**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**NASA Goddard Space Flight Center**

**Chesapeake Bay Ecological Forecasting**

*Utilizing NASA Earth Observations to Monitor Marsh Health in the Chesapeake Bay to Support the Maryland Department of Natural Resources Coastal Resiliency Assessment*

**Project Overview**

***Project Synopsis*:** This project will assist The Nature Conservancy and the Maryland Department of Natural Resources in their decision-making process by evaluating and forecasting marsh health in the Chesapeake Bay using Earth observations. Spectral vegetation indices will be derived from Landsat, Aqua, Terra, and Sentinel-2 missions to identify trends based on historical marsh health characteristics, allowing The Nature Conservancy and Maryland Department of Natural Resources to further improve a coastal resiliency assessment that identifies where natural habitats provide the greatest potential risk reduction for coastal communities.

***Community Concern:*** Wetlands are critical in supporting the healthy waters and diverse wildlife of the Chesapeake Bay watershed. Wetlands also provide habitat to hundreds of fish, bird, mammal and invertebrate species, as well as protect coastal habitats and communities from rising seas and intense storms. Protecting and restoring wetlands is a key way to promote clean water, healthy habitats, and a restored Bay. By monitoring and forecasting marsh health in the Chesapeake Bay, The Nature Conservancy (TNC) and the Maryland Department of Natural Resources (DNR) can develop more informed decision-making plans regarding restoration and conservation.

***Source of Project Idea:*** The source of the project idea came from Michelle Canick at TNC. Ms. Canick attended the Applied Earth Science Applications Showcase at NASA HQ in the summer of 2016 as a representative of TNC. Following the event, node leadership at GSFC traveled to TNC’s office in Bethesda, MD to discuss potential collaborations between TNC and DEVELOP. It was from this discussion and subsequent emails the project idea was formed, building off work already completed between TNC and the MD DNR on coastal resilience in the Chesapeake Bay. The two project partners would now like to develop a methodology for using satellite remote sensing to evaluate marsh health.

***National Application Area Addressed:*** Ecological Forecasting

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

***Study Period:*** January 2000 – January 2017; Forecasting to 2030

***Advisor:***

Dr. David Lagomasino (Post Doc Scientist, NASA Goddard Space Flight Center); Jenny Allen (Research Coordinator, Chesapeake Bay National Estuarine Research Reserve – Maryland, Maryland Department of Natural Resources)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Maryland Department of Natural Resources | Nicole Carlozo, Natural Resource Resiliency Planner, Chesapeake and Coastal Service | End-User | No |
| The Nature Conservancy (TNC) | Michelle Canick, Conservation Information Manager | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision-Making Process:***The Maryland Department of Natural Resources provides roughly $25 million per year of funding to local governments and nonprofits to help restore the Chesapeake Bay. The recently completed Maryland Coastal Resiliency Assessment used the Natural Capital Project’s InVEST Coastal Vulnerability Model (Arkema et al. 2013) to estimate the relative effectiveness of existing natural habitats to buffer Maryland’s shoreline from the coastal hazards of erosion and flooding. One limitation of the analysis is that it considered the presence or absence of marshes and other coastal habitats, but not the health or quality of these habitats.

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

*Maryland Department of Natural Resources* – Partners are familiar with evaluating landscape and community resilience, but have not incorporated remote sensing in the measurement of marsh health. They manage conservation data in a geospatial environment and are familiar with ArcMap and the use of Esri products.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*The Nature Conservancy* (TNC) – They work in partnership with the Maryland Department of Natural Resources and have limited capability in using satellite data at the research scale. They have a detailed understanding of the importance of marsh health on the region, but do not currently measure marsh health using remote sensing.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Michelle Canick and Nicole Carlozo will be POCs for communication with the DEVELOP team. In-person meetings as well as weekly and biweekly teleconference calls and email exchanges will be maintained throughout the course of the term.

***Transition Plan*:** Upon successful completion of the project, all deliverables will be handed off in person to project partners. Joint meetings will be held between TNC and MD DNR to discuss accomplishments and strategize for the incorporation of resulting maps within the calendar year. The project team will communicate with the MD DNR so deliverables can be well-integrated with existing datasets.

***Letters of Support*:**

Michelle Canick, Conservation Information Manager, The Nature Conservancy

Nicole Carlozo, Natural Resource Resiliency Planner, Maryland Department of Natural Resources

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 5 TM** | Spectral vegetation indices | Vegetation indices will be used to identify historical marsh health at the landscape scale. |
| **Landsat 7 ETM+** | Spectral vegetation indices | Vegetation indices will be used to identify historical marsh health at the landscape scale. |
| **Landsat 8 OLI** | Spectral vegetation indices | Vegetation indices will be used to identify historical marsh health at the landscape scale. |
| **Aqua or Terra MODIS** | Spectral vegetation indices | Vegetation indices will be used to identify historical marsh health at the landscape scale. |
| **Sentinel-2 MSI** | Spectral vegetation indices | Vegetation indices will be used to identify historical marsh health at the landscape scale. |

***Ancillary Datasets:***

NOAA – Coastal LiDAR and DEM data – validation and supplementation of other remotely-sensed data

USDA Forest Service – ForWarn MODIS data – view NDVI profiles of marsh greenness in study area

