**NASA DEVELOP National Program**

Langley Research Center

**Spring 2015**

**North Carolina Water Resources**

*Utilizing NASA Earth Observations to Monitor Extent of Harmful Algal Blooms in the Albemarle-Pamlico Estuary*

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**Past or Other Contributors**

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**Partner Organizations**

* USGS North Carolina Water Science Center, End-User, Michelle Moorman- Biologist
* Albemarle-Pamlico National Estuary Partnership (APNEP), End-User, Jim Hawhee, Dr. Bill Crowell- Director, Dr. Dean Carpenter, & Don Field

**Applied Sciences National Applications Addressed:**

Water Resources

**Study Area:** North Carolina

**Study Period:** 2004-2014

**Earth Observations & Parameters**

Aqua, MODIS-, multispectral reflectance

Landsat 8, OLI- multispectral reflectance

Landsat 7, ETM+ multispectral reflectance

Landsat 1-5 MSS - multispectral reflectance

**80-100 Word Objectives Overview**

The objective of this project is to provide a ten year time series representation of harmful algal blooms (HABs) in the Albemarle-Pamlico National Estuary as a general representation of their spatial and temporal extent. Organizations concerned with preserving water quality throughout the Albemarle and Pamlico Sounds will be able to use this information along with *in situ* water sample data to better evaluate the relationships between the HABs and other environmental factors.

**Abstract**

Harmful algal blooms (HABs) cause significant ecological damage to aquatic systems by blocking sunlight to submerged aquatic vegetation (SAV) and other organisms, and disrupting water chemistry by producing air- and waterborne toxins that negatively affect the health of fish, shellfish, and human beings. In the Albemarle and Pamlico Sounds, the USGS North Carolina Water Science Center biologists monitor HABs by taking point samples throughout the region, but they lack a method to track the spatial extent of HABs throughout the entire sound during the year. Calculations using ocean color data available from Aqua MODIS provided a method to detect the presence of chlorophyll-a as a proxy for algae on a large scale. Landsat 1-8 images of the study area were used to as background basemaps for all cartographic products delivered to the end-user. Spatial information regarding HAB behavior over the past decade can be used to analyze the potential relationships between local activities, estuary characteristics, and seasonal patterns on HAB extent by all organizations concerned with water quality in the area.

**Community Concerns**

* Up to 74% of HAB events in North Carolina between 2005 and 2012 produced microcystin or other cyanobacterial toxins which are known to cause adverse health effects including death in domestic animals and wildlife.
* Submerged aquatic vegetation (SAV) suffers when HABs block sunlight. The Albemarle-Pamlico Estuary contains 99% of the Atlantic Coast’s SAV outside of Florida. Rising threats to SAV put the region at increased risk of shoreline erosion and reduced water clarity, decreased oxygen production and nutrient concentration in affected waters, and reductions in food sources for fish, shellfish, and other wildlife, among other dangers.
* HABs affect water chemistry and create hypoxic zones during the decay process, which results in fish kills.

**Current Management Practices & Policies**

The USGS North Carolina Water Science Center biologists and other state entities take point samples of water content throughout the estuaries in an effort to monitor HAB extent. Some samples are only taken seasonally, and overall sampling frequency and spatial distribution vary across the Albemarle-Pamlico Sound. North Carolina has a standard limiting chlorophyll concentration in its waters, but no policies are in place to limit phosphorus or nitrogen. Artificial eutrophication from these excess nutrients have been positively linked with HABs. The USGS North Carolina Water Science Center and APNEP are interested in using their knowledge of the spatio-temporal characteristics of HAB events to influence decision-making regarding water quality standards.

**Decision Support Tools**

* Large-scale HAB extent maps with Landsat-derived base-maps
* Historical maps using MODIS data that show HAB extent with respect to time

**Benefit to End-User:**

* A more complete history of HAB extent going back 10 years (2004-2014)
* A larger scale of HAB monitoring to supplement information gathered from *in situ* data collection efforts

**Models Utilized**

* Goddard Space Flight Center Ocean Color Web - OC3M Chlorophyll Algorithm

**Ancillary Datasets Utilized**

* North Carolina Water Science Center- *in situ* water sample data
* National Water Quality Monitoring Council- *in situ* water sample data and monitoring station locations

**Software Utilized**

SeaDAS (Linux version) - processing MODIS data

ESRI ArcGIS - Raster Manipulation/Analysis, Image Enhancement & Map Creation

Python- data processing