**NASA DEVELOP National Program**

**2019 Summer Project Proposal**

**Virginia – Langley**

**Hampton Roads Urban Development II**

*Assessing Urban Tree Canopy and Impervious Surface Distribution to Inform Urban Planning in Hampton, Virginia*

**Project Overview**

***Project Synopsis*:** This project will support the City of Hampton’s urban management initiatives through the application of Landsat and Sentinel data to assess urban tree canopy and impervious surface distribution. The project will create a series of tree canopy and impervious surface distribution maps for Hampton for select years from 2000 to 2019 that can be used to analyze infiltration and inundation in the urban environment. These products will support the City of Hampton’s management strategies, which prioritize nature-based solutions to help the community build environmental resilience.

***Community Concern:*** The City of Hampton is a low-lying coastal community situated near the mouth of the Chesapeake Bay in Virginia. Hampton city officials are focused on managing their landscape in ways that make their local environment safer and more resilient to the effects of extreme weather. One aspect of that is to design urban landscapes that slow, store, and divert water during high flow events, thus limiting flooding and infrastructure damage. Green infrastructure and urban forestry initiatives can help accomplish that objective; however, impervious surfaces (e.g. concrete, cement, metal) facilitate the flow of water over land surfaces and prevent infiltration. This project will quantify the distribution of impervious surfaces and urban tree canopies within the City of Hampton to help city staff integrate spatial data into their decision making.

***Source of Project Idea:*** This project builds on a DEVELOP project conduced in the fall 2018 term and was formulated through conversations between City of Hampton officials and the LaRC Center Lead. This is a particularly apt collaboration because DEVELOP’s National Program Office and Langley Research Center node are both located within the City of Hampton.

***National Application Areas Addressed:*** Urban Development, Water Resources, Disasters

***Study Location:*** Hampton, VA

***Study Period:*** January 2000 – June 2019

***Advisor:*** Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POCs (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City of Hampton** | Bruce Sturk, Director of Federal Facilities Support; Lucy Stoll, Senior City Planner; David Imburgia, Environmental & Sustainability Manager; Allan Lambert, GIS Manager | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The City of Hampton is actively engaged in several initiatives focused on responding to and planning for environmental stressors. Its *Resilient Hampton* campaign is a multi-faceted approach to addressing changes in their local environment. The city currently uses a variety of spatial data and regularly seek collaboration with federal partners and other organizations. City officials aggregate information and present it to the city council, which then sets policy. They are already focused on a variety of efforts related to urban hydrology, flooding, and urban landscape planning. City staff hope to further explore ways of making the community more holistically resilient.

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

*City of Hampton* – The City of Hampton already uses some remotely sensed datasets and has numerous officials who regularly utilize GIS in their work. It has previously used NASA Earth observations during the initial DEVELOP partnership but does not regularly utilize NASA data outside the context of that project. The second term project will build their capacity to use Earth observations in a manner that they have not previously explored and will use some of their preexisting data resources as well.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Langley Center Lead and Science Advisor have maintained contact with Hampton officials since the completion of the fall 2018 project and will coordinate an introductory meeting between the new DEVELOP team and city staff the first week of the term. The DEVELOP team will maintain contact with city officials throughout the term with periodic emails and approximately bi-weekly in-person updates.

***Transition Plan*:** The Project Lead will coordinate with the city officials to schedule an in-person project handoff meeting. The project team will package all results and data files onto flash drives and/or DVDs for direct transfer to the project partners. At this meeting, the project team will discuss the project methodology and explain all file structures and the organization of data files.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI**  | Surface Reflectance  | Surface reflectance data will be used to create the percent impervious and percent tree canopy products. |
| **Landsat 5 TM** | Surface Reflectance  | Surface reflectance data will be used to create the percent impervious and percent tree canopy products. |
| **Sentinel-2 MSI** | Surface Reflectance | Surface reflectance data from Sentinel-2 will be used to supplement Landsat data to create the percent impervious and percent tree canopy products. |

***Ancillary Datasets:***

City of Hampton fine resolution commercial imagery – used to define impervious surfaces and urban tree locations and inform an algorithm which can be applied to Landsat and Sentinel imagery

City of Hampton maps & shapefiles – used to define the bounds of the study and overlay areas of interest onto the results of the project

USDA National Agriculture Imagery Program (NAIP) – used alongside commercial imagery to help train and define impervious surfaces and urban vegetation

United States Geological Survey National Land Cover Database (NLCD) Imperviousness product – comparison to the team’s own percent impervious product

