**NASA DEVELOP National Program**

NASA Langley Research Center

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**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**

University of Georgia DEVELOP Location Participants:

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**Partner Organizations**

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

**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. Large scale monitoring of the estuaries gives a more comprehensive view of HAB activity throughout the year which may reveal patterns in HAB behavior in relation to seasonal weather changes. Having more complete historical observations of the spatial and temporal characteristics of HAB activity will benefit all organizations concerned with maintaining water quality in the sound.

**Abstract**

Harmful algal blooms (HABs) cause significant ecological damage to aquatic systems by disrupting water chemistry, producing toxins, and blocking sunlight to submerged vegetation and other organisms. 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 monitor the spatial extent of HABs throughout the entire sound during the year. For this project, the OCM-3M algorithm used Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) Level 2 Data downloaded from NASA Goddard Space Flight Center’s Ocean Color SeaDAS Website via a Linux operating system to calculate levels of chlorophyll-a as a proxy for the presence of algae. These calculations used multispectral reflectance bands available from Aqua MODIS to detect the presence of chlorophyll-a and cyanobacteria produced by HABs on a large scale. Data for these calculations focused solely on the immediate area surrounding the Albemarle and Pamlico Sounds, then reprojected from their original sinusoidal form to the NAD83 projected coordinate system. Landsat 8’s Operational Land Imager (OLI) provided reference base maps and higher resolution floating algae maps for informational purposes during periods of known HAB activity, as well. End-users were able to use the ten year time series to supplement their *in situ* data to assess HAB behavior throughout the region.

**Community Concerns**

* Up to 74% of HAB events in North Carolina between 2005 and 2012 produced microcystin or other cyanobacterial toxins that are known to cause adverse health effects including death in domestic animals and wildlife.
* Submerged vegetation, an important habitat for aquatic invertebrates and fish, suffers when HABs block sunlight. The Albemarle-Pamlico Estuary contains 99% of the Atlantic Coast’s submerged vegetation outside of Florida.
* HABs affect water chemistry and create hypoxic zones during the decay process, causing 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**

* HAB estimation maps at high resolution during known bloom events from Landsat imagery
* Historical maps using MODIS data that show HAB extent with respect to time

**Benefit to End-User:**

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

**Models Utilized**

* University of Georgia DEVELOP Location, Floating Algae Index (FAI) Python Script

**Ancillary Datasets Utilized**

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

**Software Utilized**

SeaDAS - processing MODIS data

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

Python - FAI script