**NASA DEVELOP National Program**

****Jet Propulsion Laboratory

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**Gulf Coast Ecological Forecasting**

*Utilizing Spaceborne and Airborne Sensors to Monitor the Health of Louisiana’s Coastal Wetlands*

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**Team Members:**

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**Applied Sciences National Applications Addressed:**

Ecological Forecasting

**Study Area:** Louisiana, USA

**Study Period:** 1986 – 2014 (wetland change detection and biomass, mangrove growth potential), 2025-2100 (wetland response to sea level rise)

**Partners/Collaborators**

Louisiana State University: Victor H. Rivera-Monroy

USGS National Wetlands Research Center: Tom Doyle

**Blurb**

This project used remote sensing to monitor the health of coastal wetlands and to assess their vulnerability to sea level rise and human activity along Louisiana’s coast. Landsat 8 data was used in conjunction with land cover datasets to perform change detection, and wetland biomass was estimated using Synthetic Aperture Radar (SAR) data. Within coastal Louisiana, the team modeled mangrove ecosystem productivity and wetland response to climate change using the FORMAN model (Chen and Twilley 1998) and the Sea-Level Affecting Marshes Model (SLAMM), respectively.

**Community Concerns**

* Coastal wetlands offer a variety of ecosystem services such as improved water quality, protection from storm surges, and habitat for wildlife.
* However, coastal wetlands in Louisiana are continually threatened by development, pollution, and rising sea levels.
* With sea-level rise coastal wetlands may become inundated which can result in loss of wetland habitat or the wetland changing into another wetland class.

**Current Management Practices & Policies**

Coastal Wetlands Planning, Protection and Restoration Act (Public Law 101-646, Title III CWPPRA) provides funding to help restore wetlands within Louisiana. To date over 110,000 acres of wetlands in Louisiana have benefitted from this legislation. There are limited analyzed remote sensing data on coastal wetlands within Louisiana and most projects are small-scale field measurements, including biomass, salinity, nutrients and erosion rates. A large scale study along the entire Louisiana coast or Gulf Coast is impractical, therefore utilizing remote sensing techniques is crucial for large scale analyses.

**Abstract**

Louisiana’s coastline is home to widespread wetland ecosystems, including salt marshes and mangrove forests, which provide vital ecological services. These wetlands are extremely vulnerable to sea level rise due to climate change, urban development, and the relatively low elevation along Louisiana’s coast. To assess the health, distribution, and vulnerability of tidal wetlands, a variety of datasets and models were investigated. This involved using a time series from 1984 to the present of Landsat 5 and 8 and National Wetlands Inventory data to perform change-detection. NASA’s Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) and the Japanese Aerospace Exploration Agency’s (JAXA) Advanced Land Observing Satellite (ALOS) Phased Array type L-band Synthetic Aperture Radar (PALSAR) data were also used to create estimates of biomass within wetlands along Louisiana’s coastline. These data then informed the implementation and interpretation of two ecological models. First, the FORMAN Model was presented as a preliminary tool to assess the growth potential of Louisiana’s mangrove ecosystems. Then, the Sea Level Affecting Marshes Model (SLAMM) was applied to investigate wetland vulnerability and predict the response of all coastal wetlands in Louisiana to sea level rise. This model implemented the Intergovernmental Panel on Climate Change’s (IPCC) climate change projection A1B, which then allowed for the estimation of biomass loss with increasing sea level. With these data compiled and tools implemented, the overall health and vulnerability of Louisiana’s coastal wetlands could be appraised to inform further research and official decision-making.

**Decision Support Tools**

* Coastal wetland change detection map - Map of change in Normalized Difference Vegetation Index (NDVI) from Landsat data in wetland regions.
* Coastal wetland biomass map - Maps of total above-ground biomass by wetland type derived from UAVSAR and ALOS PALSAR data.
* Mangrove growth potential map - Map of ecosystem productivity in mangrove wetland regions, measuring potential tree growth based on the FORMAN model.
* Coastal wetland sea level rise response map - Maps of projected change in wetland type due to sea level rise based on SLAMM for the years 2025, 2050, 2075, and 2100.

**Benefit to End-User:**

* Compilation of data, tools, and scripts to model mangrove ecosystem productivity and wetland response to climate change.
* Understanding of how sea-level rise caused by projected climate change will impact coastal wetlands.
* Knowledge of biomass loss and therefore carbon storage change with sea-level rise.

**Earth Observations & Parameters**

Landsat 5, Thematic Mapper (TM) - NDVI and change detection

Landsat 8, Operational Land Imager (OLI) – NDVI and change detection

Space Shuttle Endeavor, Shuttle Radar Topography Mission (SRTM) v2 - Digital elevation

model

Gulf Stream III, Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) -

Canopy structure and biomass

Advanced Land Observing Satellite (ALOS), Phased Array type L-band Synthetic

Aperture Radar (PALSAR) - Canopy structure and biomass

**Models Utilized**

FORMAN Model - Mangrove ecosystem productivity

Warren Pinnacle Consulting, Inc., Sea Level Affecting Marshes Model (SLAMM) –

Forecast wetland response to sea level rise

**Ancillary Datasets Utilized**

Louisiana State University Virtual Coast Data Archive - LiDAR DEM

USGS 1 km MODIS-based Maximum Green Vegetation Fraction - Fractional coverage USGS National Land Cover Dataset - Land cover

USGS National Hydrography Dataset - Watersheds

USGS Water Data for the Nation - Salinity and nutrient availability

US Fish and Wildlife Service National Wetlands Inventory - Wetlands map

**Software Utilized**

ArcGIS - UAVSAR data processing, biomass and canopy height calculations, map

production

QGIS - Landsat 8 OLI data processing

Next ESA SAR Toolbox - ALOS PALSAR data processing

Python - Implementation of the FORMAN model

LibreOffice Calc - Biomass regression modeling and tidal chart manipulation

SLAMM - Predictive wetland sea level rise response modeling

R - Statistical operations for Landsat and SAR data