**NASA DEVELOP National Program**

**2018 Fall Project Proposal**

**Virginia – Langley**

**Hampton Roads Urban Development**

*Monitoring Hampton’s Coastline and Assessing Barrier Island Transgression to Enhance Coastal Management*

**Project Overview**

***Project Synopsis*:** This project will support the City of Hampton’s coastal management through the application of Landsat and Sentinel data to map and forecast potential coastline change and barrier island transgression over time. The project will pursue three objectives: 1) create a time series of land cover classifications for Hampton Roads between 1988 and 2018, 2) create an annual average coastline map from binary coastline water/land classifications, and 3) identify areas of concern for potential shoreline loss and barrier island transgression. These products will support the City of Hampton’s shoreline management and coastal resilience strategies that prioritize natural and nature-based solutions to combating sea level rise.

***Community Concern:*** Situated at the mouth of the Chesapeake Bay and open to the direct forces of the Atlantic Ocean, Hampton's shorelines are its first line of defense during storm events. Beaches, dunes, barrier islands and coastal wetlands provide critical species habitat and direct protection from tropical storms and nor’easters events like Hurricane Isabel (2003), Tropical Storm Ernesto (2006) Nor’Ida (2009), Hurricane Irene (2011), Hurricane Sandy (2013), and Hurricane Matthew (2016). Successful shoreline management requires methods for assessing and quantifying extent and health of coastal features. Quantification of coastal change over the past 30 years will provide a baseline for future evaluation of loss and degradation, and support management strategies that target areas with greatest loss and prioritize nature-based solutions for combatting sea level rise and future storms.

***Source of Project Idea:*** The City of Hampton identified multiple project ideas that would support their environmental decision making and this project was mutually selected as the first project for collaboration with the Virginia – Langley node.

***National Application Areas Addressed:*** Urban Development, Ecological Forecasting, Disasters

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

***Study Period:*** January1988 – October 2018

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

**Partner Overview**

***Partner Organization:***

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

***End-User Overview***

***End User’s Current Decision-Making Process:***The City of Hampton is responding to and planning for environmental stressors through multiple approaches. The *Hampton Beachfront and Storm Protection Management Plan* published in 2011 identifies beach management strategies to reduce damage and property loss resulting from storm impacts and coastal flooding. “Resilient Hampton” is a city-wide initiative to improve and bolster the community’s strengths to alleviate stresses and enable recovery from extreme events. The Comprehensive Coastal Resource Management Portal serves as a gateway to information and tools to assist in implementation of tidal shoreline laws and policy, an interactive map viewer of shoreline land cover and sea level rise scenarios, shoreline and tidal marsh inventory, and other coastal information resources. The Adapt VA Interactive Map provides information relating to social vulnerability and physical risk.

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

*City of Hampton* – The City of Hampton does not currently use NASA Earth observations. They are familiar with the benefits of remote sensing data and are interested in increasing their knowledge of, and skill to use, NASA data that could provide additional data points in their decision-making processes. They host multiple interactive mappers that could benefit from potential inclusion of more satellite data products.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The DEVELOP team will coordinate an introductory in-person meeting at the start of the term for the project team to meet with the City of Hampton officials and discuss objectives. This will be followed by either weekly or bi-weekly telecons for progress updates. Communication will be led by Lauren Childs-Gleason, Lindsay Rogers, and Jonathan O’Brien until the Project Lead has been identified, at which time they will serve as the primary POC during the term.

***Transition Plan*:** At the end of the term, the team will do an in-person hand off to the City of Hampton that includes a presentation of the results and a tutorial of the methods and datasets used. A results package will be created including shapefiles and other map products and provided to the City of Hampton GIS Lead for review and potential replication. At this time, no code is planned to be created so software release will not be a requirement.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Land cover, spectral vegetation indices | Landsat data will be combined with Sentinel data for a time series that identifies land cover change, shoreline averages, and sets a baseline for forecasting of vulnerable areas. |
| **Landsat 7 ETM+** | Land cover, spectral vegetation indices | Landsat data will be combined with Sentinel data for a time series that identifies land cover change, shoreline averages, and sets a baseline for forecasting of vulnerable areas. |
| **Landsat 5 TM** | Land cover, spectral vegetation indices | Landsat data will be combined with Sentinel data for a time series that identifies land cover change, shoreline averages, and sets a baseline for forecasting of vulnerable areas. |
| **Sentinel-2 MSI** | Land cover, spectral vegetation indices | Sentinel data will be combined with Landsat data to enhance the time series of land cover change and shoreline averages, and to create a baseline for future analyses. |
| **Sentinel-1 CSAR** | Water extent | SAR data will be explored for identifying the coastline. |

