Utilizing NASA Earth Observations to Assess Marine Sediment Fluxes and Determine Marsh Vulnerability in the Plum Island Estuary

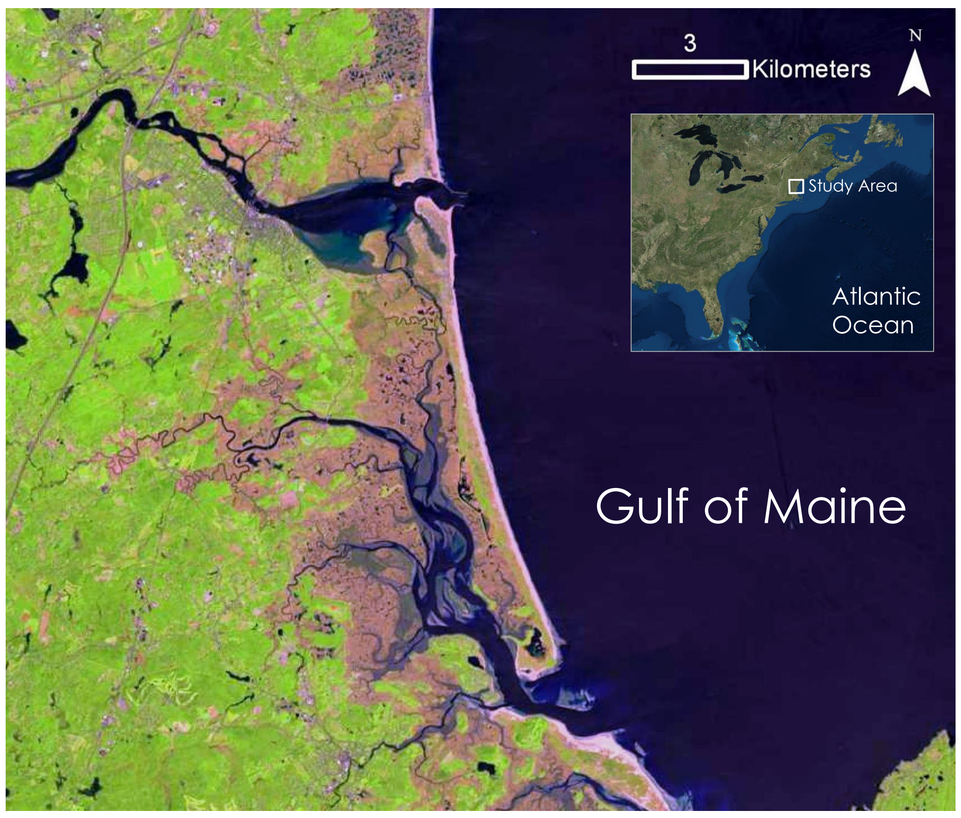
Abstract

Salt marshes provide valuable ecosystem services, including protection from coastal storms, erosion control, carbon sequestration, improved water quality, and ecological diversity. Plum Island Estuary (PIE), the largest salt marsh in the northeast United States, is a two thousand year-old ecosystem located thirty-five miles north of Boston, Massachusetts. As sea level rises, the structure and health of this marshland ecosystem depends on sediment availability. Current research in the estuary, performed by the United States Geological Survey (USGS) and the Woods Hole Marine Biological Laboratory (MBL), uses point-measurements of sediment fluxes. However, these isolated data points can be misleading when attempting to understand system-wide changes. Landsat 8 Operational Land Imager (OLI) and Sentinel-2 MultiSpectral Instrument (MSI) imagery from 2013 to 2017 were compared to *in situ* data measurements. An algorithm was generated to calculate total suspended sediment concentration and distribution in the estuary. In dynamic ecosystems like salt marshes, utilizing remote sensing to quantify and visualize sediment supply assists end users in generating current and future vulnerability assessments of PIE to sea level rise.

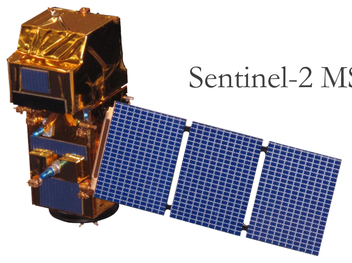
Objectives

- **Develop** an accurate methodology for estimating suspended sediment in PIE
- **Determine** suspended sediment concentrations (SSC) from satellite imagery
- **Observe** SSC along a transect in the estuary's main channel
- **Generate** a time-series from 2013 to 2017 of total suspended sediment

