**NASA DEVELOP National Program**

**2018 Spring Project Proposal**

**Massachusetts – Boston**

**Plum Island Water Resources**

*Using NASA Earth Observations to Quantify Sediment Supply in Plum Island Sound and Help Determine Vulnerability of the Plum Island Salt Marshes*

**Project Overview**

***Project Synopsis*:** Vulnerability of coastal areas to sea level rise is directly related to sediment supply: net import of sediment indicates growth and resilience against sea level rise, while net export of sediment indicates coastal deterioration. However, determining the input of sediments from the ocean to the sediment budget is challenging. This project will use Earth observations coupled to model results to determine the spatial distribution and fluxes of suspended sediments between Plum Island Sound in Massachusetts and the Atlantic Ocean. The team will use Landsat 8 OLI and Sentinel-2 MSI imagery to derive the temporal variability of water turbidity and suspended sediment concentrations at the bay inlet and will validate the data using available *in situ* measurements of turbidity and suspended-sediments concentration (SSC). These data will be used by USGS, the Plum Island Ecosystems LTER, and the Parker River National Wildlife Refuge to compute the sediment budget of the entire system.

***Community Concern:*** US Fish and Wildlife Region 5 Refuges manage approximately 24,000 hectares of coastal wetlands, a diverse ecosystem that is undergoing drastic change under accelerating sea-level rise and changing climatic forcing. The refuges have implemented hundreds of millions of dollars in restoration projects to enhance coastal resiliency in response to signs of marsh destabilization, such as widening channels, water logged platforms, accelerating erosion, and internal disintegration. However, more data on the long-term viability of salt marsh units are needed in order to target limited resources to those sites that most likely to persist with sea level rise.

***Source of Project Idea:*** Previous collaborative work by the USGS and Dr. Fagherazzi have shown that sediment flux is critically important to wetland long-term viability. As sea levels rise, wetland complexes must import sediment to maintain the structure of tidal channels, intertidal flats, and the marsh platform. Most wetland assessments rely on point measurements of suspended-sediment concentration, accretion, and/or elevation change, which can be misleading. In fact, disintegrating wetlands release a large internal sediment supply that can lead to enhanced accretion and elevation, but an overall loss of vegetated area. From their past work, the USGS and Dr. Fagherazzi concluded it is critical to use more spatially and temporally integrative measures of stability, like remote sensing data, to guide management and restoration priorities. Fluxes of sediments between the ocean and bays are the most difficult to determine and therefore a high priority for the USGS.

***National Application Area Addressed:*** Water Resources

***Study Location:*** Plum Island Estuary, MA

***Study Period:*** 2013 – 2017

***Advisors:*** Sergio Fagherazzi (Boston University), Cédric Fichot (Boston University), Neil Ganju (USGS)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| USGS, Woods Hole Coastal and Marine Science Center | Dr. Neil Ganju, Research Oceanographer | End User | Yes |
| US Fish and Wildlife Service, Parker River National Wildlife Refuge | Nancy Pau, Biologist | Collaborator | No |
| Long Term Ecological Research Network, Plum Island Ecosystems LTER | Anne Giblin, Interim Director, Ecosystems Center | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The USGS, in collaboration with Dr. Fagherazzi (Boston University) and Nancy Pau (US Fish and Wildlife), is measuring fluxes of sediments in different marshes of Plum Island Sound, MA. These data are used by the Parker River National Wildlife Refuge to develop rapid assessment metrics that can be applied by US Fish and Wildlife Service (USFWS) and other conservation organizations to assess salt-marsh persistence on a regional-scale and allow USFWS to conduct region-wide vulnerability assessment and focus future research, management, restoration, and acquisition funds where needed.

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

*USGS, Woods Hole Coastal and Marine Science Center* – The group of Dr. Neil Ganju at USGS has used Landsat imagery in the past in order to determine vegetation cover in coastal bays. The methodology developed in this NASA DEVELOP project will enable the USGS to use Landsat data to assess the availability and fluxes of marine sediments in a coastal bay. The methodology developed herein will also be tested in the near future for other bays along the US East Coast.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*US Fish and Wildlife Service, Parker River National Wildlife Refuge* – Nancy Pau, along with Sergio Fagherazzi, and Neil Ganju, is currently funded by the Department of Interior to calculate the sediment budget of several marshes within Plum Island Sound. The overarching goal of the project is to determine whether parts of the marsh are deteriorating because of sea level rise. The wildlife refuge will provide feedback on the results and product generated by the DEVELOP team.

*Long Term Ecological Research Network, Plum Island Ecosystem LTER* – PIE-LTER is highly interested in fluxes of sediments, water and nutrients within the Plum Island System. They are funded by NSF and will provide *in situ* data (e.g. turbidity) to facilitate validation.

