**NASA DEVELOP National Program**

**2019 Fall Project Proposal**

**Alabama – Marshall**

**Delaware Urban Development**

*Utilizing NASA Earth Observations to Assess Coastline Replenishment Initiatives and Shoreline Risk along Delaware's Coasts*

**Project Overview**

***Project Synopsis*:** Delaware’s coastal areas are dynamic environments that are susceptible to the impacts and effects of natural coastal disasters and severe weather, such as hurricanes with severe winds and devastating storm surges. Partnering with the Delaware Shoreline and Water Management Program, this project seeks to assess the impacts that these events have on the coastal fronts along the Atlantic Ocean using data from Landsat 8 OLI, Landsat 7 ETM+, Sentinel-1 C-SAR, Sentinel-2 MSI, and SRTM. This project has three objectives: 1) identify areas of current/potential shoreline loss along the Delaware coast that could benefit from restoration efforts, 2) assess the impacts of the current restoration efforts, and 3) create time-series coastline maps. The maps produces for this project can provide the partner with information that can better inform it’s decision-making in the face of extreme weather and rising sea levels.

***Community Concern:*** In late 2012, Hurricane Sandy, the largest Atlantic hurricane on record, wreaked havoc on the shorelines of New England. While New Jersey, Connecticut, and New York encountered the higher storm surges, Delaware experienced unprecedented tidal flooding as Sandy moved north across the Eastern Seaboard. In 2011, a historic nor’easter ravaged the East Coast with 40 mph winds along the Delaware coast. Delaware sits on a level plain with nearly 30 miles of ocean coastline (and an additional 350 miles of inlets, bays, and rivers) and has the lowest mean elevation in the US. This unique topography elevates Delaware’s risk to damage and erosion during extreme weather events. Over the past two decades, the state and federal government organizations like the State of Delaware’s Shoreline and Waterway Management Program have invested over $100 million to create dunes and dredge sand to strengthen the shoreline’s resilience to storms. While beaches, cliffs, and headleads naturally recede over time, intervention by the state can decrease the rate of recession. Coastal replenishment efforts coordinated by both government and non-profit organizations have restored beaches following major storm events; analyzing areas most at risk can provide cost-efficient mitigation strategies and evaluations of the success of these projects over time.

***Source of Project Idea:*** This project idea came from discussions among Alabama – Marshall Node leadership with the goal of assessing the current shoreline erosion risk along the Delaware coast. After reaching out to local organizations, the Delaware Department of Natural Resources proved to be the most appropriate entity to engage with in this project.

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

***Study Location:*** DE

***Study Period:*** January 2010 – May 2019

***Advisors:*** Dr. Jeffrey Luvall (NASA Marshall Space Flight Center), Dr. Robert Griffin (University of Alabama in Huntsville)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Delaware Department of Natural Resources and Environmental Control, Division of Watershed Stewardship** | Jesse Hayden, Environmental Scientist | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***The Shoreline and Waterway Management Program regulates the construction of coastal areas through sand nourishment, floodplain mapping, and coastal hazard identification. It works to protect and enhance eroded beaches and increase resilience to coastal storms. These programs protect and enhance Delaware’s coasts using science-based dune and beach management practices including nourishing eroding coastlines, planting beach grass to promote dune growth, fencing dune areas to protect from pedestrian traffic, and administrating an Adopt-A-Beach program. The program works to improve the state’s ability to endure severe coastal storms with minimal damage to public and private property and local infrastructure.

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

*State of Delaware, Shoreline and Waterway Management Program* – Currently, the Shoreline and Waterway Management Program relies on geospatial data, such as aerial imagery, for the mapping and conservation of Delaware’s coastlines; however, the program does not process its own data before use. Private firms are contracted to create risk and floodplain maps.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:**  The Center Lead will schedule a conference call for the first week of the term so that the participants and partners can be introduced. During this time, the team can determine if there are any alterations that need to be made to the end products. The Project Lead will be the main point of contact for the partner throughout the term, send updates weekly via email, and organize biweekly meetings.

