**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**NASA Langley Research Center**

**Chesapeake Bay Water Resources II**

*Assessing Water Clarity to Identify Potential Areas of Submerged Aquatic Vegetation (SAV) in the Chesapeake Bay to Assist in Monitoring Efforts*

**Project Overview**

***Project Synopsis*:** To assess the feasibility of using remote sensing of turbidity to determine water clarity thresholds for submerged aquatic vegetation (SAV), the NASA DEVELOP team will utilize Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 to assist the Virginia Department of Environmental Quality (VADEQ) in exploring new avenues to increase their temporal sampling of the Chesapeake Bay. Annual maps of water clarity for the main stem of the Chesapeake Bay and its tidal tributaries will be produced, and compared to aerial flyover data and *in situ* water samples for validation.

***Community Concern:*** Submerged aquatic vegetation (SAV) is an important coastal ecosystem that provides habitat and food resources to many economically-important species, and stabilizes near-shore sediments. However, SAV is particularly affected by water clarity conditions. As SAV is dependent on sunlight attenuating through the water column, sediments and other particulate matter that wash into the Chesapeake Bay affect the growth and resiliency of SAV patches. Currently, the VADEQ does not have the resources to completely monitor the Chesapeake Bay annually, thus, pursuing the feasibility of remotely sensing water clarity could increase their temporal and spatial sampling.

***Source of Project Idea:*** The idea for this project originated from a conversation among members of the Virginia Department of Environmental Quality (VADEQ) and DEVELOP representatives Jamie Favors and Dr. Kenton Ross after previously working with the VADEQ on Virginia Water Resources projects.

***National Application Area Addressed:*** Water Resources

***Study Location:*** Chesapeake Bay, VA

***Study Period:*** January 1995 – December 2016

***Advisor:*** Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Virginia Department of Environmental Quality | Tish Robertson, Office of Ecology, Water Quality Monitoring and Assessment | End-User | No |
| US Geological Survey, Water Science Center | Peter Tango, Chesapeake Bay Monitoring Coordinator | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision-Making Process:***The VADEQ monitors and assesses water clarity every two years to identify potential areas habitable to SAV. These water clarity assessments drive Total Maximum Daily Load (TMDL) regulations that are managed by the Environmental Protection Agency (EPA). The Virginia Institute of Marine Science (VIMS) collects water quality and SAV presence data for the VADEQ, which is used to create acreage goals for subsets of the Chesapeake Bay and its tributaries. However, the size of the Chesapeake Bay makes it difficult to sample more than a few tributaries each year, and thus the VADEQ is unable to provide an annual, Bay-wide assessment of water clarity.

***End-User’s Capacity to Use NASA Earth Observations:***

*Virginia Department of Environmental Quality*  – The end-user is familiar with NASA Earth observations, and previously worked on a project with DEVELOP in Summer 2015 and Fall 2015. However, they do not currently have a system in place to utilize remotely-sensed data to assess water clarity, which will be provided by this project.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate weekly with the partners through email updates on project progress. Additionally, the team will meet partners biweekly, via telephone or video call, in order to facilitate discussion and feedback on methods and end products. The main POCs will be the team lead, and the LaRC Center Lead as needed.

***Transition Plan*:** End products will be provided to the partners via an in-person meeting (if available) or a video conference at the end of each term so that the maps can immediately be integrated into the VADEQ’s decision-making process. The tool finalized in the second term of this project will be delivered to the partners either virtually or in an in-person meeting after completing the software release process.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI** | Normalized Difference Turbidity Index (NDTI) | Used to create maps identifying areas of high and low water clarity and where suitable SAV habitat can be found in the Chesapeake Bay and its Virginia tributaries. |

***Ancillary Datasets:***

ESA Sentinel-2 MultiSpectral Instrument (MSI) – turbidity – compare to Landsat results

Virginia Institute of Marine Science (VIMS) Virginia Estuarine and Coastal Observing System (VECOS) – *in situ* water clarity measurements – validate map products

***Software & Scripting:***

Google Earth Engine API – Landsat and Sentinel-2 analysis

Esri ArcGIS – map creation

ACOLITE – Landsat and Sentinel-2 analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Annual Water Clarity Maps (Bay-wide)** | Used to identify areas suitable for SAV based on an assessment of water clarity across the entire Chesapeake Bay each year, and how well this product aligns with *in situ* monitoring data. | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI will be used to created the Normalized Difference Turbidity Index to assess water clarity and correlate with *in situ* turbidity data. | I |
| **Annual Water Clarity Maps (Tributaries)** | Used to identify areas suitable for SAV based on an assessment of water clarity within Virginia tributaries annually, and how well this product aligns with *in situ* monitoring data. | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI will be used to created the Normalized Difference Turbidity Index to assess water clarity and correlate with *in situ* turbidity data. | I |
| **Automated Tool for Continued Monitoring of Water Clarity** | An automated tool will assist in continued monitoring of water clarity across the Chesapeake Bay and its Virginia tributaries, and allow for future assessment of the relationship between NASA Earth observations and *in situ* monitoring data. | N/A | III or IV |

***End-User Benefit*:** The results of this project will benefit the VADEQ by providing map products with greater spatial and temporal assessments of the Chesapeake Bay than the *in situ* and aerial-based data currently used by the department. The NASA DEVELOP team will assess the feasibility of remotely sensing water clarity and provide an automated tool for the VADEQ to continue monitoring into the future, complementing current time and effort spent on monitoring water clarity.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2017 Spring (Start) to 2017 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2017 Spring (LaRC) – Chesapeake Bay Water Resources
  + The first term of this project began developing water clarity regressions using Landsat data and *in situ* monitoring data for the Chesapeake Bay and its Virginia estuaries. Further, they created annual maps of water clarity, all within Google Earth Engine API.
* **Term 2 (Proposed Term):** 2017 Summer (LaRC) – Chesapeake Bay Water Resources II
  + The second term of this project will primarily focus on updating the regressions developed in the first term of the project by applying atmospheric correction, and assess other data sources (e.g., Sentinel-2) that could benefit VADEQ. A secondary focus of the term will be on partner handoff, updating maps once methodology is complete and cleaning up the methodology for software release.

***Related DEVELOP Work:***

2009 Summer (NASA Langley Research Center) – Chesapeake Bay Water Resources: The Integration of NASA Earth Observation Data into the Chesapeake Bay Watershed Model

2010 Spring (NASA Langley Research Center) – Chesapeake Bay Water Resources and Eco Forecasting: Mapping Submerged Aquatic Vegetation in the Chesapeake Bay Watershed Using Remote Sensing and GIS Algorithms

2015 Fall (Wise County Clerk of Circuit Court’s Office & NASA Langley Research Center) – Virginia Water Resources II: Utilizing NASA Earth Observations to Identify Algal Hotspots in the Chesapeake Bay

2015 Summer (Patrick Henry Building) – Virginia Water Resources: Monitoring Harmful Algal Blooms through NASA Earth Observations in the James River for Improved Water Management

2016 Summer (University of Georgia) – Southeast Ecological Forecasting III: Utilizing NASA Earth Observation and Proximal Remote Sensing for Mapping the Spatio-Temporal Distribution of *Hydrilla verticillata*

**Notes & References:**

***References:***

State Water Control Board. (2011). Virginia water quality standards. 9 VAC 25-260.

United States Environmental Protection Agency. (2008). Ambient water quality criteria for dissolved oxygen, water clarity and chlorophyll *a* for the Chesapeake Bay and its tidal tributaries. EPA 903-R-08-001.