***Ancillary Datasets:***

City of Hampton Shoreline maps & shapefiles – compare historic/present maps with satellite-derived land cover maps

USDA National Agriculture Imagery Program (NAIP) – compare with satellite-derived land cover maps

US Census Bureau population & demographic data – identify population locations for flooding events

***Modeling:***

TerrSet Land Change Modeler (POC: Sean McCartney, SSAI/NASA Goddard)

***Software & Scripting:***

Esri ArcPro – data processing & manipulation, land cover classifications, change analyses, map making

Exelis ENVI 5.0 – image processing, enhancement, and classification

ESA Sentinel Application Platform (SNAP) – image preprocessing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **City of Hampton Land Cover Classification** | The City of Hampton can use these classification maps to improve their understanding of urban encroachment and land use change over time, so that they can identify areas of concern for targeted remediation and restoration efforts. | Unsupervised classifications and change detections of Landsat & Sentinel data will be created to quantify land cover types within the Hampton Roads region.  | N/A |
| **Annual Coastline Location Average**  | The City of Hampton can use the coastline location average as a baseline to inform decision making relating to shoreline loss and identify areas of concern. | A binary classification of water/non-water will be conducted using Landsat & Sentinel (spectral and SAR) data for multiple scenes per year and then averaged and compared year to year. | N/A |
| **Before/After Major Event Case Studies** | The City of Hampton will be able to visualize change caused by punctuated events throughout the past 30 years to enhance understanding and inform the community for future events. | Landsat data will be used to look at a select few historical events. | N/A |
| **2018 Risk Map** | The City of Hampton can use this risk map in alignment with the Adapt VA risk maps to identify areas for targeted restoration and mitigation efforts. | Land classifications, change detections, and socioeconomic data will be combined to identify at-risk coastal areas. | N/A |
| **ArcGIS Online Story Map** | The City of Hampton can use the story map as a communication tool to the public to emphasize the importance of coastal management best practices and how remote sensing information can be used to make informed decisions. | Landsat and Sentinel-derived maps will be highlighted in the story map for their applications in coastal management. | N/A |
| **Project Methodology Tutorial / Training** | This training will be presented in a hand-off workshop at the end of the term so that the City of Hampton can continue the use of Earth observations and implement into future projects. | Brief modules for each satellite dataset used in the project will be created and presented for future replication. | N/A |

***End-User Benefit*:** The end products will support the City of Hampton in multiple ways: 1) provide a baseline for future analysis, 2) improve understanding of shoreline loss and barrier island transgression in the area, 3) support targeted solutions for coastal restoration and conservation efforts, 4) provide a methodology for conducting an annual coastal assessment that can be replicated into the future, and 5) reduce costs by supporting the targeting of areas at greatest potential risk.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Fall

***Related DEVELOP Work:***

2009 Spring & Summer (SSC) – Chandeleur Islands Disasters: Assessment of Tropical Cyclone Induced Transgression of the Chandeleur Islands for Restoration and Wildlife Management

2016 Fall (VA) – Grand Canyon Water Resources: Utilizing NASA Earth Observations to Assist the National park Service in Monitoring Shoreline Land Cover Change in the Lower Grand Canyon

2017 Summer (GA-AL) – Costa Rica Oceans: Assessing Changes in Vegetation and Marine Environments at the Isla del Coco Marine Reserve with Satellite Imagery

2018 Summer (JPL) – Southern California Coast Disasters: Improving Flood Extent Mapping Using the Coastal Storm Modeling System (CoSMoS) Tool with NASA Earth Observations and UAVSAR within Southern California

2010 Summer (LaRC) – Outer Banks Climate: Using NASA Remote Sensing to Characterize North Carolina Coastal Change

**Notes & References:**

***References:***

City of Hampton Comprehensive Map viewer: <http://cmap2.vims.edu/CCRMP/Hampton2012/Hampton_CCRMP_Viewer.html>

Resilient Hampton Inititiave: <https://hampton.gov/3459/Resilient-Hampton>

City of Hampton <https://hampton.gov/DocumentCenter/View/32/hampton-beachfront-plan?bidId>=

Adapt VA Interactive Map: <http://cmap2.vims.edu/AdaptVA/adaptVA_viewer.html>