***Transition Plan*:** At the end of the term, end products and results will be disseminated to the project partner through a web conference. During this meeting, the team will give a presentation of the results and field any questions that the partner may have. This will be followed by a tutorial explaining how to use the end products.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 8 OLI** | Surface reflectance | Landsat 8 OLI data will be combined with Sentinel-1 C-SAR and Sentinel-2 MSI data to create time series maps that identify shoreline extent changes. Landsat 8 OLI data will also be used for a risk analysis product. |
| **Landsat 7 ETM+** | Surface reflectance | Landsat 8 OLI data will be combined with Sentinel -1 C-SAR and Sentinel-2 MSI data to create time series maps that identify shoreline extent changes. |
| **Sentinel-2 MSI** | Surface reflectance | Sentinel-2 MSI data will supplement Landsat 7 and 8 data to create time series maps that identify shoreline extent changes. |
| **Sentinel-1 C-SAR** | Backscatter values, water extent | Sentinel data will be combined with Landsat data to enhance the time series of land cover change, shoreline extent, and the risk analysis. |
| **SRTM** | Elevation | SRTM elevation data were used to derive aspect and slope for the erosion risk analysis. |

***Ancillary Datasets:***

* Delaware Environmental Observing System (DEOS) Wind Data – This dataset will assist in determining the susceptibility of coastline erosion due to wind patterns.
* NOAA Coastal Change Analysis Program (C-CAP) – Land cover data will be used to identify existing coastline, coastal land cover classes, and wetlands.
* US Census Bureau population & demographic data – This data will identify population locations for flooding events.
* USDA Soil Survey Geographic Database (SSURGO) – This dataset will be used to identify different soil types and erodibility.

***Software & Scripting:***

* Esri ArcGIS – Raster manipulation and analysis, imagery processing, and map production
* ESA Snap Toolbox – Sentinel-1 C-SAR data preprocessing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Coastline Erosion Susceptibility Maps** | The end user will use these maps to identify areas that are currently susceptible to erosion | Sentinel-1 C-SAR, Landsat 8 OLI, Landsat 7 ETM+, Shuttle Radar Topography Mission and ancillary datasets will be integrated into an online map showing the areas that are at risk of erosion. | N/A |
| **Replenishment Comparison Maps** | The end user will use these maps to compare areas that have been targeted by its previous restoration efforts to assess the impact of replenishment overtime. | Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI will be used to monitor the status of coastline erosion and replenishment efforts over time according to a threshold. | N/A |
| **Pre- and Post-Disaster/Significant Event Analysis** | This analysis will provide the end user with an evaluation of coastline changes before and after major meteorological events. | Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI will be used to analyze the coastline after a natural disaster. | N/A |
| **Delaware Shoreline ArcGIS Online Story Map** | This product will communicate the benefit of using NASA Earth observations for addressing coastal erosion across Delaware. The Shoreline and Waterway Management Program will use this Story Map as an outreach tool. | Landsat 7 ETM+, Landsat 8 OLI, Sentinel-1 C-SAR, Sentinel-2 MSI, SRTM, and ancillary datasets will be integrated into an online map showing the areas that are at risk of erosion and as well as to suggest areas for planning restoration efforts. | N/A |

***End-User Benefit*:** The end products of this project will support the State of Delaware Shoreline and Waterway Management Program in its work towards restoring the coastlines following a natural disaster or an intense storm event. The Coastline Erosion Susceptibility Maps will be used for erosion monitoring and will assist the partners in identifying locations that need immediate attention. Information gathered and presented by this project will also help the Delaware Shoreline and Waterway Management Program assess the success of it ongoing replenishment programs..

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Fall

***Related DEVELOP Work:***

2019 Summer (LaRC) – Assessing Urban Tree Canopy and Impervious Surface Distribution to Inform Urban Planning in Hampton, Virginia

2018 Fall (LaRC) – Enhancing Coastal Management by Monitoring Hampton’s Coastline and Barrier Island Transgression with the Aid of NASA Earth Observations

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

2017 Spring (GA) – Utilizing NASA Earth Observations to Assess Sea Level Rise and Develop Optimal Green Infrastructure Plans to Restore Mangrove Habitat and Enhance Coastal Resiliency

**References:**

Klemas, V. (2013). Using remote sensing to select and monitor wetland restoration sites: An overview. *Journal of Coastal Research,* *289*, 958-970. doi:10.2112/jcoastres-d-12-00170.1