**NASA DEVELOP National Program**

**2017 Fall Project Proposal**

**Alabama - Mobile**

**Coastal Alabama Water Resources II**

*Using NASA Earth Observations to Forecast Water Quality in the Mobile Bay and Mississippi Sound to Enhance Future Marine and Fisheries Management*

**Project Overview**

***Project Synopsis*:**

Ocean water quality indicators such as turbidity, sea surface temperature (SST) and salinity each critically affect marine life in the northern Gulf of Mexico. In the Mobile Bay and Mississippi Sound, the marine life is vitally important to the local economy as seafood and tourism are large contributors to the influx of money into the area. In recent years, the area has suffered loss of marine and coastal habitat due to urbanization, oil spills, and hurricanes. In response, during the first term of this project, NASA Earth observations were used to gather historical and present water quality data. The second term of the project will primarily focus on forecasting these parameters into the future using Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+) Landsat 8 Operational Land Imager (OLI), Suomi National Polar-Orbiting Partnership Visible Infrared Imaging Radiometer Suite (NPP VIIRS), Aqua Moderate Resolution Imaging Spectroradiometer (MODIS), and the Sentinel-2 Multispectral Instrument (MSI) to understand habitat changes for oysters and manatees specifically.

***Community Concern:*** Salinity, SST, and turbidity all play an important role in the health of coastal habitat and marine health. Many community leaders, researchers, and commercial fisheries in the coastal Alabama area need these measurements to manage these areas and to plan for the future. Suitable water quality in the region is vastly important for maintaining healthy environments for the fishing and shellfish industries. Water quality is also a factor in identifying areas of focus for creating living shorelines and conducting habitat restorations.

***Source of Project Idea:*** The need for this project to aid manatee habitat management was discussed initially in response to a DEVELOP presentation at the Mobile Bay National Estuary Program’s August 2016 Science Advisory Committee Meeting. The need for a project to aid oyster fisheries management was discussed throughout the Mobile County Health Department (MCHD) node’s previous partnership with the Alabama Coastal Foundation. Further communications regarding the project between Dr. Ruth Carmichael from the Dauphin Island Sea Lab (DISL) and Dr. Maury Estes as well as between the MCHD node and Mark Berte, Executive Director of the Alabama Coastal Foundation (ACF), resulted in a DEVELOP proposal being put forth for the summer term. Follow up conversations with The Nature Conservancy (TNC) Alabama Chapter brought forward the need to forecast these ocean parameters for future management.

***National Application Areas Addressed:*** Oceans, Ecological Forecasting

***Study Location:*** Mobile Bay, AL, and Mississippi Sound, MS

***Study Period:*** June 2003 – June 2007; Forecasting to 2030

***Advisors:*** Joe Spruce (Science Systems & Applications, Inc), Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Alabama Coastal Foundation | Mark Berte, Executive Director | End User | Yes |
| The Nature Conservancy, Alabama Chapter | Dina Knight, Conservation Information Manager | End User | No |
| Dauphin Island Sea Lab, Manatee Sighting Network | Dr. Ruth Carmichael, Senior Marine Scientist II | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The ACF and TNC currently rely on field measurements and buoy data in order to collect salinity, temperature, and turbidity data for management purposes. The data they currently collect is an important factor in the management of aquatic wildlife. Additionally, the ACF began the Oyster Shell Recycling Program in fall of 2016 and since then, has collected over 3.5 million shells to place back into the water to promote oyster population growth. The program started with 6 restaurants and has now expanded to over 30. This upcoming fall the ACF will begin the process of placing recycled oyster shells. TNC is involved in restoration of living shorelines.

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

*Alabama Coastal Foundation* –The ACF is familiar with NASA Earth observations and has used them in a previous project partnered with DEVELOP.

*The Nature Conservancy, Alabama Chapter* - TNC is familiar with NASA Earth observations but is not currently using them to enhance decisions.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Dauphin Island Sea Lab, Manatee Sighting Network* –The end user has experience with the Gulf Coast marine life and can provide data and advice for the teams.

***Dissemination by Boundary Organizations*:**

*Alabama Coastal Foundation* - The ACF would like to ensure that the information from this project has a large impact for all of its partners throughout the state. As a result, they will not only utilize information from the project themselves but distribute resulting products amongst their partners and use the project to educate the public. The ACF plans to work with local partners, environmental groups, as well as high schools and colleges, in order to identify potential areas for oyster reef restoration and promote the importance of the oyster shell recycling program to the area.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Communication will initiate during the first week of the term to introduce the team and determine if there have been any changes to the desired end products. The team will ask the project partners how often they would like to receive updates; however, it is typically once every two weeks. Communication may be more frequent with local partners.

***Transition Plan*:** Virtual presentations or in-person hand-offs will be arranged with partners and the end products will be delivered electronically. The combined end products will aid the project partners in their research about how salinity, sea surface temperature and turbidity may be affecting wildlife along the Alabama coastline. Efforts will also be made to conduct a tutorial for the partners, providing instruction on the methods and data utilized during the course of the project. A software release is not anticipated for this project.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Aqua MODIS** | Surface reflectance | Certain bands in Aqua MODIS will be used to calculate an algorithm that will estimate the salinity levels throughout the Mobile Bay area. |
| **Suomi NPP VIIRS** | Surface reflectance | Certain bands in Suomi NPP VIIRS will be used to calculate an algorithm that will estimate the salinity levels and sea surface temperature throughout the Mobile Bay area. |
| **Landsat 8 OLI & TIRS** | Surface reflectance, Sea surface temperature | OLI bands in Landsat 8 will be used to detect quantify turbidity and TIRS bands will be used to detect and quantify sea surface temperature along the Alabama Coast. |
| **Lansat 7 ETM+** | Surface reflectance | Bands from Landsat 7 will be used to detect and quantify sea surface temperature in the Mobile Bay and Mississippi Sound area. |
| **Landsat 5 TM** | Surface reflectance | Bands from Landsat 5 will be used to detect and quantify sea surface temperature in the Mobile Bay and Mississippi Sound are. |
| **Sentinel-2 MSI** | Surface reflectance | Certain bands in Sentinel-2 MSI will be used to detect quantify turbidity along the Alabama Coast |

