**NASA DEVELOP National Program**

**Summer 2016 Project Proposal**

**Mobile County Health Department**

**Mobile Bay Ecological Forecasting and Water Resources II**

Monitoring Marsh Conditions in Coastal Alabama Using NASA Earth Observations to Support the Alabama Coastal Foundation’s Restoration and Conservation Initiatives

**Project Overview**

***Objective:*** To apply NASA satellite data to asses historical and current marsh conditions within priority watersheds, and to assist the Alabama Coastal Foundation in their decision-making process.

***Community Concern:*** The coastal marshlands and submerged aquatic seagrass beds of Southern Alabama have decreased in extent over the past few decades. Disturbance factors such as expanding urban land use and saltwater intrusion are increasingly threatening these areas. The Alabama Coastal Foundation (ACF) is conducting work to help restore and conserve such marsh ecosystems, which offer vital habitat to multiple wildlife species of concern. By highlighting areas of decreasing marsh health and mapping predicted marsh extent, the ACF and partner organizations can develop more informed decision making plans and focus funding efforts to help achieve restoration and conservation goals.

***National Application Areas Addressed:*** Ecological Forecasting, Water Resources

***Study Location:*** Mobile County and Baldwin County, AL

***Study Period:*** January 1984 – July 2016; 2030

***Advisors:*** Dr. Kenton Ross (NASA Langley Research Center), Dr. Just Cebrian (Dauphin Island Sea Lab)

***Source of Project Idea:*** This project was initiated through communications between the node’s mentor, Dr. Eichold, and the ACF. The ACF generated several project ideas they would be interested in pursuing - and through a meeting with the node management, science advisors, and other interested local organizations - the proposed project was created.

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Alabama Coastal Foundation | Mark Berte, Executive Director | End-User | Yes |
| Dauphin Island Sea Lab | Dr. Just Cebrian, Marine Scientist | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision Making Process:***

The ACF seeks to improve the coastal environment of Alabama through cooperation, education, and participation. As a result, the ACF partners with different organizations to collect the necessary field and reference data to help guide decision-making. Currently, no remote sensing data is utilized in their management practices other than Google Earth.

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

Alabama Coastal Foundation – The ACF has not used NASA Earth observations before, though they are somewhat familiar with DEVELOP research and some NASA ROSES projects that pertained to coastal Alabama. This project will introduce them to how NASA EO data can be used to specifically monitor marsh health and establish a methodology to continue monitoring marshes in the future.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

Dauphin Island Sea Lab (DISL) – The DISL will be providing leveraged resources through expert science advising as well as *in situ* data collection.

***Boundary Organization Dissemination:***

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 such as the Mobile Baykeepers, Conservation Alabama, or Alabama Water Watch 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 marsh restoration or conservation.

***Project Communication & Transition Overview***

***In-Term Communication Plan:***

The team will frequently communicate with the partner throughout the term via email, teleconferences, and in person meetings. Weekly to biweekly in-person meetings with the ACF and DISL are anticipated due to the close proximity of the partner.

***Transition Approach:***

Due to the close proximity of the partner, an in-person hand-off is anticipated at the end of the term. After the completion of the project, the ACF will work with local partners, environmental groups, as well as high schools and colleges, in order to identify potential areas for marsh restoration or conservation. The tools will be used to help guide their decision-making plans as early as fall 2016. No software release is anticipated at this moment.

**Letter of Support:** Alabama Coastal Foundation, Mark Berte, Executive Director

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 1,2, &3 MSS** | Vegetation indices | Will be used to extract vegetation indices identifying historical marsh health at the landscape scale. These results will be used to visualize historic marsh health, providing project partners with maps to focus their restoration efforts. |
| **Landsat 5 TM** | Vegetation indices | TM data will be utilized to extract vegetation indices identifying historical marsh health at the landscape scale. These results will be used for trend analysis, providing project partners with maps to focus their restoration efforts. |
| **Landsat 7 ETM+** | Vegetation indices | ETM+ data will be utilized to extract vegetation indices identifying historical marsh health at a smaller scale. These results will be used for trend analysis, providing project partners with maps to focus their restoration efforts. |
| **Landsat 8 OLI** | Vegetation indices/Land Use Land Cover | OLI data will be utilized to extract vegetation indices identifying current marsh health and these results will then be used for trend analysis. OLI data will also be utilized to create an updated Land Use Land Cover map of the study area. |
| **Aqua/Terra MODIS** | Vegetation indices | MODIS will be used to extract phenological responses in the vegetation greenness of coastal marshes in the study area as well as to provide a dataset with finer temporal resolution. These results will be used to help assess the analyses conducted with Landsat data. |

***Ancillary Datasets:***

Alabama Coastal Foundation – Watershed Boundaries – Delineation of study area

NOAA – Coastal LiDAR and DEM data – Validation and supplementation of other remotely sensed data

USDA Forest Service – ForWarn MODIS data – view NDVI profiles of marsh greenness during the study period

DEVELOP 2016 Summer Team, DISL, MBNEP *–* *In situ* vegetation pigmentation data – validation of remotely sensed data

***Models:***

TerrSet Earth Trends Modeler for ArcGIS/IDRISI Land Change Modeler (POC: Dr. James Toledano, Clark Labs)

