**NASA DEVELOP National Program**

****Stennis Space Center

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**Coastal Texas Oceans II**

Enhancing Remote Sensing Capabilities of the *Sargassum* Early Advisory System (SEAS) Through the Use of NASA Earth Observations and Open Source GIS

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**Applied Sciences National Applications Addressed:**

Oceans

**Study Area:** Texas Gulf Coast

**Study Period:** January 2003, April 2012 - Present

**Community Concerns**

* Communities nestled along the coastline rely heavily on tourism as a primary source of income, with Texas beach tourism generating approximately $7 billion per year.
* Public use of these beaches can be severely restricted by the periodic mass landings of free-floating brown macroalgae known as *Sargassum*.
* These *Sargassum* landings often occur with little or no warning, and can last for weeks at a time, usually during the prime tourist season, thereby negatively affecting the economies of the region.
* Trapped anthropogenic litter within the *Sargassum* can include plastics, paper, and medical and industrial waste, potentially creating a health hazard.
* Since some Texas beaches have been anthropomorphically elongated, *Sargassum* can no longer naturally migrate up and supplement the dune system, ergo coastal managers have utilized machinery to move the *Sargassum* wracks into the dunes

**80-100 Word Blurb**

Every year the Texas Gulf Coast economy is threatened by periodic mass landings of *Sargassum*. Managing these landings creates financial strains on coastal municipalities. Scientists at Texas A&M University at Galveston have implemented the *Sargassum* Early Advisory System (SEAS), which provides coastal managers with landing predictions through the use of remote sensing. The objectives this term include working with SEAS to enhance remote sensing methodologies using open-source GIS to aid in the detection and tracking of *Sargassum* near the Texas Gulf Coast.

**Abstract**

*Sargassum,* also known as Gulfweed, is a genus of brown macroalgae that can be found floating in large, dense mats. The two species found within the Gulf are *Sargassum fuitan* and *S. natans.* These species are holopelagic, meaning the entire lifespan of these organisms are spent in open water. At sea, these *Sargassum* mats serve as a viable habitat to unique and diverse communities of marine organisms. However, when these large quantities of *Sargassum* land on Texas beaches, they pose a serious threat to the Texas coastal economy. The decomposition of *Sargassum* and the organisms therein give rise to unattractive odors. *Sargassum* can also trap plastics, paper, medical and industrial waste. Furthermore, several Texas beaches have been anthropomorphically elongated and Sargassum can no longer naturally migrate up and supplement the dune system. Coastal managers have utilized machinery to move the *Sargassum* wracks to the top of the dunes. The removal of these large mats is both costly and time consuming, especially if unexpected. If provided with early notice of the arrival of *Sargassum*, land managers can be better prepared to allocate resources for beach cleanup. In 2012, scientists at Texas A&M University at Galveston began utilizing NASA Earth Observations, specifically LandsatLook “Natural Color” JPEG images, to track *Sargassum* mats in the Gulf of Mexico as they approach the Texas Gulf Coast. Their Sargassum Early Advisory System (SEAS) notifies coastal managers of these Sargassum episodes so that managers are better prepared for proper cleanup efforts and resources can be allocated appropriately. This project focused on converting methodologies for image manipulation established by the Fall 2013 Coastal Texas Oceans I team for use in Quantum GIS. Tutorials produced from this project were provided to SEAS. This included calculating various indices on Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and Landsat 8 Operational Land Imager (OLI) images such as Normalized Difference Vegetation Index (NDVI), Floating Algae Index (FAI), and a Near Infrared/Red band ratio.

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**Partners/Collaborators**

Dr. Thomas Linton, Texas A&M University, *Sargassum* Early Advisory System (SEAS)

**Current Management Practices & Policies**

The Texas Gulf Coast provides a natural recreational asset to thousands of visitors every year. This three hundred mile beach system is managed and maintained by both public and private stakeholders. Each year over $2.91 million dollars is allocated to relocating the abundance of *Sargassum* that lands on Texas beaches. Beach managers have typically had to rely on emergency funds to assist in removing heavier than normal *Sargassum* from the beach. This creates an unexpected hardship, since their annual budgets have little to no room for unforeseen expenditures. In response, Texas A&M University at Galveston developed SEASto investigate the use of remote sensing and geospatial technologies in warning coastal managers as early as possible regrading incoming *Sargassum* events. These predictions allow beach managers to adjust their allocation of resources for the timely and efficient management of *Sargassum* landings. The SEAS team continually presents their *Sargassum* detection findings to numerous organizations along the Texas Gulf Coast, including Home Owners Associations, the Texas Academy of Science, American Shore and Beach Preservation Association, Texas Association of Environmental Professionals, Galveston Chamber of Commerce, Civic Groups, Lambda Kappa Alpha Texas A&M University at Galveston Honors Program, and Texas General Land Office. They also reach out to regional high schools by teach students how to analyze these images themselves and submit them to SEAS.

Currently, the SEAS Program uses open source image editors and LandsatLook “Natural Color” JPEG images to analyze satellite imagery from NASA’s Landsat 7 ETM+ and Landsat 8 OLI. Once seaweed is determined to be present, ocean and atmospheric current data from the HYbrid Coordinate Ocean Model ( HYCOM) and Buoyweather.com are used to forecast the arrival of the *Sargassum* mats as they approach the Texas Coast. This current software does not utilize band manipulation techniques or processing, which could potentially further increase the contrast between the floating *Sargassum* and the water in the background.

**Benefit to End-User:**

* Overview of remote sensing, how to apply remotely sensed data, and overall usefulness of NASA Earth Observations Systems (EOS)
* Enhanced *Sargassum* detection tutorials for use with ArcGIS and QGIS

**Decision Support Tools**

* Improved *Sargassum* detection methodology enabling end-users to implement the use of QGIS software instead of Paint. This would potentially allow for image manipulation in order to enhance visual detection of *Sargassum.* This will include a technical paper and a number of tutorials explaining project methodologies and results
* Example products of indices, classifications, and image enhancements to better detect *Sargassum* in Landsat 7 and 8 data

**Earth Observations & Parameters**

Landsat 4-5 TM- Spectral vegetation indices and Visible/NIR imagery

Landsat 7 ETM+-Spectral vegetation indices and Visible/NIR imagery

Landsat 8 OLI - Spectral vegetation indices and Visible/NIR imagery

**Future Applicable NASA Missions**

Aqua AMSR-E (Advanced Microwave Scanning Radiometer)-SST; Sea Surface Winds

Aqua & Terra MODIS (Moderate Resolution Imaging Spectroradiometer)- Remote Sensing Reflectance-250m products

**Models Utilized**

None used

**Ancillary Datasets Utilized**

NOAA National Data Buoy Center – In-situ measurements of wind and currents

Texas Automated Buoy System (TABS) – In-situ measurements of wind and currents

**Software Utilized**

Erdas Imagine - land classification of Landsat imagery, generation of environmental monitoring indices, and analysis of *Sargassum* detection products

ArcGIS - Raster Manipulation/Analysis, Image Enhancement & Map Creation of Landsat 7 ETM+, Landsat 8 OLI

QGIS- Raster Manipulation/Analysis, Image Enhancement & Map Creation of Landsat 7 ETM+, Landsat 8 OLI

Python scripting software – automation of digital number to reflectance value conversions and calculation of indices