**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**NASA Langley Research Center**

**Mississippi Sound Water Resources II**

*Synthesizing Trends in Water Quality Parameters that Affect Oyster Reef Production in the Mississippi Sound Using NASA Earth Observations*

**Project Overview**

***Project Synopsis*:** The objective of this project is to develop a climatology of water quality parameters in the western portion of the Mississippi Sound and to support the Mississippi Department of Marine Resources (MDMR) in mapping environmental conditions that affect oyster reef health. This project will utilize Aqua and Terra MODIS, SMAP, MUR, Sentinel-2 MSI, Landsat 7 ETM+, and Landsat 8 OLI and TIRS data to create a time series of changes in several environmental parameters from 2000 to 2016 in order to differentiate between subtle and episodic impacts on oyster reefs. These products can contribute to MDMR’s monitoring efforts by determining which parameters have the most impact on productivity, and which trends have greater impact during episodic or subtle events.

***Community Concern:*** Oyster reefs provide important ecological services: filtering particulates from the water column, providing habitat and food resources to other species, and reducing wave action and storm surge. Over the past few decades, changes in water quality and stochastic occurrences such as Hurricane Katrina have significantly depleted the number of oysters and productivity of oyster reefs in the Gulf of Mexico. Understanding the environmental conditions that affect oyster health, as well as the ability to predict when poor conditions are imminent, is critical to the continued management of oyster reefs in the Mississippi Sound.

***Source of Project Idea:*** The project idea was originally proposed by the Mississippi Department of Marine Resources (MDMR) after conversations with the NASA DEVELOP National Program Office.

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

***Study Location:*** Mississippi Sound, MS

***Study Period:*** January 2002 – December 2016

***Advisors:*** Dr. Kenton Ross (NASA Langley Research Center); Ben Holt (NASA Jet Propulsion Laboratory); Dr. Severine Fournier (NASA Jet Propulsion Laboratory)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Mississippi Department of Marine Resources | George Ramseur, Director of Office of Restoration and Resiliency;  Charlie Robertson, Shellfish Bureau;  Karen Clark, GIS Administrator;  Robert Gruba, GIS Analyst;  Scott Gordon, Director of Shellfish Bureau (retired); | End-User | No |

***End-User Overview***

***End-User’s Current Decision-Making Process:***The Mississippi Department of Marine Resources is responsible for monitoring and ensuring the continued health of oyster reefs in the Mississippi Sound. Data is collected primarily through water quality sampling near the reefs, in addition to SCUBA studies conducted during the harvesting season. MDMR also utilizes USGS *in situ* monitoring stations as a secondary source of water quality information, particularly discharge information from tributaries and their confluence in the Missisippi Sound. Since 2004, oyster harvest has decreased by more than 90% in the Sound. As a result, Mississippi’s governor signed an Executive Order establishing an Oyster Council in order to halt and potentially reverse the downward trend in oyster harvest. Several restoration efforts are currently underway, including a reduction or cap on oyster harvests, as well as continued research into aquaculture and other technologies to restore oyster populations to previous levels.

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

*Mississippi Department of Marine Resources* – The end-user is familiar with NASA Earth observations, but does not currently integrate them as the major component in their decision-making process.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team lead will be the main POC for the project. Biweekly telephone or video calls will be conducted with the project partners to discuss methodology and deliverables, in addition to weekly emails to update the partners on weekly progress.

***Transition Plan*:** End products will be delivered through a webinar conducted at the end of the term in order to facilitate discussion and feedback on the products. The time series graphs and climatology maps will be immediately available for partner analysis and integration into their decision-making process.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Aqua, Terra MODIS** | Chlorophyll-a, ADG, sea surface temperature, surface reflectance | Aqua MODIS parameters will be used to assess trends in chlorophyll-a and ADG concentrations, and analyze changes in temperature. Terra MODIS will be used to assess turbidity using linear relationships with reflectance. |
| **SMAP** | Salinity | SMAP data will be used to investigate changes in salinity between 2015 and 2017, and salinity’s relationship to other water quality parameters. |
| **Landsat 7 ETM+, Landsat 8 OLI and TIRS** | Chlorophyll-a, sea surface temperature, land cover | Landsat data will be used to assess trends in chlorophyll-a and temperature on a finer spatial scale than MODIS; additionally, they will be used to assess changes in Lousiana marsh coverage adjacent to the Mississippi Sound. |
| **MUR** | Sea surface temperature (daily 1km blended product) | MUR will be used to analyze changes in temperature over study period, and for comparison with MODIS. |
| **ESA Sentinel-2 MultiSpectral Imager (MSI)** | Chlorophyll-a, turbidity | Sentinel-2 will be used to compared to Landsat results. |

***Ancillary Datasets:***

MDMR and USGS Real-Time Hydrological Monitoring Stations – *In situ* temperature, salinity – validate remotely-sensed data

River Discharge data – Flow rates – used in model calculations

Lake Ponchartrain Basin Foundation – hydracoast maps – qualitatively assess parameter results

