NASA DEVELOP National Program
2021 Summer Project Proposal

California – Ames
Louisiana Water Resources
Using NASA Earth Observations to Monitor Historical Changes in the Extension of Seagrass Meadows in the Breton National Wildlife Refuge in Louisiana

Project Overview

Project Synopsis: This project aims to assess how changes in turbidity and sunlight attenuation serve as means to identify submerged aquatic vegetation (SAV) in the Breton National Wildlife Refuge (BNWR) in Louisiana. This project will support the Louisiana Coastal Protection and Restoration Authority (CPRA) and the Louisiana Department of Natural Resources (LDNR) to track the location and growth of seagrass meadows throughout the area surrounding the Chandeleur Islands. This project will utilize Aqua MODIS, SMAP, Sentinel-2 MSI, Landsat 7 ETM+, and Landsat 8 OLI to create a time series of water quality parameters from 2000 to 2020, as well as static maps highlighting turbidity and seagrass bed locations. The project will also generate an interactive tool via Google Earth Engine (GEE) for extended monitoring of water-quality-related data and calculation of a Normalized Difference Turbidity Index (NDTI). These products can contribute to the partners' initiatives to locate and monitor seagrass meadows throughout Louisiana's waters.

Community Concern: Breton National Wildlife Refuge is located in southeastern Louisiana in the offshore Breton and Chandeleur Islands. This area has been negatively affected by several detrimental forces over the past two decades, including Hurricane Katrina and the Deepwater Horizon Oil Spill. The focus of many restoration efforts surrounds revegetating the aquatic zones. Submerged aquatic vegetation provides important habitat resources and ecological services throughout the waters of Louisiana. It helps aquatic systems by absorbing excess nutrients, trapping suspended sediment, and slowing shoreline erosion. As climate change threatens to change sea level, increase turbidity, and more, SAV is vital in ensuring that a functional ecosystem is in place for the future of Louisiana's aquatic habitats. Understanding the extent to which seagrass meadows have changed throughout Louisiana's waters is critical in the preparation and response to impending climate disturbances.

Source of Project Idea: This project came from conversations between NASA DEVELOP Ames Research Center scientist Dr. Juan Torres-Pérez and Fellow Britnay Beaudry, and later contacting Deputy Executive Director Gregory Grandy at the Coastal Protection and Restoration Authority and Coastal Resource Scientist Supervisor Mark Hogan at the Louisiana Department of Natural Resources.

National Application Areas Addressed: Water Resources
Study Location: Louisiana Coastal Zone
Study Period: January 2000 – June 2021

Advisor: Dr. Juan Torres Pérez, (NASA Ames Research Center)

Partner Overview

Partner Organizations:

Organization	POC (Name, Position/Title)	Partner Type	Boundary Org?
Louisiana Coastal Protection and Restoration Authority	Gregory Grandy, Deputy Executive Director	End User	No

Louisiana Department of Natural Resources, Office of Coastal Management	Mark Hogan, Coastal Resource Scientist Supervisor; Sara Krupa, Coastal Resource Scientist Manager	End User	No

End User Overview
End Users' Current Decision-Making Process:
The Coastal Protection and Restoration Authority focuses on development and implementation efforts to achieve comprehensive coastal protection for Louisiana. The CPRA is required to produce an Annual Plan that provides an update on the state's efforts to protect and restore its coast and describes the short-term and long-term results that citizens can expect to see as the state progresses toward a sustainable coast. The Louisiana Department of Natural Resources is charged with implementing the Louisiana Coastal Resources Program (LCRP) and this requires that it protects, develops, and, where feasible, restores or enhances the resources of the state's coastal zone. The prime concerns are to promote sustainable and responsible use of the natural resources of Louisiana, and to regulate activities that may lead to the loss of wetlands and coastal resources. The department uses an online data portal to gather and store geospatial data related to coastal wetlands.