***Dissemination by Boundary Organizations*:**

*USGS, Woods Hole Coastal and Marine Science Center* – The USGS will communicate results and products to the LTER network and the Parker River National Wildlife Refuge, likely in the form of short presentations. The project might potentially lead to a publication which will disseminate the results to the greater community.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Dr. Fagherazzi and the Center Lead at the Massachusetts - Boston node will be the POC between USGS, the NASA DEVELOP node, and the Parker River National Wildlife Refuge. The team will communicate with the partners once a month during the project.

***Transition Plan*:** At the end of the project, the DEVELOP team will provide USGS with the time series of suspended-sediment concentration and in the water column of Plum Island Sound as well as the sediment concentration calibration.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI** | Remote-sensing reflectance (Rrs), turbidity, suspended-sediment concentration (SSC) | High-resolution maps (30 m) of turbidity and suspended sediment concentration will be used with the outputs of a hydrodynamic model to derive sediment fluxes in and out of the sound. These data will be combined with Sentinel-2 to increase the temporal coverage for the study area. |
| **Sentinel-2 MSI** | Remote-sensing reflectance (Rrs), turbidity, suspended-sediment concentration (SSC) | High-resolution maps (10-20 m) of turbidity and suspended sediment concentration will be used with the outputs of a hydrodynamic model to derive sediment fluxes in and out of the sound. These data will be combined with Landsat 8 to increase the temporal coverage for the study area. |

***Ancillary Datasets:***

Boston University (C. Fichot) *in situ* measurements of Remote-Sensing Reflectance (Rrs) – Algorithm development and product validation

Boston University (S. Fagherazzi and C. Fichot) *in situ* measurements of turbidity and SSC – Algorithm development and product validation

Boston University (S. Fagherazzi) *in situ* measurements of surface-water currents – Model product validation

***Modeling:***

Delft3D model (POC: Sergio Fagherazzi, Boston University)

***Software & Scripting:***

SeaDAS – Remote sensing data atmospheric correction and re-projection for Landsat 8

ACOLITE - Remote sensing data atmospheric correction for Landsat 8 and Sentinel-2

Exelis ENVI – Remote sensing data visualization

Esri ArcGIS – Production of maps

MATLAB – Data processing

R – Statistical analyses

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Surface-Water Turbidity and SSC Maps** | This information will provide the partners with valuable information about the spatio-temporal variability of surface-water turbidity and SSC in the Plum Island Estuary. These products will directly inform about the sensitivity of these variables to environmental forcing. These products will also be used to derive the sediment-flux products described below. | A local algorithm will be applied to Landsat-8 OLI and Sentinel-2 MSI remote-sensing reflectances to produce maps of turbidity and SSC over Plum Island Sound. | N/A |
| **Maps of Suspended–Sediment Exchange (Fluxes in and out of the Plum Island Sound)** | These data will help constrain sediment budgets for the estuary. These budgets, in turn, will provide valuable information about the vulnerability of the Plum Island salt marsh and inform future management strategies to increase the resilience of this environment to a changing climate. | The high-resolution maps of SSC will be combined with water-flux outputs from the model to generate maps of sediment fluxes in and out of Plum Island Sound. | N/A |

***End-User Benefit*:** Coupling Earth observations to the model outputs will greatly facilitate the estimation of surface sediment distributions and sediment flux in and out of the inlet, compared to the use of field measurements. The results will allow the end-user to better quantify sediment budgets for the Plum Island Estuary and help guide preservation or restoration practices.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Spring

***Related DEVELOP Work:***

Summer 2014 (ARC) – American Samoa Oceans: Evaluating a Watershed Modeling Approach for Water Quality on Near-Shore Coral Reef Ecosystems in American Samoa Using NASA Earth Observations

Spring 2017(LaRC) – Chesapeake Bay Water Resources: Assessing Water Clarity to Identify Potential Areas of Submerged Aquatic Vegetation (SAV) in the Chesapeake Bay

Summer 2017(LaRC) – Chesapeake Bay Water Resources II: Assessing and Assisting Monitoring Efforts of Water Clarity to Identify Potential Areas of Submerged Aquatic Vegetation (SAV) in the Chesapeake Bay

Summer 2017 (AL & MSFC) – Coastal Alabama Oceans: Using NASA Earth Observations to Evaluate Water Quality in Coastal Alabama to Enhance Marine Wildlife Management.

Summer 2017 (JPL) – San Francisco Bay-Delta Water Resources: Utilizing NASA and ESA Earth Observations to Monitor Turbidity Conditions in the San Francisco-Bay Delta

**Notes & References:**

***References:***

Kirwan, M. L., Temmerman, S., Skeehan, E. E., Guntenspergen, G. R. & Fagherazzi, S. (2016). Overestimation of marsh vulnerability to sea level rise. *Nature Climate Change, 6***,** 253–260.