**Hampton Roads Urban Development**

*Enhancing Coastal Management by Monitoring Hampton’s Coastline and Barrier Island Transgression with the Aid of NASA Earth Observations*

**VPS Title:** Protect the Most on the Coast: Remote Sensing in the Hampton Coastal Community

**Project Team**

***Project Team*:**

Danielle Ruffe (Project Lead), danielle.ruffe@gmail.com

Eric Deutsch

Holly Gould

Shaifali Prajapati

***Advisors & Mentors*:**

Dr. Kenton Ross (NASA Langley Research Center)

**Project Overview**

***Project Synopsis*:**

This project utilized Landsat data to enhance the City of Hampton’s coastal management system by mapping and deriving coastline change and barrier island transgression over a 30-year period. There were four objectives: (1) to produce an annual average coastline map from binary coastline water/land classifications, (2) to establish areas of concern for potential shoreline loss and barrier island transgression, (3) to define communities at risk from effects of coastal degradation, and (4) to enhance community public outreach by creating an ArcGIS story map. The City of Hampton will use these end products for shoreline management coastal resilience strategies that prioritize sustainable and nature-based solutions to adapt to sea level rise.

***Abstract*:**

Situated at the mouth of the Chesapeake Bay, Hampton, Virginia is one of the most vulnerable areas in the United States for environmental stressors such as flooding, sea level rise, and storm surge. The city is engaged in several initiatives and partnerships to aggregate geospatial data to improve their coastal resilience planning. The City of Hampton is working towards visualizing the changing dynamics of its coastline and preparing more efficiently for future storm events. In order to assist in achieving these goals, this project capitalized on the temporal range of the Landsat series of optical satellites to create a 30-year time analysis from 1988 to 2018 of the Hampton coastline. The team derived coastline maps by consolidating multiple images from each year to generate annual average coastline locations, which were then incorporated into risk assessment maps and an ArcGIS story map. The results delineate areas that are at-risk to shoreline loss while demonstrating that there is a more recent trend towards modest shoreline inundation and transgression. By building a greater understanding of the fluctuations of Hampton’s coastline, city planners can more effectively build resilience plans and communicate with policy makers.

**Keywords:**

Landsat, remote sensing, annual coastal average, coastal management, barrier island transgression

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

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

***Study Period:*** January 1988 – October 2018

***Community Concerns:***

* Hampton’s shoreline is the city’s buffer to natural disaster events, such as hurricanes and tropical storms; subsequently, flooding and shoreline loss could result in damage to developed areas.
* The City of Hampton needs a way to define at-risk areas for community citizens who have been affected by long-term coastal degradation.
* There is a lack of public education resources informing Hampton residents about at-risk areas for coastal erosion and barrier island transgression.

***Project Objectives:***

* Develop an efficient methodology for delineating and analyzing coastal features for the City of Hampton
* Determine regions that are vulnerable to flooding and erosion events
* Provide the City of Hampton with a technical report that further informs the partner’s efforts in shoreline conservation
* Design an ArcGIS Story Map to assist the City of Hampton with public awareness in their coastal management efforts

**Partner Overview**

***Partner Organization:***

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

***Decision Making Practices & Policies***:

The City of Hampton is responsible for planning and responding to environmental stressors along the area’s coastlines and barrier islands; the city has implemented several preventative measures to assist in coastal management efforts. The “Resilient Hampton” initiative is a broad city-wide campaign that focuses on adaptive strategies for extreme weather events. A part of this initiative includes coastal management efforts geared toward shoreline restoration projects through nature-based solutions. In addition to the “Resilient Hampton” initiative, the city currently employs interactive web mappers, Adapt VA and The Comprehensive Coastal Resource Management Portal, as a form of public outreach to show Hampton residents sea level rise scenarios, inventories, and other coastal resources. The City of Hampton gathers data from Center for Costal Resources Management, Virginia Institute of Marine Science, Virginia Geographic Information Network, and NASA Earth observations.

***Project Benefit to End User***:

This project will help the City of Hampton increase their capacity for coastline management by providing a baseline for future analysis of shoreline loss and barrier island transgression. The annual coastline location average maps and risk maps will further support the city’s “Resilient Hampton” initiative through the identification of coastal erosion at risk areas aiding the city in targeting areas for future restoration projects. Also, the ArcGIS story map will augment the city’s current public outreach efforts by providing a narrative to coastal erosion. Additionally, the software and technical paper will supply a methodology to carry out annual coastline assessments for future assessments.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI** | Land cover, spectral vegetation indices | Landsat data from 2013 to 2018 were combined to create a time series that identified land cover change and shoreline location averages, which will set a baseline for forecasting of vulnerable areas. |
| **Landsat 7 ETM+** | Land cover, spectral vegetation indices | Landsat data from 1999 to 2018 were combined to create a time series that identified land cover change and shoreline location averages, which will set a baseline for forecasting of vulnerable areas. |
| **Landsat 5 TM** | Land cover, spectral vegetation indices | Landsat data from 1984 to 2012 were combined to create a time series that identified land cover change and shoreline location averages, which will set a baseline for forecasting of vulnerable areas. |

***Ancillary Datasets:***

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

cover maps

USGS National Structures Dataset (NSD) – assign values based on the cluster of structures in proximity to one another

USGS Gridded Soil Survey Geographic (gSSURGO) Database – measure areas for the degree of soil erodibility

LiDAR Bare Earth Digital Elevation Model (DEM) – measure the degree of slope, measure the vertical distance to water

National Land Cover Database (NLCD) – categorize risk of erosion based on land cover type

Chesapeake Bay Bathymetric Digital Elevation Model – compare land cover elevation to bathymetry

NOAA Continually Updated Shoreline Product (CUSP) – measure horizontal distance of land to water

***Software & Scripting:***

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

Google Earth Engine API – data processing & manipulation, water indices, annual coastline averages

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Annual Coastline Location Average Maps** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI | The City of Hampton can use the coastline location average and time change maps as a baseline to inform decision making related to shoreline loss and identify areas of concerns.  | IV |
| **Risk Maps** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI | The City of Hampton can use the risk map in alignment with the Adapt VA risk maps to identify areas of targeted restoration and mitigation efforts. | N/A |
| **ArcGIS Online Story Map** | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI | 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 could be used to make informed decisions. | N/A |

**Project Handoff Package**

**Transition Plan:**

Working with local partners, the project was handed off in-person in the 10th week of the term at the City of Hampton Town Hall. The team handed off our end products, which entailed annual coastline average change maps and risk maps with their associated data, an ArcGIS story map portal, as well as a coastline change detection code. The team created a partner-focused presentation concerning project development, as well as teaching the project partners logistics of user interfaces and mapping procedures.

*Software Release Plan*: There was a software release for the JavaScript code created by the team for Google Earth Engine. The City of Hampton NASA DEVELOP partners were notified in the first meeting of the term about the length of the software release process through export control. The end products were converted into user interfaces so that the partners could access the data before they received the code. The Project Lead oversaw the software release process and the handoff of the final code to the partners at the City of Hampton.

**Team POC:** Danielle Ruffe, danielle.ruffe@gmail.com

**Software Release POC**: Danielle Ruffe, danielle.ruffe@gmail.com

**Partner POC**: Bruce Sturk, bsturk@hampton.gov

**Handoff Package:**

* Annual Coastline Average Maps
* Risk Maps
* ArcGIS Online Story Map
* Technical Paper
* Video

**References:**

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