End User's Capacity to Use NASA Earth Observations:
Louisiana Coastal Protection and Restoration Authority – The end user is familiar with NASA Earth observations, and regularly uses remotely sensed data for research and monitoring efforts. However, its uses of remotely sensed data have not included aquatic systems, and is interested in its applications towards seagrass and water quality monitoring efforts.

Louisiana Department of Natural Resources, Office of Coastal Management – The Office of Coastal Management has utilized remotely sensed data in the past, but is unfamiliar with the capabilities of NASA Earth observations and using specific data products. While the department's online data portal has spatial information and imagery, the office currently does not have a way to quickly access and visualize regularly-updated and remotely-sensed data related to habitat changes. It is interested in the capacity building opportunity to integrate more Earth Observation into its research and habitat management practices.

Project Communication & Transition Overview
In-Term Communication Plan: The team will have bi-weekly teleconferences with the partners to discuss project methodologies and analyses. The Project Lead and the Fellow at the California – Ames node will be the primary points of contact for in-term communications with project partners.

Transition Plan: A formal end-user handoff will take place at the end of the project term in the form of a videoconference via Microsoft Teams or WebEx. Project end products and deliverables will be sent to partners via NASA Large File Transfer (LFT) after the project ends. This project will require the NASA software release process, and software will be delivered to partners after the process is complete.

Earth Observations Overview
Earth Observations:

Platform & Sensor	Parameter(s)	Use
Landsat 8 OLI	Chlorophyll, Turbidity, Irradiance/Reflectance	These data will be used to analyze changes in Chlorophyll-a, Turbidity, and Irradiance/ Reflectance in the BNWR to create the seagrass bed maps, turbidity maps, time series analysis, and GEE tool.

Landsat 5 TM	Chlorophyll-a, Turbidity, Temperature, Irradiance/Reflectance	These data will be used to analyze the change in Chlorophyll-a, Turbidity, Temperature, and Irradiance/Reflectance in the BNWR to create the seagrass bed maps, turbidity maps, time series analysis, and GEE tool.
Landsat 7 ETM+	Chlorophyll-a, Turbidity	These data will be used to analyze changes in Chlorophyll-a and Turbidity in the BNWR to create the seagrass bed maps, turbidity maps, time series analysis, and GEE tool.
Sentinel-2 MSI	Chlorophyll-a, Turbidity	These data will be used to analyze changes in Chlorophyll-a and Turbidity in the BNWR to create the turbidity maps, time series analysis, and GEE tool.
Aqua MODIS	Chlorophyll-a, Total Suspended Matter, $K_d(490)$	These data will be used to analyze changes in Chlorophyll-a, Total Suspended Matter, and Kd(490) in the BNWR to create the time series analysis and GEE tool.
SMAP L-band Radiometer	Sea Surface Salinity	These data will be used to analyze changes in Sea Surface Salinity in the BNWR to create the time series analysis and GEE tool.

Ancillary Datasets:
- US Fish and Wildlife Service National Wetlands Inventory (NWI) – Assess the general wetland and coastal area functions and cover types
- NOAA Continually Updated Shoreline Product (CUSP) – Mean-high water shoreline measurements will assist in evaluating how the distance from land to water has changed over time
- CPRA Chandeleur Island *In Situ* Data – Measured bathymetric data, seagrass bed locations, and water quality measurements of the study area from 2014 to compare with 2021 measurements and validate of end products
- Multi-Scale Ultra-High Resolution (MUR) – Analyze changes in sea surface temperature in the BNWR to create the time series analysis and GEE tool

Modeling:
- Spatial Likelihood of Occurrence (SLOO) – Assist in the prediction efforts for potential seagrass bed locations within the Chandeleur Islands

Software & Scripting:
- Google Earth Engine API – Image processing and construction of web-based tool for water parameter monitoring and analysis
- Esri ArcGIS Pro – Raster manipulation, SLOO model creation, and map product generation

