**NASA DEVELOP National Program**

**2022 Summer Project Proposal**

**Maryland – Goddard**

**Chesapeake Bay Agriculture**

*Monitoring Marsh Migration in Maryland’s Coastal Croplands*

**Project Overview**

***Project Synopsis*:** Rising sea level leaves coastal croplands vulnerable to the impacts of saltwater intrusion. The effects of saltwater intrusion and increased salinization can be widespread and include marsh migration, loss of cropland, and decreased agricultural productivity; all of which jeopardize the livelihoods of farmers and other coastal agriculture fishing industries. The Eastern Shore Land Conservancy (ESLC) and the University of Maryland are currently working to understand how saltwater intrusion impacts agriculture in the Chesapeake Bay region and the Maryland Department of Planning is the lead agency on Maryland’s plan to adapt to saltwater intrusion and salinization. To help inform these efforts, the team will use Landsat 5 TM, Landsat 7 EMT+, Landsat 8 OLI, Sentinel-2 MSI, and PlanetScope data to generate detailed Land Use Land Cover (LULC) maps that identify agricultural land, open water, and marsh. Assessment of LULC change over time will be used to monitor marsh migration and loss of agricultural land. Forecasted LULC will highlight agricultural land at risk to the impacts of salinization.

***Source of Project Idea***: The Fellow at the GSFC node for the NASA DEVELOP National Program reached out to the GSFC community with a call for projects. Dr. Lola Fatoyinbo suggested that we contact Dr. Pinki Mondal and Dr. Kate Tully to discuss saltwater intrusion issues along the Eastern Shore in Maryland. All advisors recommended reaching out out the Eastern Shore Land Conservancy and Maryland Department of Planning. All parties address environmental concerns associated with saltwater intrusion from varying perspectives.

***Actionable Decision***: Increases in soil salinity stemming from saltwater intrusion can lead to shifts in marsh habitat, decreases in crop productivity, and loss of agricultural land. These impacts threaten the livelihoods of farmers and coastal fisheries in the Chesapeake Bay region. Collectively, the partners are working to better understand how saltwater intrusion has been affecting the Eastern Shore landscape and the communities that reside in the region. The remote sensing derived end products from this work will potentially inform planning measures developed by the Maryland Department of Planning and the ESLC.

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

***Study Period:*** January 2000 – December 2021; Forecasting to 2040

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**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Eastern Shore Land Conservancy** | Larisa Prezioso, Restoration Specialist | End User | No |
| **Maryland Department of Planning** | Jason Dubow, Resource Conservation and Management; Deborah Herr Cornwell, Resource Conservation Planner | Collaborator | Yes |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to use Earth Observations:*** The ESLC is a land trust that uses conservation easements to protect privately-held land on the Eastern Shore of Maryland. ESLC has protected over 65,000 acres of farmland, forests, and wetlands through over 300 easements. The ESLC identifies and ranks priority areas within their service area. Priority areas are determined using data that considers wildlife corridors, land cover, and development patterns. Parcel-level prioritization focuses on proximity to ongoing development, vulnerability to sea-level rise, and the presence and/or absence of rare and threatened species. The ESLC also works on the ground with farmers, documenting how saltwater intrusion has impacted agricultural land in the region. Currently, NASA Earth observations are not used to inform their decision-making practices. This project will provide a unique understanding of how Maryland’s coastline has changed over the last twenty years and will generate resources that can be used for future agricultural planning efforts in the region.

**Partner Interest/Demand:** Monitoring marsh migration is priority for the ESLC and the Maryland Department of Planning. The impacts of sea level rise and saltwater intrusion are being noticed by farmers in the region and according to conversations with the ESLC, some farmers are considering moving their livelihoods to plan ahead. While this is a documented issue, maps demonstrating marsh migration over time are not widely available and could be helpful for both organizations as they work to better understand the implications of saltwater intrusion across the Easternshore’s agricultural landscape. Furthermore, forecasted maps would be very valuable for future planning purposes.

***Partner Communications***: Partner communication began in fall 2021. Several meetings were held to discuss the scope of the project prior to the start of the summer term. The information gathered during those meetings has been compiled into this document for the team’s reference. During the term, the team will meet with the ESLC and the Maryland Department of Planning virtually via Microsoft Teams on a biweekly basis. We also discussed additional opportunities for the team to visit with science advisors and end users in person. This would allow the team to speak with farmers and gain perspective on the environmental issues being explored in this project. Regular communication with the partners will be maintained through email and the Project Lead will serve as the main point of contact for the team.