**Decision Support Tool & End-Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Marsh Health Trend Analysis Maps | This product will be used to identify areas where the Alabama Coastal Foundation should focus future protection, restoration, and mitigation efforts based on historical marsh health characteristics. | Maps identifying areas of historical marsh health derived from Landsat MSS, Landsat 5 (TM), Landsat 7 (ETM+), Landsat 8 (OLI), and Aqua/Terra (MODIS) data. | 2 |
| Marsh Health Forecast Maps | The Alabama Coastal Foundation will use this product to identify where they should focus future protection, restoration, and mitigation of marshes based on these predictive maps. | Maps predicting the future health of the marshes using the current and past marsh health from Landsat MSS, Landsat 5 (TM), Landsat 7 (ETM+), Landsat 8 (OLI), and Aqua/Terra (MODIS) data as the input for TerrSet’s Earth Trends Modeler. | 2 |
| Current Land Use Land Cover Map | The Alabama Coastal Foundation will use this product to identify the extent of current marshes. | Maps of current Land Use Land Cover using Landsat 8 (OLI) data to be used as the input for TerrSet’s Land Change Modeler. | 2 |
| Land Use Land Cover Forecast Maps | This product will assist the Alabama Coastal Foundation in identifying marsh areas that may increase or decrease in the future based on current and historic land use land cover maps. | Maps of current and historic Land Use Land Cover will be used to project future Land Use Land Cover. | N/A |

***End-User Benefit:***

Coastal marshes in the Mobile and Baldwin counties are known to have decreased in extent over the last several decades. By identifying the areas where marsh health has decreased, and by predicting the future marsh extent, the ACF will be able to better allocate funds and planning efforts. Existing datasets will be utilized to focus on marshes within Mobile and Baldwin counties. Several indices that act as a proxy for marsh health will be used to identify areas of concern. The ACF will use the information to engage their partners to help enhance their decision-making process. The ACF intends to use project results to help prioritize and focus coastal marsh restoration efforts that can vary depending on the watershed.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2016 Spring (Start) to 2016 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2016 Spring (MCHD) – Mobile Bay Ecological Forecasting and Water Resources
  + The team used MODIS NDVI data to understand marsh characteristics in the study area and established baseline conditions of marsh health for the study watersheds. Preliminary analyses of marsh phenology were conducted to better understand the role of disturbance factors such as storms, fires, drought, or flooding. The maps and data created during this term will be used to conduct a long term trend analysis of the marsh health during the final term and better understand the role of disturbances on marsh phenology.
* **Term 2 (Proposed Term):** 2016 Summer (MCHD) – Mobile Bay Ecological Forecasting and Water Resources II
  + During the second and final term, the team will use image fusion codes in an effort to derive high temporal resolution products at a moderately high spatial resolution. Landsat will be used to increase the spatial resolution of the end products created from MODIS during the previous term. The use of the fusion approach will strengthen the understanding of how marsh health has changed over time. Historic Landsat 1, 2, & 3 MSS data will be used to create a historic visualization of marsh health in the study area. Alternative spectral indices to NDVI will be investigated as a potential improved or supplemental means to monitor coastal marsh in the study area. *In situ* vegetation indices data will be collected during this term and used for analysis and validation of marsh health of the study area. Partner involvement will consist of in-person hand offs along with presentations of the results to local organizations**.** Partner interaction will increase due to the anticipated increase of field work during this term and increased opportunities to present.

***Related DEVELOP Work:***

2015 Summer (Langley) - North Carolina Ecological Forecasting: Evaluating the use of NASA Earth Observations to Monitor Wetland Health in the Albermarle-Pamlico Watershed

2015 Fall (JPL) – Louisiana Ecological Forecasting: Using UAVSAR, AVIRIS and AirSWOT to Examine Historic Trends and Model Sediment Transport within the Wax Lake Delta, Louisiana to Inform Coastal Restoration Efforts

2015 Fall (Langley) – North Carolina Ecological Forecasting: Evaluating the Application of NASA Earth Observations to Rapidly Detect and Forecast Change in Wetland Types at a Regional Scale

2014 Fall (SSC) – Mississippi Water Resources and Ecological Forecasting: Utilizing NASA Earth Observations to Assist the Pascagoula River Audubon Center’s Migratory and Coastal Bird Habitat Monitoring and Restoration Planning Activities

2015 Spring (SSC) – Mississippi Water Resources and Ecological Forecasting II: Utilizing NASA Earth Observations to Assist the Audubon Mississippi Coastal Bird Stewardship Program with Habitat Monitoring and Restoration Planning Activities

2014 Fall (MCHD) – Mississippi Water Resources: Mapping Extent of Critical and Endangered Mississippi Watersheds to Assist Restoration Efforts and Conservation Planning Using NASA Earth Observations

2014 Spring (MCHD) – Mississippi Water Resources II: Mapping Extent and Modeling Ecological and Anthropogenic Stressors of Critical and Endangered Watersheds to Assist Restoration Efforts and Conservation Planning Using NASA Earth Observations

**Project Needs/Requests**

***Participants Requested:*** 4

***Software & Scripting:***

ERDAS IMAGINE – Land cover classification of Landsat 5, 7, and 8 imagery

ArcGIS – Map creation and raster manipulation

TerrSet – Marsh health forecast maps, Land Use Land Cover forecast maps

dnppy – Scripts for converting Landsat data to TOA reflectance with Python

STARFM – Pair Landsat and MODIS data

**Notes & References:**

***Notes:*** MBNEP is in the process of conducting a land cover map using one meter multispectral imagery.

***References:***

Spruce, J.P, J. C. Smoot, J.T. Ellis, K. W. Hilbert, and R.A. Swann. 2014. Geospatial method for computing supplemental multi-decadal U.S. coastal land-use and land-cover classification products, using Landsat data and C-CAP products, GeoCarto International, 29:470-485.