United States Geological Survey National Land Cover Database (NLCD) Canopy Cover product – comparison to the team’s own percent canopy cover product

***Software & Scripting:***

Esri ArcGIS Pro – data visualization, data processing, and map creation

Esri ArcMap – data visualization, data processing, map creation

Python – data manipulation, data management, process automation

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Percent Impervious Surface Maps**  | The partner will use these maps to understand the spatial distribution of impervious surfaces, which they can use to analyze hydrology across the city and make decisions about urban planning.  | Landsat and Sentinel data will be used in conjunction with high resolution data from the partner to generate these distribution maps. | N/A |
| **Impervious Surface Change Maps** | The partner will use these to visualize changes in impervious surface distribution through time.  | These maps will be based on an assessment of the Percent Impervious Surface Maps, which themselves are based on Landsat and Sentinel data.  | N/A |
| **Percent Urban Canopy Maps**  | The partner will use these maps to understand the spatial distribution of trees and vegetation, which they can use to analyze hydrology across the city and make decisions about urban planning. | Landsat and Sentinel data will be used in conjunction with high-resolution data from the partner to generate these distribution maps.  | N/A |
| **Urban Canopy Change Maps** | The partner will use these to visualize changes in urban canopy distribution through time.  | These maps will be based on an assessment of the Percent Urban Canopy Maps, which themselves are based on Landsat and Sentinel data.  | N/A |
| **Project Methodology Tutorial**  | The partner will use the tutorial as a point of reference to understand and potentially replicate the methods of the project in the future. | N/A | N/A |

***End-User Benefit*:** The results of this project will allow end users at the City of Hampton to better understand the distribution of impervious surfaces and urban vegetation. In the broader context of their work, these are important parameters to build into hydrologic models and urban planning procedures. They hope to better understand how impervious surfaces and urban vegetation affect the movement of water across the landscape. These end products will give them initial insight into important spatial relationships and give a preliminary assessment of ecosystem services. This will allow them to make better-informed decisions about tree planting and planning procedures.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2018 Fall and 2019 Summer

***Multi-Term Objectives:***

* **Term 1:** 2019 Fall (LaRC) – Hampton Roads Urban Development
	+ The first term of the project produced coastline change maps to identify areas of concern related to shoreline loss. Using these maps and other factors that affect coastal erosion (e.g. elevation, distance to water, soil, land cover, etc) the team created a map to show localized coastal erosion risk. In collaboration with the City of Hampton, the team created an Esri Story Map that identifies target areas of concern and restoration for the city.
* **Term 2 (Proposed Term):** 2019 Summer (LaRC) – Hampton Roads Urban Development II
	+ The second term will focus on mapping impervious surfaces and tree canopy cover across the City of Hampton. The team will create land cover change maps to analyze changes in the spatial distribution of these land cover classes over time. Because the project end users are local to NASA Langley, the team will conduct an in-person hand off at city offices to conclude the final term of the project.

***Previous Term:***

2018 Fall (LaRC) – Hampton Roads Urban Development: Monitoring Hampton’s Coastline and Assessing Barrier Island Transgression to Enhance Coastal Management

***Related DEVELOP Work:***

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

2018 Spring (GA) – Miami Beach Urban Development II: Utilizing NASA Earth Observations to Assess Vegetation Resiliency and Water Quality Concerns to Enhance Green Infrastructure Plans in Light of Extreme Weather Events

**Notes & References:**

***Notes*:** The links below will give the project team a sense for the city’s campaigns and initiatives. These are a good place to start understanding the scope of the project partner’s work.

Adapt VA. (n.d.). [Interactive map that can display flooding, vulnerability, infrastructure, shoreline management, and natural resources]. *Adapt VA Interactive Map.* Retrieved from <http://cmap2.vims.edu/AdaptVA/adaptVA_viewer.html>

Center for Coastal Resources Management Virginia Institute of Marine Science. (n.d.). [Interactive map of Hampton, Virginia]. *City of Hampton comprehensive map viewer*: Retrieved from <http://cmap2.vims.edu/CCRMP/Hampton2012/Hampton_CCRMP_Viewer.html>

City of Hampton. (2011 April). Hampton beachfront and storm protection management plan. Retrieved from <https://hampton.gov/DocumentCenter/View/32/hampton-beachfront-plan?bidId>=

United States Department of Agriculture. (2018). [Map of NAIP coverage from 2002 to 2018 created by the Aerial Photography Field Office] *NAIP coverage 2002-2018*.Retrieved from <https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/APFO/status-maps/pdfs/naipcov_2018.pdf>