**NASA DEVELOP National Program**



Mobile County Health Department

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Mobile Bay Ecological Forecasting

Monitoring Marsh Conditions in Coastal Alabama using NASA Earth Observations to Support the Alabama Coastal Foundation’s restoration and Conservation initiatives

 **Technical Report**

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# I. Abstract

[Placeholder - do not put anything here until the final draft submission. The abstract in the project summary is where the working draft of the abstract should “live”]

**Keywords**

Alabama, coastal ecosystems, ecological forecasting, salt marsh, remote sensing, MODIS, NASA Earth Observing Systems (EOS)

# II. Introduction

**Background**

A marsh is a wetland dominated by herbaceous plant species, and is typically found at the edges of water bodies. Wetlands are widely considered one of the most productive ecosystems of the biosphere (Steffen et al. 2010). Marshes are categorized as one of several types: freshwater marsh, brackish marsh, and salt marsh. These areas act as a transition zone between aquatic and terrestrial ecosystems, and provide invaluable ecosystem services to human society. Coastal counties in the United States (US) account for about 17% of land area, yet just over half (53%) of the population lives in a coastal zone (NEP 2008; Craft et al. 2009). For the purposes of this study, focus is given to coastal marshes surrounding Mobile Bay.

Mobile Bay is an estuary, meaning that it is an area where freshwater and saltwater mix due to tidal fluctuations. Therefore, this area has freshwater marshes in the upper delta areas and along headwaters, which transitions through brackish marshes and finally into saltwater marshes in areas closer to the Gulf of Mexico (GOM). The waterways draining into Mobile Bay have created the second largest river delta system within the United States (NEP 2008). Salt marshes mitigate flooding and coastal erosion, buffer inland areas from severe weather events, filter polluted waters, and provide habitat for a plethora of species. Many of these species, such as shrimp, crab, and oyster, are crucial to coastal economies (Handley et al. 2007; NEP 2008; Moody et al. 2013).

Coastal areas of Alabama have seen dramatic decreases in wetlands over the last 200 years due to a variety of natural and anthropogenic stressors (Handely et al. 2007; Craft et al. 2009; NEP 2008). Urban development, invasive species, resource extraction activities, and sea-level rise (SLR) are among the most concerning disturbances that marshlands face (NEP 2008). According to Handley et al. (2007), Coastal Alabama lost 54.4% (36,468 acres) of all emergent wetland between 1955 and 2002. The decline and fragmentation of marsh ecosystems create many undesirable effects due to the loss of services and goods.

Coastal erosion increases because the roots of marsh grasses are no longer holding soils together (Moody et al. 2013). As these habitats are lost, many species become endangered, or even extinct. Water chemistry changes, as it no longer has the marshland to filter out impurities (Handley et al. 2007). We then see harmful algal blooms (HABs) develop in the GOM threatening coastal fisheries and local economies (NEP 2008). These negative effects are only a few of the most obvious. However, many groups have come together to support environmental efforts directed towards marshland. Handley et al. (2007) notes that marsh decline has decreased over time, likely due to the advent of environmental laws and interest groups.

**Project Objectives**

The main objective of this project is to assist the Alabama Coastal Foundation (ACF) in their decision-making process by applying NASA satellite data to assess historical and current marsh health. Land change models are used to predict future extent of marshland, which allows the partners to focus funding and efforts in the most beneficial areas.

**Study Area**

The focus area for this project is Mobile and Baldwin counties, which comprise the area known as Coastal Alabama (Fig. 1). These counties lie on the Gulf of Mexico between Mississippi and Florida. Mobile Bay, parts of Mississippi Sound, and Perdido Bay are the main water bodies in the study area. Coastal Alabama marshland is found along these water bodies, as well as riparian environments further inland.

Figure 1 - Map showing study area – Not Final Map!

**Study Period**

The study period for this project ranged from January 1984 to January 2016. This timeframe is influenced by available Landsat 5 data, which dates back to 1984. However, not all data will be able to cover the entire timeframe. For example, MODIS data is only available beginning in 2000, and is used to gain a better understanding of temporal changes rather than spatial distribution.

**National Application Addressed**

This project focused on the Ecological Forecasting application area, which addresses community concerns regarding local ecosystems. Ecological forecasts are used to predict changes in ecosystems in response to a variety of disturbances, as well as the resulting impact on human societies that depend on the services offered by ecosystems. This project also falls under the Water Resources application area.

**Project Partners**

Partners for this project include the Alabama Coastal Foundation (ACF) and the Dauphin Island Sea Lab (DISL). The ACF is both an end-user and a boundary organization, while the DISL operates as a collaborator. These organizations work with many others to promote coastal conservation, restoration, and protection. Field surveys, quality testing, and species inventories are being performed by these organizations to establish and monitor coastal marsh health. Because current methods are often costly and laborious, the DEVELOP team at the Mobile County Health Department is approaching the problem by using NASA satellite data to perform similar analyses at a much larger scale that are more cost-effective. Data from field studies are provided by partners and used to ensure accurate remotely sensed findings.

# III. Methodology

**Data Acquisition:**

Most recent National Land Cover Database (NLCD 2011) was created by Multi-Resolution Land Characteristics Consortium (MLRC). This data was retrieved from [mrlc.gov](file:///C%3A%5CUsers%5CNASA%20DEVELOP%5CDocuments%5CCyberLink) for the purpose of Land use Land cover Classification (LULC). Additional regional data were downloaded from NOAA Coastal Change Analysis Program (C-CAP) to improve the understanding of coastal upland and wetlands. This data set is the 2010-era classification of U.S. Alabama/Mississippi region. A topo bathymetric model of Northern Gulf of Mexico 2013 was retrieved from National Oceanic and Atmospheric Administration (NOAA). Wetland likelihood data (2011) based on a continuum of wetness from dry to water was retrieved from NOAA’s National Ocean Service (NOS), Office for Coastal management (OCM). Watershed boundary data of the study area was received from Alabama Coastal Foundation (ACF).

Atmospherically corrected MODIS / Terra,Version 6, 8 day surface reflectance product at 250 m resolution were retrieved from NASA’s Land Process Distributed Active Archive Center (LP DAAC). These reflectance data were used to extract vegetation indices such as normalized difference vegetation index (NDVI) to view NDVI profiles of marsh greenness across MODIS era from 2000 – present. This profile will generate a better understanding of marsh characteristics and establish a baseline conditions for marsh health. NDVI is based on the high absorption of energy by vegetation pigments in the red and low absorption in the near-infrared spectral range (Simas et al., 2001) and can be calculated as -

NDVI = (NIR – R) / (NIR + R).

R and NIR stand for spectral reflectance measurement acquired in the visible red and near infra-red regions, respectively.

Landsat MSS, TM, ETM plus and OLI data were retrieved from USGS Global Visualization Viewer (GLOVIS) to extract vegetation indices such as NDVI to identify historical marsh health at the landscape scale. Fifteen years of climate data (precipitation and temperature) retrieved from National Weather Service to understand the precipitation and temperature deviation in the study area.

Software used in this project includes

* ERDAS IMAGINE 2015, for land classification of Landsat imagery.
* Arc GIS 10.3.1, 2015 for raster manipulation/analysis, image enhancement and map creation.
* TerrSet Land Change Modeler (LCM) for Land modelling and forecasting of marshes.

**Data Processing**

Coming soon!

**Data Analysis**

Coming soon!

# IV. Results & Discussion

Coming soon!

# V. Conclusions

Coming soon!

# VI. Acknowledgments

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# VII. References

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# VIII. Content Innovation

Coming soon!

# IV. Appendices

Coming soon!