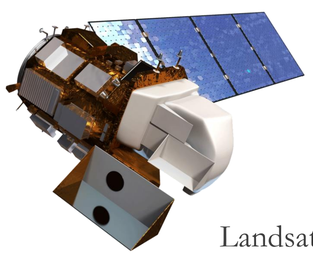
Study Area



Earth Observations



Sentinel-2 MSI



Landsat 8 OLI

Methodology

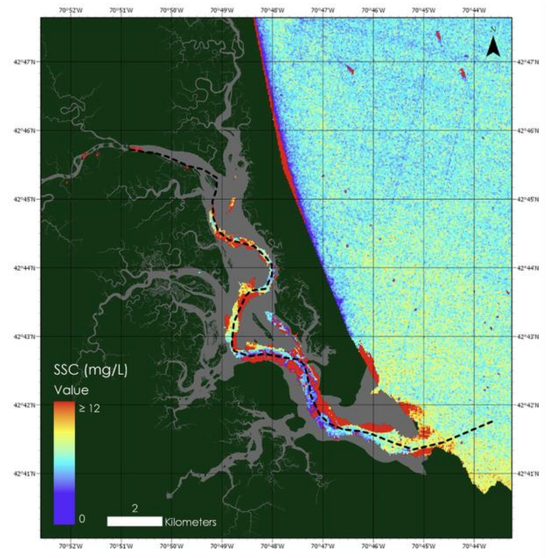
Data Acquisition and Processing → Algorithm Development → Product Generation

- *In situ* data
- Satellite imagery (GloVis)
- Atmospheric correction (ACOLITE)
- An empirical algorithm based on *in situ* data
- Polynomial regressions in R
- SSC maps (ArcGIS Pro)
- Distance vs. SSC graphs (SeaDAS and MATLAB)

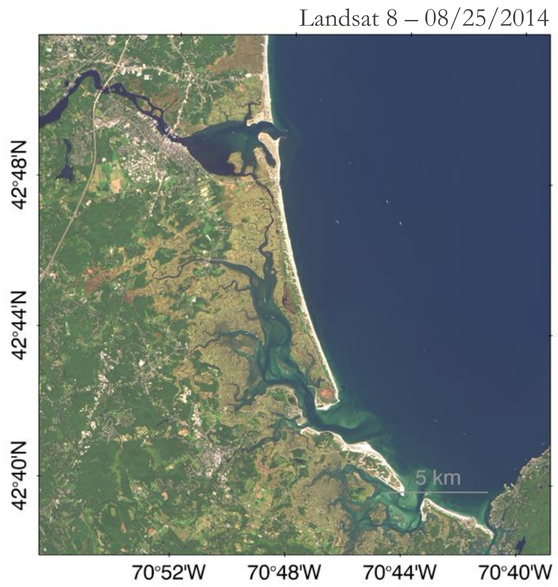
Project Partners

United States Geological Survey (USGS), United States Fish and Wildlife Service (USFWS), and Plum Island Ecosystems Long Term Ecological Research Network (PIE LTER)

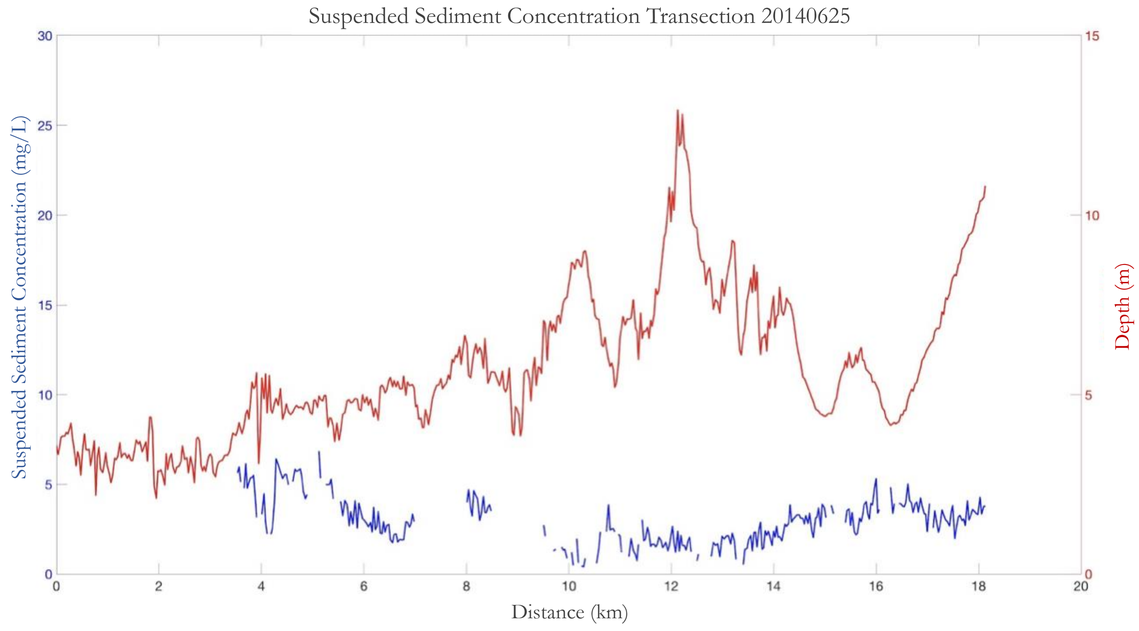
Results



Landsat 8 – 08/25/2014



Suspended Sediment Concentration Transection 20140625



Conclusions

- In general, suspended sediment concentration decreases along the transect.
- The applied algorithm is able to derive SSC from remote sensing data, but some of the results still show bottom effect.
- Atmospheric corrections need to be refined in order to eliminate noise and negative impacts of aerosols.
- Calculation of SSC in the Plum Island Estuary is feasible for areas deep enough to avoid issues with bottom reflectance.

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