**Assateague Island Ecological Forecasting**

*Characterizing Nearshore Suspended Sediments and Land Cover Change Relative to Sediment Bypassing and Catastrophic Events*

**Project Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:***

North of Assateague Island, the construction of the Ocean City inlet jetty system disrupted the natural process of sediment transport along the Assateague Island shoreline, threatening the island’s wildlife habitats and geologic integrity. Our team utilized imagery from Landsat 5 ETM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI to map historical changes of nearshore suspended sediment and land cover and to forecast land cover change. This project enabled our partners at the National Park Service and United States Army Corps of Engineers to make better-informed decisions regarding the Assateague Island Sediment Restoration Project.

***Abstract:***

Assateague Island is located off the coast of Maryland and Virginia and serves as a home to sensitive species and habitats. However, infrastructure development disrupted the natural sediment transport processes of the barrier island, which accelerated erosion of the island’s shoreline. To counteract this, the United States Army Corps of Engineers (USACE) initiated semiannual sediment bypassing operations in 2004. Over time, financial constraints limited the amount of sediment deposition possible, leading to concerns over navigational issues in nearby channels and the possibility of the operations not providing their intended benefits. To address these issues, NASA DEVELOP partnered with the National Park Service (NPS) and USACE. Our team performed time series analyses of nearshore suspended sediment from 2004-2020 and landcover change from 2006-2018 with satellite imagery from Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), Landsat 8 Operational Land Imager (OLI), and Sentinel-2 MultiSpectral Instrument (MSI). The sediment transport analyses showed that suspended sediment levels are seasonally dependent. Meanwhile, historical land cover trends included a net increase in unconsolidated shore and a net decrease in open water. Land cover change was then forecast to 2021, 2031, and 2046 using the IDRISI TerrSet Land Change Modeler. Our model predicted the most drastic land cover changes in the southern portion and the least on the eastern foreshore of the island. As a result, this project allowed our partners to understand the impact of sediment bypassing operations more fully and make better-informed decisions regarding the island’s management.

***Key Terms:***

remote sensing, sediment bypassing, land cover change, Random Forest, IDRISI TerrSet, piping plover, ocean color

***National Application Areas Addressed:*** Ecological Forecasting, Water Resources

***Study Location:*** Assateague Island, MD and VA

***Study Period:*** April 2004 – March 2021, forecasting to 2021, 2031, and 2046

***Community Concerns:***

* Infrastructure development disrupted Assateague Island’s natural sediment transport processes and accelerated erosion of the island’s shoreline.
* Assateague Island provides a habitat for sensitive flora and fauna, including the federally threatened piping plover (*Charadrius melodus)*.
* Sediment bypassing operations have deposited decreasing amounts of sediment since the program began in 2004 due to funding shortages, leading to navigational issues in nearby channels where the USACE dredges sediment.

***Project Objectives:***

* Perform time-series analyses of nearshore suspended sediment from 2004-2020
* Characterize land cover change from 2006 to 2018
* Forecast landcover change to 2021, 2031, and 2046

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **National Park Service, Assateague Island National Seashore** | Bill Hulslander, Park Manager | End User | No |
| **US Army Corps of Engineers** | Justin Callahan, Project Manager | End User | No |
| **National Park Service, Ocean and Coastal Resources Branch, Water Resources Division, Northeast Region** | Cathy Johnson, Northeast Ocean and Coastal Resource Program Coordinator /Coastal Ecologist | Collaborator | No |
| **National Park Service, Natural Resource Stewardship and Science Directorate** | Monique LaFrance Bartley, Marine Ecologist | Collaborator | No |

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

The partners at Assateague Island act in accordance with the park’s general management plan, which requires natural or nature-based coastal resilience and adaptation management strategies. The sediment restoration project currently involves management strategies led by the US Army Corps of Engineers and the NPS, including semiannual offshore dredging and deposition of sand along the island’s littoral zone. This practice aims to nourish the shoreline and mitigate negative effects from the Ocean City inlet jetty system. In addition, partners use yearly ground-based shoreline surveys and beach topographic profile surveys to monitor progress and plan future sediment bypassing operations and revegetation efforts in the habitats of sensitive species before and after storm surge disturbances. The partners do not currently use NASA Earth observations to inform park management or sediment restoration project decisions.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM** | Aquatic reflectance, suspended sediment | Landsat 5 TM aquatic reflectance and suspended sediment data were used in the nearshore suspended sediment time-series analysis. |
| **Landsat 7 ETM+** | Aquatic reflectance, suspended sediment | Landsat 7 ETM+ aquatic reflectance and suspended sediment data were used in the nearshore suspended sediment time-series analysis. |
| **Landsat 8 OLI** | Land cover | Landsat 8 OLI data were used to determine land cover change over time and model future land cover change. |
| **Sentinel-2 MSI** | Aquatic reflectance, suspended sediment | Sentinel-2 MSI aquatic reflectance and suspended sediment data were used in the nearshore suspended sediment time-series analysis. |

***Ancillary Datasets:***

* US Army Corps of Engineers, Annual Shoreline Survey Data – used in conjunction with NASA EO data to ground-truth shoreline measurements and dredging/sediment bypassing events
* ASIS Boundary File – used to define the study area for the project
* NPS, Assateague Island land cover vegetation maps – used with EO data to create time-series maps of habitat for threatened and endangered species; included in training data for forecasted land cover/habitat suitability maps
* NOAA Coastal LiDAR – bathymetry, DEM data
* University of Colorado Sea Level Explorer – used as a source of contextual information about local sea-level rise, based on NASA radar altimeter monitoring
* NAIP aerial imagery, USDA FSA – used as reference imagery in analyzing land cover

***Modeling:***

* Random Forest (POC: Keith Weber, ISU GIS TReC) – used to classify land cover
* IDRISI TerrSet Land Change Modeler (POC: Keith Weber, ISU GIS TReC) – used to visualize historical land cover change and forecast future land cover change out to 2021, 2031, and 2046

***Software & Scripting:***

* Esri ArcPro 2.8 – Time series map creation of nearshore suspended sediments and landcover change
* Google Earth Engine (GEE) – Cloud-based collection and processing of earth observation data
* Optical Reef and Coastal Area Assessment (ORCAA) – GEE-based script for the estimation of suspended sediment from ocean color and turbidity

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Near Shore Suspended Sediment Time Series Maps from 2004 to 2020** | Landsat 5 TM  Landsat 7 ETM+  Sentinel-2 MSI | These maps will allow partners to visualize how nearshore suspended sediment has changed over time in relation to the recent sediment bypassing project. | N/A |
| **Historical Land Cover Change Maps from 2006 to 2018** | Landsat 8 OLI | These maps will show partners how land cover has changed over time to help them plan nature-based management strategies and restoration projects. | N/A |
| **Forecasted Land Cover Change Maps for 2021, 2031, 2046** | Landsat 8 OLI | These maps will provide the partners with modeled future land cover change scenarios while accounting for storm disturbance events. | N/A |

***Product Benefit to End User:***

Our project deliverables provided Assateague Island management with a decadal-scale look at the results of their ongoing sediment bypassing operations. They will be able to better understand the effects of the sediment bypassing operations on nearshore turbidity. Specifically, our project partners will be able to make better-informed decisions regarding habitat restoration, protection, and revegetation projects based on our time series maps of historical landcover change, forecasted land cover, and historical sediment transport.

**References**

Hapke, C. J., Himmelstoss, E. A., Kratzmann, M. G., List, J. H., & Thieler, E. R. (2010). National assessment of shoreline change: Historical shoreline change along the New England and Mid-Atlantic coasts. US Geological Survey.