Index (NDFI) | Sentinel-1 NDFI flood maps will be used to demonstrate flood extent and floor vulnerability in the flood risk assessment.  |
| **Terra MODIS** | Land Surface Temperature & Emissivity (LST&E) | LST products will be compiled to assess urban heat island effects on underserved communities vulnerable to flood. |

***Ancillary Datasets:***

Dartmouth Flood Observatory Surface Floodwater Records – The surface water records will be incorporated in the analysis to assess the accuracy of the flood extent products.

FEMA Flood Map Service Center – FEMA flood map products will be used to compare the historical flood extent analysis to generate an accuracy assessment.

NOAA NCEI Local Climatological Data (LCD) – Local weather and climatological data will be used to better define flood risk assessments

SEDAC Gridded Population of the World (GPW) – Socioeconomic data will be incorporated in the analysis to observe the vulnerability of the underserved communities to flooding incidents.

US Census Bureau Population Dataset – Census data will be employed to observe the demographic characteristics in the city of Mobile.

US Census Bureau TIGER/Line Shapefiles – Shapefiles of downtown Mobile derived from census population data and Mobile county shapefile

USDA National Agricultural Imagery Program (NAIP) – High-resolution (1 meter) land cover and tree canopy assessments to be used for detecting smaller stands and individual trees

USGS National Land Cover Database (NLCD) – 2016 NLCD layers, will serve as comparisons for the team-created land cover products

***Software & Scripting:***

Esri ArcGIS Pro – Raster manipulation, map product generation, and image classification development

QGIS SCP plugin – Raster manipulation, land cover maps compilation, and geo-spatial data visualization

ERDAS Imagine – Image classification, raster data product generation and geo-spatial data analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Urban Heat Maps** | These maps will demonstrate the heat distribution across the city and surrounding area to provide an understanding of the UHI effect.  | Landsat 8 TIRS and Terra MODIS data will be used to generate this end product. | N/A |
| **Surface Heat Assessment** | The surface heat assessment product will deliver annual and seasonal analysis of surface temperature to contribute to the partners’ current techniques in understanding the impacts of the urban heat island on the communities and storm water threats in the area. The result will demonstrate the correlations between the urban geographies and the surface temperature level over time | Landsat 8 TIRS-based brightness temperature data at a 120 m resolution and MODIS Land Surface Temperature and Emissivity (LST&E) products will be used to assess temperature characteristics within the study area from January 2015 to June 2018. | N/A |
| **Flood Extent Analysis** | The product will provide a series of storm water surface coverage maps to allow the partner to determine areas prone to flooding in both extreme weather events and daily rainfall.  | Normalized Difference Flood Index (NDFI) will be applied to Sentinel-1 SAR data to generate flood risk analysis across the region at a 20 m resolution.  | N/A |
| **Socioeconomic and Demographic Risk Evaluation** | The analysis will observe the socioeconomic status and the demographic characteristics in the study area and will compare the variables to the generated end products to expand the partners’ understanding of the vulnerability of the marginalized communities to flood and extreme heat. | SEDAC GPW socioeconomic data will be combined with US Census Bureau demographic information including income, age, gender, and family structure to compare them to the Flood Extent Analysis and Surface Heat Assessment. The analysis will deliver a valuation of socioeconomic variables in response to the geographic setting of the area as proxy to vulnerability to flood.  | N/A |

***End-User Benefit*:** The implementation of various mitigation strategies like green infrastructure can be improved by targeting areas most at risk of the UHI effect. This geospatial approach can be a timesaving and cost effective strategy for GM. This project will assist in developing GM’s strategies to understand and mitigate urban heat and extreme flooding in its region, thus providing a basis for future green initiatives.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Summer

***Related DEVELOP Work:***

2019 Spring (LaRC) - Providence & Elizabeth Urban Development: Exploring Heat- and Flood-related Vulnerability in Urban Settings via NASA Earth Observations

2018 Fall (AL) – New Orleans Health & Air Quality: Monitoring the Urban Heat Island Effects on the Health of Residents of New Orleans, Louisiana Metropolitan Area with Landsat, Sentinel and MODIS Land Surface Temperature Products

2018 Summer (AL) – New Orleans Urban Development: Utilizing Earth Observations to Assist Groundwork New Orleans to Reduce Flood Vulnerability in New Orleans, Louisiana, Metropolitan Area

2018 Summer (AZ) - Washoe County Urban Development: Utilizing NASA Earth Observations to Assess Urban Heat Island Reduction Strategies in Washoe County, Nevada

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

2017 Spring (AZ) – Phoenix Health & Air Quality: Utilizing NASA Earth Observation to Assess the Impacts of Extreme Heat on Transit Riders in Phoenix, Arizona

**Notes & References:**

***References:***

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