***Ancillary Datasets:***

Mobile Bay National Estuary Program – Buoy Data – water quality measurements throughout the Gulf Coast

NASA Goddard Space Flight Center – Ocean Color products – measurements of aerosols and land vegetation cover as well as air, water, and land temperatures

Dauphin Island Sea Lab – Manatee Tracking Data – GPS and manatee sighting locations

Universities Space Research Association – data, salinity mapping algorithm, and report from previous NASA MSFC project for developing a coastal water salinity mapping algorithm.

***Modeling:***

Terrset Earth Trends Modeler

***Software & Scripting:***

ERDAS Imagine 2016 – Landsat and Sentinel-2 data processing, analysis and visualization

Esri ArcMap 10.3 – raster processing/manipulation, vector data processing, map creation of Aqua MODIS, Suomi NPP VIIRS, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI and TIRS, and Sentinel-2

SeaDAS – raster processing/manipulation of GSFC’s Ocean Color data

QGIS – Landsat and Sentinel-2 data processing, analysis and visualization

ACOLITE - Landsat 8 and Sentinel-2 data processing to analyze turbidity

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Coastal Salinity Algorithm with Aqua MODIS | This end product will assist in filling a data gap for the end-user. The end user currently does not have reliable salinity measurements available for their decision-making processes. | This end product will apply a pre-existing salinity algorithm to Aqua MODIS data. The results will be compared to local buoy data for assessing accuracy. | N/A |
| Coastal Salinity Algorithm with Suomi NPP VIIRS | This end product will assist in filling a data gap for the end-user. The end user currently does not have reliable salinity measurements available for their decision-making processes. | This end product will apply a pre-existing salinity algorithm to Suomi NPP VIIRS data. The results will be compared to local buoy data for assessing accuracy. | N/A |
| Sea Surface Temperature Time Series Analysis | This end product will provide the end users with measurements of sea surface temperature for the area and assist in establishing baseline conditions. | This end product will be used as a parameter in the overall habitat suitability map. Data will be compared to local buoy data for assessing accuracy. | N/A |
| Turbidity Time Series Analysis | This end product will provide the end users with measurements of turbidity for the area and assist in establishing baseline conditions. | This end product will be used as a parameter in the overall habitat suitability map. Data will be compared to local buoy data for assessing accuracy. | N/A |
| Habitat Suitability Maps | This end product will benefit the end users by providing them with a visualization of areas where habitat may be changing for marine mammals or where oyster restoration may be suitable. This product will provide the end-users with a better understanding of where to focus resources. | This end product will combine the MODIS, VIIRS, Landsat 8, and Sentinel-2 data into a finalized map product. | N/A |
| Water Quality Forecasting Products | This end product will benefit the end users by providing them with forecasted turbidity, SST, and salinity data. This will provide end-users with a better understanding of which parameters are predicted to change over time. | This end product will utilize MODIS, VIIRS, Landsat 5 and 8, and Sentinel-2 data to forecast SST, salinity, and turbidity. | N/A |

***End-User Benefit*:**

The products generated will allow the end users to identify areas where oyster shells and living shorelines may be suitable for placement. Currently, the ACF does not have a means to conduct GIS or remote sensing analyses and look to outside organizations to support initiatives where including these analyses is needed. The TNC currently has a limited number of employees in the local office with GIS experience. The products, methodologies, and tutorials created from this project will assist the TNC in creating future products and continuing further analyses.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2017 Summer to 2017 Fall

***Multi-Term Objectives:***

* **Term 1:** 2017 Summer (AL & MSFC) – Coastal Alabama Oceans
  + The first term of this project focused on analyzing turbidity, SST, and salinity data from 2007 and 2017 to create habitat suitability maps for oysters and manatees. During the first term TNC joined the project and teams conducted fieldwork with DISL and TNC. The first term provided the methodology and data to forecast with during the second term.
* **Term 2 (Proposed Term):** 2017 Fall (AL) – Coastal Alabama Oceans II
  + The second term of the project will be focused on incorporating additional sensor data into the analyses. Efforts will also be made to forecast water quality parameters to the future. The partnership with the ACF, TNC, and DISL is expected to strengthen through additional field work opportunities, outreach events, and bi-weekly communications. The project will conclude with an in-person handoff and tutorials for the partners.

***Previous Terms:***

2017 Summer (AL & MSFC) - Coastal Alabama Oceans

***Related DEVELOP Work:***

2015 Fall (JPL) – Los Angeles Oceans: Remote Sensing Detection of Wastewater Plumes to Assess Public Water Quality in Los Angeles County

2015 Fall (AL) – Coastal Texas Water Resources II: Using NASA Earth Observations to Laguna Madre Water Conditions through Land Cover Mapping and Thermal Analysis

2015 Summer (GSFC) – Maryland Ecological Forecasting: Utilizing NASA Earth Observations to Monitor and Strengthen the Survivorship of Maryland’s Sea Turtles