**NASA DEVELOP National Program**

**2019 Spring Project Proposal**

**Alabama – Mobile**

**Mobile-Tensaw Delta Water Resources**

*Using NASA Earth Observations to Evaluate Changes in Land Cover and Water Quality in the Mobile-Tensaw Delta in Southern Alabama*

**Project Overview**

***Project Synopsis*:** The Mobile-Tensaw River Delta is located on the banks of the Mobile and Tensaw rivers and is home to unique and diverse ecosystems that are important to the natural, cultural, and economic resources in the area. While this region provides essential ecosystem services to the local community, the recent urban expansion, industrial pollution, and extensive agricultural activities have degraded the water quality in the delta and subsequently, Mobile Bay. This project will utilize Landsat 8 OLI, GPM IMERG, and SRTM as inputs to the Soil Water and Assessment Tool (SWAT) model to assess the current state of the lower watershed and present scenario assessments of the effect of future change. The project's results will be used and disseminated by the project's partners who actively seek to preserve and conserve this vital ecosystem.

***Community Concern:*** Situated in southern Alabama, the Mobile-Tensaw Delta represents the convergence of nine major rivers. This riparian region consists of interconnected streams, swamps, lakes, forests, and marshes which provide optimal habitat for aquatic and terrestrial species alike. The delta also provides a plethora of ecosystem services to the surrounding area including carbon sequestration, pollution management, climate regulation, and water filtration of approximately 15% of the nation’s fresh water. The Mobile-Tensaw Delta has been coined “America’s Amazon” because of its rich biodiversity and ecological importance. It is home to more species of plants and animals than anywhere in the United States, including 126 species of fish, 46 mammals, 69 reptiles, 30 amphibians and over 300 species of birds. The delta contains the only known pitcher plant bog in the world and was recognized as a National Natural Landmark in 1974. Dams upstream are negatively affecting stream flow and sediment loads while fish populations decline and invasive plant and animal species threaten the delicate ecosystems. Human-induced ecological alterations could have disastrous effects on the delta, the surrounding communities and beyond.

***Source of Project Idea:*** The initial idea for this project was proposed based on a conversation between the E. O. Wilson Biodiversity Foundation, Dr. Bernard Eichold, and the DEVELOP Alabama – Mobile node. The idea was further developed in conversation with Alabama – Mobile science advisors and guidance from the National Program Office and partner organizations.

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

***Study Location:*** Mobile-Tensaw Delta, AL

***Study Period:*** August 1990 – December 2018

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

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Alabama Department of Conservation and Natural Resources, Weeks Bay National Estuarine Research Reserve** | Sarah Johnston, GIS Specialist  | End User | No |
| **Alabama Department of Conservation and Natural Resources, Alabama State Lands Division** | Shonda Borden, Manager  | End User | Yes |

***End-User Overview***

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

The Alabama State Lands Division of the Alabama Department of Conservation and Natural Resources (ADCNR) seeks to manage and maintain a broad range of state-owned properties throughout Alabama. Most lands managed by the Division are trust lands managed for specific purposes, however, the State Lands Division works closely with partner departments within the ADCNR including the Weeks Bay National Estuarine Research Reserve (NERR) to utilize research in areas of ecological importance in the region to promote informed management and good stewardship practices. The Alabama State Lands Division currently operates the 5 Rivers Delta Resource Center, where this research is disseminated to the public through a variety of education initiatives. A portion of the research of Weeks Bay NERR examines the ecological importance of the Mobile-Tensaw Delta to provide evidence in support of long-term conservation efforts. While 5 Rivers Delta Resource Center is familiar with NASA Earth observations, they have yet to leverage it in their work.

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

*Alabama Department of Conservation and Natural Resources, Alabama State Lands Division* - Currently, the Alabama State Lands Division does not utilize NASA Earth observations. However, they have a basic familiarity with several sensors and would like to incorporate them into their work.

*Alabama Department of Conservation and Natural Resources, Weeks Bay National Estuarine Research Reserve* - Currently, the Weeks Bay National Estuarine Research Reserve conducts limited research using NASA Earth observations, but has not utilized NASA products for monitoring and analysis specific to the Mobile-Tensaw Delta region.

***Dissemination by Boundary Organizations*:**

*Alabama Department of Conservation and Natural Resources, Alabama State Lands Division* – The Alabama State Lands Division operates 5 Rivers Delta Resource Center in Mobile, Alabama. At 5 Rivers, good stewardship practices and conservation efforts are encouraged through educational programs, community outreach, and local events. These initiatives are supported by research through other departments including the Weeks Bay National Estuarine Research Reserve.

*Alabama Department of Conservation and Natural Resources, Weeks Bay National Estuarine Research Reserve* – The Weeks Bay National Estuarine Research Reserve disseminates research through their coastal training program that provides science-based tools for coastal decision-makers. Their research provides a scientific basis for coastal and riparian management for both scientists and resource managers. Their education program works to promote conservation practices in marine environments to educators and the general public.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Communication between the DEVELOP team and the project partners will take place biweekly via teleconference or in-person meetings. Lines of communication will remain open if issues arise, but these meetings will primarily involve project updates and high-level results. The Center Lead will coordinate an initial project meeting within the first two weeks of the term and will transition this responsibility to the Project Lead. Initial communications will be collaborative, involving all partners to determine key project goals.