MDMR – historic catch data, biological sampling program, fecal coliform sampling – compare remotely-sensed water quality data to oyster productivity

Louisiana Wildlife and Fisheries – Louisiana oyster data and lease information – compare remotely-sensed water quality data to Louisiana oyster information

Louisiana Department of Health and Hospitals – fecal coliform data – compare to remotely-sensed water quality data

***Software & Scripting:***

Esri ArcGIS – analysis of watershed (ArcSWAT); SMAP

SeaDAS – Aqua MODIS and Landsat 8 OLI & TIRS analysis

Matlab – SMAP analysis

R – Landsat, MODIS, and MUR processing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Climatologies and Time Series of Chlorophyll-a, ADG, Salinity, Turbidity, and Sea Surface Temperature** | These products will provide information on trends in chlorophyll-a, ADG, sea surface temperature, salinity, and turbidity from 2002-2016 for both episodic and subtle changes in water quality which will indicate which factors appear to have the most impact on oyster productivity. These products will also focus on specific events of significance to MDMR. | Aqua and Terra MODIS, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI & TIRS, and MUR products will be processed to create monthly averages, which will then be compared to oyster productivity information to qualitatively assess effects on oysters. | I |
| **Current Conditions Map** | This product will illustrate recent conditions in chlorophyll-a, ADG, and turbidity to indicate effectiveness of recent management decisions (e.g., Governor’s Oyster Council), and which areas are showing the most improvement. | Aqua and Terra MODIS, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI & TIRS, SMAP, Sentinel-2, and MUR products will be processed to create monthly averages, and then will be used to create visual maps indicating water quality conditions over the last two years. | I |
| **Ocean Salinity and River Discharge Analysis** | Graphs and correlations depict ocean salinity and turbidity related to freshwater/brackish flow into Gulf of Mexico to assess potential runoff impacts, and if discharge is reaching reefs via historical current routes. | SMAP and Terra MODIS, in addition to *in situ* data, will be used to assess river discharge through salinity and turbidity measurements in order to assess discharge directionality, and if previous water quality conditions are continuing to affect oyster reefs. | I |
| **Oyster Reef Productivity Correlations** | Correlations between oyster reef productivity and water quality parameters will illustrate how water quality changes are potentially impacting oyster reef production, and subsequently, harvest. | Oyster reef *in situ* data and water quality parameters from MUR, Terra and Aqua MODIS, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI & TIRS, and SMAP will be compared using correlations. | I |

***End-User Benefit*:** The results of this project will benefit the end-user by providing a historical perspective on multiple water quality parameters that impact oyster reef health. The time series provided can be incorporated into future research and management efforts as the MDMR analyzes the products for recent trends that may impact future productivity of the reefs.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Term: 2017 Spring (Start) to 2017 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2017 Spring (LaRC & JPL) – Mississippi Sound Water Resources
  + The first term of this project created climatologies and time series of chlorophyll-a, ADG, sea surface temperature, salinity, and turbidity to assess trends in water quality, in addition to a river discharge analysis. For example, some of these products were at a spatial resolution of 4km, but alternative processing in SeaDAS would be able to create 1km resolution versions of the same products.
* **Term 2 (Proposed Term):** 2017 Summer (LaRC) – Mississippi Sound Water Resources II
  + The proposed second term of this project would focus on partner handoff. The team will refine and complete the climatologies created in the first term, and will add another subsampling region between Chandeleur Islands and Lake Borgne. Additionally, the team will update maps using 1 km products produced in SeaDAS. Further, the team will explore creating a toolbox/tutorial for partners to continue utilizing methodology in the future. Additional datasets from Louisiana and other local organizations will be used to supplement satellite measurements (e.g., Lake Ponchartrain Basin Foundation hydracoast maps. Finally, the team will compare their products to assess trends/environmental reactions to discharge events, low oxygen events, etc.

***Previous Terms:***

2017 Spring (LaRC & JPL) – Mississippi Sound Water Resources

***Related DEVELOP Work:***

2015 Summer (NASA Ames Research Center) – Mexico Water Resources: Utilizing NASA Earth Observations to Detect Factors Contributing to Hypoxic Events in the Southern Gulf of Mexico

2015 Fall (Wise County Clerk of Circuit Court’s Office) – Virginia Water Resources II: Monitoring Chlorophyll and Harmful Algal Blooms through NASA Earth Observations in the Lower Chesapeake for Improved Water Management

2009 Spring (NASA John C. Stennis Space Center) – Louisiana Disaster Management and Ecological Forecasting: Assessment of Tropical Cyclone Induced Transgression of the Chandeleur Islands for Restoration and Wildlife Management

2011 Fall (NASA John C. Stennis Space Center) – Gulf of Mexico Ecological Forecasting: Analyzing Multi-Year Trends of Chlorophyll, Ocean Color, Light Extinction Coefficient (K490), and Fluorescent Line Height Values from MODIS Oceanographic Data Products to Aid NOAA’s Decision Support Systems for Coral Reef Ecosystem Management within the Flower Garden Banks National Marine Sanctuary