Decision Support Tool & End Product Overview

End Products:

End Product	Partner Use	Datasets & Analyses	Software Release Category
Seagrass Beds Map	Maps of seagrass meadows change with time and variations in the	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI data and a calculated SLOO model	N/A

	extension of the Chandeleur Islands.	will be used to assess changes in seagrass meadows extension and geomorphological dynamics of the Chandeleur Islands within the Breton National Wildlife Refuge.	
Turbidity Map	Maps highlighting areas of low and high turbidity throughout the study area will enhance partners' understanding of suitable areas for SAV growth.	Sentinel-2, Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI, will be used to indicate areas of turbidity that can potentially support healthy populations of SAV.	N/A
Water Quality Time Series Analysis	Maps of turbidity, chlorophyll-a, total suspended matter, salinity, and sea surface temperature over time can be used to observe changes in water quality as they relate to changing populations of SAV.	Aqua MODIS, SMAP, Sentinel-2 MSI, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and MUR data will be used to assess changes in turbidity, chlorophyll-a, total suspended matter, salinity, and sea surface temperature over time.	N/A
Google Earth Engine Louisiana Water Resources Tool	This Google Earth Engine tool will create charts and maps of water quality conditions, allowing partners to continually monitor changes in water quality throughout the Louisiana Coastal Zone.	Aqua MODIS, SMAP, Sentinel-2 MSI, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and MUR data will be utilized to create a monitoring application to track water quality parameters and calculate a NDTI for areas surrounding the Breton National Wildlife Refuge.	III

End User Benefit: The results of this project will benefit the end user by providing a historical perspective on multiple water quality parameters that are related to seagrass meadow viability. End products can be incorporated into future research and used alongside current datasets as the LDNR continues its effort to monitor coastal change, and the CPRA looks to increase production of seagrass meadows around the Chandeleur Islands.

Project Timeline & Previous Related Work
Project Timeline: 1 Term: 2021 Summer

Related DEVELOP Work:
2019 Fall (ARC) – Hawaii Water Resources: Monitoring the Impacts of Land-Based Sources of Pollution on Water Quality Along the Coast of West Maui, Hawai'i, to Assess Coral Reef Condition
2017 Spring (LaRC) – Chesapeake Bay Water Resources: Assessing and Assisting Monitoring Efforts of Water Clarity to Identify Potential Areas of Submerged Aquatic Vegetation (SAV) in the Chesapeake Bay
2017 Summer (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

2017 Spring (LaRC & JPL) – Mississippi Sound Water Resources: Synthesizing Trends in Water Quality Parameters Affecting Oyster Reef Health in the Mississippi Sound Using NASA Earth Observations

2017 Summer (LaRC) – Mississippi Sound Water Resources II: Synthesizing Trends in Water Quality Parameters that Affect Oyster Reef Production in the Mississippi Sound Using NASA Earth Observations

References:

DeMarco, K., Couvillion, B., Brown, S. & La Peyre, M. (2018). Submerged aquatic vegetation mapping in coastal Louisiana through development of a spatial likelihood occurrence (SLOO) model. *Aquatic Botany*, *151*, 87-97.
https://doi.org/10.1016/j.aquabot.2018.08.007

Suir, G.M., Sasser, C.E. & Harris, J.M. (2020). Use of remote sensing and field data to quantify the performance and resilience of restored Louisiana wetlands. *Wetlands*, *40*, 2643–2658.
https://doi.org/10.1007/s13157-020-01344-y

Xu, S., Xu, S., Zhou, Y., Yue, S., Zhang, X., Gu, R., … Liu, M. (2021). Long-term changes in the unique and largest seagrass meadows in the Bohai Sea (China) using satellite (1974–2019) and sonar data: implication for conservation and restoration. *Remote Sensing*, *13.5*, 856.
http://dx.doi.org/10.3390/rs13050856