***Transition Plan*:** All end products and deliverables will be provided to the project partners through email following the project’s completion. An in-person handoff will be conducted at the end of the term. If an in-person meeting is not feasible, a virtual handoff presentation will be conducted via web conference, either Google Hangouts or WebEx. During this meeting, the team will present the project results to the partners and field any questions they may have.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 5 TM** | Surface reflectance  | Landsat 5 imagery will be used to classify land cover as an input for the SWAT model. |
| **Landsat 7 ETM+** | Surface reflectance | Landsat 7 imagery will be used to classify land cover as an input for the SWAT model. |
| **Landsat 8 OLI** | Surface reflectance | Landsat 8 imagery will be used to classify land cover as an input for the SWAT model.  |
| **Sentinel-2 MSI** | Surface reflectance  | Sentinel-2 data will be used to classify land cover at a 10 m resolution as an input for the SWAT model. |
| **GPM IMERG**  | Precipitation | GPM IMERG will be used as the precipitation measurement for the SWAT model. |
| **SRTM** | Digital Elevation Model | The SRTM will provide elevation data needed for the SWAT model. |

***Ancillary Datasets:***

USGS National Land Cover Dataset (NLCD) – The 100 m resolution products will be used to further identify land cover changes.

National Estuarine Research Reserve System, Centralized Data Management Office (CDMO) – The *in situ* measurements will be used to validate NDTI.

National Center for Environmental Prediction Climate Forecast System Reanalysis (NCEP CFSR) – Relative humidity, wind, solar radiation, and air temperature data were used for SWAT weather inputs

Food and Agriculture Organization (FAO UN) Harmonized World Soil Database v 1.2 – Soil classification used as an input for the SWAT model

USGS National Water Information System - Water flow and water quality parameters used to calibrate the model.

***Modeling:***

ArcSWAT (POC: Kathrene Garcia, NASA DEVELOP)

SWAT-CUP (POC: Kathrene Garcia, NASA DEVELOP)

***Software & Scripting:***

ArcGIS 10.5 – Raster manipulation and analysis, imagery processing, and map creation

QGIS – Raster manipulation, land cover maps compilation, and geo-spatial data visualization

R studio – Downloading and preprocessing precipitation data

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Land Use Land Cover Time Series**  | This product will identify areas that have undergone land cover change over four major time steps (1990, 2000, 2010, 2018). The partners will use this product to demonstrate the reality of land cover change for the Mobile-Tensaw Delta over the past three decades.  | Landsat 5, Landsat 7 ETM+, and Landsat 8 OLI will be used to assess land cover change over the study period.  | N/A |
| **Baseline Watershed Assessment** | This product will assess the current state of watersheds in the Mobile-Tensaw Delta. The partners will use this product to understand the current outputs from sub-basins in the lower reaches of the river and identify potential areas for conservation efforts. | Landsat 8 OLI, GPM IMERG, and SRTM, as well as ancillary soil and climatic data will be used as inputs to the SWAT model. *In situ* measurements from USGS will calibrate and validate the model's results.  | N/A |
| **Land Cover Scenario Assessment** | This product will determine the effect of potential land cover change on the lower parts of the watershed. The partners will use this product to support their conservation efforts. | Landsat 8 OLI, GPM IMERG, and SRTM, as well as ancillary soil and climatic data will be used as inputs to the SWAT model. | N/A |
| **Climatic Scenario Assessment** | This product will model the hydrologic effect of potential climatic changes on the Mobile-Tensaw delta. The partners will use this product to support their conservation efforts.  | Landsat 8 OLI, GPM IMERG, and SRTM, as well as ancillary soil and climatic data will be used as inputs to the SWAT model. | N/A |
| **Delta in the Delta Story Map** | This product will communicate the changes that have occurred in the delta as well as the results of this project. The partners will use it to disseminate information and encourage more research and protection of the area. | The SWAT model outputs and land cover time series derived from Landsat 5, Landsat 7 ETM+, Landsat 8 OLI, GPM IMERG, and SRTM will be highlighted in this story map.  | N/A |

***End-User Benefit*:** The project methods and analysis will contribute to the ADCNR’s current conservation efforts in the Mobile-Tensaw Delta. The end products will justify the department’s conservation efforts and highlight the usefulness of remotely sensed data in monitoring the delta and surrounding areas. In particular, the products can assist resource managers in their evaluations of change in the Mobile-Tensaw Delta and also provide justification for future conservation initiatives.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Spring

***Related DEVELOP Work:***

Summer 2018 (MSFC) – Chao Phraya Water Resources: Assessing Water Quality in Thailand’s Chao Phraya Watershed through Modeling Sediment Concentration and Urban Footprint

Summer 2016 (AL) - Mobile Bay Eco Forecasting: Monitoring Marsh Conditions in Coastal Alabama Using NASA Earth Observations to Support the Alabama Coastal Foundation’s Restoration and Conservation Initiatives

Spring 2018 (GA) - Osa Peninsula Water Resources: Assessing Threats to River Water Quality and Mangrove Health Based on Watershed Land Use on the Osa Peninsula, Costa Rica

Summer 2018 (GA) - Osa Peninsula Water Resources II: Utilizing NASA Earth Observations to Evaluate Effects of Land Use Change on Watershed Health and Carbon Sequestration in the Osa Peninsula, Costa Rica

**References:**

***References:***

Ellis, J. T., Spruce, J. P., Swann, R. A., Smoot, J. C., & Hilbert, K. W. (2011). An assessment of coastal land-use and land-cover change from 1974–2008 in the vicinity of Mobile Bay, Alabama. *Journal of Coastal Conservation*, *15*(1), 139-149.

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