***Modeling:***

TerrSet Earth Trends Modeler and Land Change Modeler (POC: Dr. James Toledano, Clark Labs)

***Software & Scripting:***

ERDAS IMAGINE – image processing of Landsat, MODIS, and DEM data

Esri ArcGIS – raster and vector processing and manipulation, statistical analysis, map creation

TerrSet – marsh health forecast maps, Land Use Land Cover forecast maps

dnppy – scripts for converting Landsat data to TOA reflectance with Python

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Marsh Health Trend Analysis Map(s)** | This product will be used to identify areas where The Nature Conservancy and Maryland Department of Natural Resources should focus future protection, restoration, and mitigation efforts based on historical marsh health characteristics. | Maps identifying areas of historical marsh health derived from Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Aqua or Terra MODIS data | II |
| **Marsh Health Forecast Maps** | The Nature Conservancy and Maryland Department of Natural Resources will use this product to identify where they should focus future protection, restoration, and mitigation of marshes based on these predictive maps. | Maps predicting the future health of the marshes using the current and past marsh health from Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, and Aqua or Terra MODIS data as the input for TerrSet’s Earth Trends Modeler | II |

***End-User Benefit*:** Implementation of a well-calibrated, Earth observation-based remote-sensing technology at the landscape scale will greatly enhance the ability of MD DNR and TNC to assess marsh health. The end-user will have an improved ability to assess the need for marsh restoration efforts, and will be empowered to use adaptive management approaches to improve conservation program performance. Within Maryland Department of Natural Resources, information will be used to identify marsh areas of high and low restoration need.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2017 Summer

***Related DEVELOP Work:***

2016 Summer (Mobile County Health Department) – Mobile Bay Eco Forecasting II: Monitoring Marsh Conditions in Coastal Alabama Using NASA Earth Observations to Support the Alabama Coastal Foundation’s Restoration and Conservation Initiatives

2016 Spring (Mobile County Health Department) – Mobile Bay Eco Forecasting: Monitoring Marsh Conditions in Coastal Alabama Using NASA Earth Observations to Support the Alabama Coastal Foundation’s Restoration and Conservation Initiatives

2015 Summer (NASA Langley Research Center) - North Carolina Ecological Forecasting: Evaluating the use of NASA Earth Observations to Monitor Wetland Health in the Albermarle-Pamlico Watershed

**Notes & References:**

***References:***

Arkema, K. K., Guannel, G., Verutes, G., Wood, S. A., Guerry, A., Ruckelshaus, M., Kareiva, P., Lacayo, M., & Silver, J. M. (2013). Coastal habitats shield people and property from sea-level rise and storms. *Nature Climate Change, 3*, 913-918.

Conley, D. J., Paerl, H. W., Howarth, R. W., Boesch, D. F., Seitzinger, S. P., Karl, E., ... & Gene, E. (2009). Controlling eutrophication: nitrogen and phosphorus. *Science*, *123*, 1014-1015. Retrieved from http://bvc.cea-atitlan.org.gt/id/eprint/130 on June 30, 2016.

Dahl, T. E. & Stedman, S. M. (2013). Status and trends of wetlands in the coastal watersheds of the Conterminous United States 2004 to 2009 [PDF Document]. U.S. Department of the Interior, Fish and Wildlife Service and National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Retrieved from https://www.fws.gov/wetlands/Documents/Status-and-Trends-of-Wetlands-In-the-Coastal-Watersheds-of-the-Conterminous-US-2004-to-2009.pdf on June 30, 2016.

Kearney, M.S., Rogers, A.S., Townshend, J.R.G., Rizzo, E. & Stutzer, D. (2002). Landsat Imagery Shows Decline of Coastal Marshes in Chesapeake and Delaware Bays. *EOS, Transactions, American Geophysical Union, 83*(16), 173-184.

Khanna, S., Santos, M. J., Ustin, S. L., Koltunov, A., Kokaly, R. F., & Roberts, D. A. (2013). Detection of salt marsh vegetation stress and recovery after the Deepwater Horizon oil spill in Barataria Bay, Gulf of Mexico using AVIRIS data. *PloS one*, *8*(11), e78989.

New Hampshire Estuaries Project. (2007). *The Impacts of Impervious Surfaces on Water Resources* [PDF Document]. Retrieved from http://www.northhampton-nh.gov/Public\_documents/NorthHamptonNH\_BComm/ NHEP%20Impervious%20Surf%20Flyer%20rdcd.pdf on August 9, 2016

Stedman, S. & Dahl, T. E. (2008). Status and trends of wetlands in the coastal watersheds of the Eastern United States 1998 to 2004 [PDF Document]. National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Department of the Interior, Fish and Wildlife Service. Retrieved From https://www.fws.gov/wetlands/Documents/Status-and-Trends-of-Wetlands-in-the-Coastal-Watersheds-of-the-Eastern-United-States-1998-to-2004.pdf on June 28, 2016.

Twilley, R. R. (2007). Coastal wetlands and global climate change: Gulf Coast wetland sustainability in a changing climate. *Pew Center on Global Climate, Arlington, VA*

Xu, H. (2010). Analysis of impervious surface and its impact on urban heat environment using the normalized difference impervious surface index (NDISI). *Photogrammetric Engineering & Remote Sensing*, *76*(5), 557-565.