**NASA DEVELOP National Program**

Patrick Henry Building

**Summer 2015**

**Short Title: Virginia Water Resources**

**Subtitle:** Utilizing NASA Earth Observations to Monitor the Extent of Harmful Algal Blooms in Chesapeake Bay Watershed.

**VPS Title:** Tracking Virginia’s Green Algal Monster with Remote Sensing

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

Dr. Kenton Ross (DEVELOP National Program)

**Partner Organizations**

Virginia Institute of Marine Science (VIMS), End-User, POC: Dr. Kim Reece

Virginia Department of Environmental Quality (DEQ), End-User, POC: Anne Schlegal, Dr. Tish Robertson

Old Dominion University (ODU) Department of Biological Sciences, Collaborator, POC: Dr. Todd Egerton)

Virginia Governor’s Office Deputy Secretary of Natural Resources for the Chesapeake Bay, Collaborator, POC: Russ Baxter

**Project Details**

**Applied Sciences National Applications Addressed:** Water Resources

**Study Area:** Virginia (VA) - Lower James River, Lower York River, Elizabeth River, Mobjack Bay, Chesapeake Bay

**Study Period:** May - October; 2011 - 2015

**Earth Observations & Parameters**

Aqua, MODIS - Multispectral reflectance

Landsat 8, OLI - Multispectral reflectance

Landsat 7, ETM+ - Multispectral reflectance

**Ancillary Datasets Utilized**

* Virginia Institute of Marine Science - *in situ* water sample data
* Old Dominion University - *in situ* water sample data
* National Oceanic and Atmospheric Administration – CoastWatch MODIS Chlorophyl-a product

**Models Utilized**

* Lim, J & Choi, M (2015) - Multiple regression models of spectral reflectance and water quality parameters

**Software Utilized**

ArcGIS - Raster manipulation/analysis, image enhancement & mapping of Landsat data

R - Statistical analysis, calculation and testing of chlorophyll estimation formula

**Project Overview**

**80-100 Word Objectives Overview**

The objective of this project was to provide tools that allowed our partners to determine probable locations of harmful algal blooms (HABs) in Virginia rivers (James, York, Elizabeth), the Mobjack Bay (in Mathews, Virginia), and the Chesapeake Bay. The ability to combine historical in*-*situ data, collected by VIMS and ODU, with MODIS composites and Landsat satellite data provided a more complete overview of HAB activity that benefitted our partner organizations both in terms of immediate tracking and monitoring of HABs and in the long term protection of water quality in the Chesapeake Bay watershed.

**Abstract**

Harmful algal bloom (HAB) species such as *Alexandrium monilatum* and *Cochlodinium polykroides* have had an increasing ecological impact on the Chesapeake Bay Watershed where they disrupt water chemistry, kill fish, and cause human illness. In Virginia, scientists from Virginia Institute of Marine Science (VIMS) and Old Dominion University (ODU) monitor HABs and their effect on water quality; however, these groups lack a method to monitor HABs in real time. This limits the ability to document associated water quality conditions and predict future blooms. Band reflectance values from Landsat 8 Surface Reflectance data obtained from USGS Earth Explorer and Moderate Resolution Imaging Spectroradiometer (MODIS) imagery collected from NOAA CoastWatch were cross-calibrated to create a regression model that calculated concentrations of chlorophyll. Calculations were verified with *in situ* measurements from the Virginia Estuarine and Coastal Observing System. Imagery produced with the Chlorophyll-a calculation model will allow VIMS and ODU scientists to assess the timing, magnitude, duration and frequency of HABs in Virginia’s Chesapeake watershed and to predict the environmental and water quality conditions that favor bloom development.

**Community Concerns**

* HABs are becoming increasingly common in Virginia Rivers. Blooms of native species like *Cochlodinium polykrikoides are becoming more common and more widespread.*Blooms of *Alexandrium monilatum*, a dinoflagellate not found north of Florida in the past, are now a regular occurrence in the York and James Rivers.
* *Cochlodinium polykrikoides* and *Alexandrium monilatum* reduce oxygen in water and produce toxins, which kill fish, impair shellfish development and may cause human illness.
* HABs have a negative economic impact on Virginia fisheries and the tourism industry.

**Current Management Practices & Policies**

Currently, monitoring of HABs in the Chesapeake Bay watershed occurs as a result of collaborations between the Virginia Department of Health (VDH), Virginia Institute of Marine Science (VIMS), Virginia Department of Environmental Quality (DEQ), and Old Dominion University (ODU). Real time monitoring of algal blooms is not currently readily available as it requires a complex arrangement of DNA tests to identify specific algal species from a massive amount of benign microorganisms within the water. ODU collects weekly water samples from seven fixed stations on the James River. In addition, ODU uses a boat on a fixed track to constantly sample chlorophyll levels in the Lower James River; water samples are collected when chlorophyll is above 15 mg/L. VIMS collects water sample data from the western Chesapeake Bay, as well as from fixed stations in the York River. However, data from these samples are not available until the end of the season. This limits the ability to predict HAB occurrence and document associated environmental and water quality conditions. The Virginia Pollutant Discharge Elimination System (VPDES) Permit limits industrial discharge of nitrogen and phosphorus into the Chesapeake Bay watershed in Virginia. The permits were modified in 2012 to require a four year reduction of industrial discharge in order to improve water quality in the James River and York River. The Virginia Department of Environmental Quality is interested in using the information obtained in this study to influence decision-making regarding immediate and long-term response to harmful algal blooms in the Chesapeake Bay watershed.

**Decision Support Tools & Benefits**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| HAB Sampling Guidance Maps | Landsat 8 OLI/TIRSLandsat 7 ETM+ | Will be used to identify potential sampling sites through higher resolution imagery; imagery will be available every 8 days at 30 meter resolution, available within a day of acquisition |
| Chlorophyll A Estimates at Weekly Time Step | MODIS Aqua | Will estimate chlorophyll concentrations at 1 kilometer resolution and weekly time step (potentially rolling weekly); this will be available within hours of final composite data acquisition; will assist VIMS and ODU to characterize the environmental conditions that favor bloom development |
| Maps of In-situ Data | N/a | Will illustrate trends in in-situ data collected by Old Dominion University from 2011 to 2014; will correlate in-situ data with satellite data |

**Project Imagery**



**Caption:** MODIS imagery displaying changes in chlorophyll levels in the Chesapeake Bay. Image Credit: Virginia Water Resources Team.