***Partner Experience:*** Familiarity with NASA Earth observations varies by partner organization. The ESLC is familiar, but not well versed with remote sensing applications. However, they rely on GIS and GIS datasets to conduct their work. The Maryland Department of Planning has a GIS unit in their organizationa and remote sensing applications are used to produce decadal land cover products.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 5 TM** | Land surface reflectance | Land surface reflectance will be used to create LULC maps. |
| **Landsat 7 ETM+** | Land surface reflectance | Land surface reflectance will be used to create LULC maps. |
| **Landsat 8 OLI** | Land surface reflectance | Land surface reflectance will be used to create LULC maps. |
| **Sentinel-2 MSI** | Land surface reflectance | High resolution imagery will be used to identify features of the landscape and generate LULC maps. |
| **PlanetScope**  | Land surface reflectance | High resolution land surface reflectance products will be used for validating LULC maps. |

***Ancillary Datasets:***

* ESLC Agriculture Shapefiles – identify key parcels of cropland that are of interest to the partners and validate cropland classifications
* ESLC Farm Surveys – identify parcels of farmland with known impacts of saltwater intrusion
* USGS National Land Cover Database (NLCD) – land cover information for the region to be used in land cover synthesis
* USDA Cropland Data Layer (CDL) – annual crop-specific land cover information to be used in land cover synthesis
* NOAA Coastal Change Analysis Program (C-CAP) – coastal land cover data to be used in land cover synthesis
* Chesapeake Bay Program Land Cover – coastal land cover data to be used in land cover synthesis or for validation (https://www.usgs.gov/centers/chesapeake-bay-activities/news/innovative-technology-continues-advance-chesapeake-bay)

***Modeling:***

* TerrSet Land Change Modeler (POC: Sean McCartney, Science Systems & Applications, NASA Goddard Space Flight Center) – Model LULC between 2000 and 2021, forecast LULC to 2040

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **LULC Maps (2000-2021)** | LULC Maps between 2000 and 2021 will identify key land classes including open water, marsh, and agricultural land. These maps will provide the partners with detailed information on past and current land cover trends surrounding coastal croplands.  | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-2 MSI, and PlanetScope data will be used to generate LULC Maps. Esri ArcGIS Pro will be used for completing the LULC classification. | I |
| **Marsh Migration Maps** | Maps displaying marsh migration between 2000 and 2021 will provide the partners with an understanding of how Maryland’s coastline has changed in relation to agricultural regions of interest. This information will complement landowner testimonials used by the partners to identify areas of concern in the Chesapeake Bay. | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-2 MSI, and PlanetScope data will be used to generate LULC Maps. Esri ArcGIS Pro will be used for completing the LULC classification. TerrSet Land Change Modeler will be used to assess land change over time and monitor marsh migration. | I |
| **Forecasted LULC Maps (Forecasted to 2040)** | Maps of forecasted LULC will highlight agricultural land that could be vulnerable to the impacts of marsh migration and saltwater intrusion over the next two decades. These maps can inform saltwater intrusion and salinization planning efforts by identifying priority areas for the partners.  | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Sentinel-2 MSI, and PlanetScope data will be used to generate LULC Maps. Esri ArcGIS Pro will be used for completing the LULC classification. TerrSet Land Change Modeler will be used to forecast LULC change to 2040. | I |
| **True Color Composites** | True color imagery will provide the partners with a reference for LULC maps which display classification categories.  | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI will be used as imagery for true color composites. | I |

***Priorities***: The LULC maps between 2000 and 2021 need to be completed in order to begin work on the marsh migration map or the LULC forecasting portion of the project. Therefore, the team should begin by working on the base LULC maps, then examine marsh migration over time, while working on the forecasted map. The partners are very interested in both the marsh migration map and the forecasted LULC map. All efforts should be made to complete these deliverables. The team should work with the science advisors to generate a plan for completing the base LULC efficiently.

***Similar Past DEVELOP Projects***:

* 2017 Summer GSFC Chesapeake Bay Ecological Forecasting - <https://www.devpedia.developexchange.com/dp/index.php?title=Chesapeake_Bay_Ecological_Forecasting_GSFC_Summer_2017>
* 2019 Spring LaRC Patuxent Water Resources - <https://www.devpedia.developexchange.com/dp/index.php?title=Patuxent_Water_Resources_LaRC_Spring_2019>
* 2021 Summer MSFC Delaware Ecological Forecasting - <https://www.devpedia.developexchange.com/dp/index.php?title=Delaware_Ecological_Forecasting_MSFC_Summer_2021>

**Project Timeline & Multi-term Objectives**

***Project Timeline:*** 1 Term: 2022 Summer Term

**Notes & References:**

***Notes*:** Methods carried out by the Patuxent Water Resources LaRC Spring 2019 project offer a framework for how this project could be tackled. The team utilized existing land cover datasets, to create a synthesized land cover product using USDA’s CDL, C-CAP, and the NLCD. This approach could provide a robust land cover product over time, providing more opportunity to analyze marsh migration during the term. In addition to the partner data noted in the ancillary datasets, the ESLC also has imagery documenting the impacts of saltwater intrusion on farmland. Dr. Kate Tully from the University of Maryland also works in the field collecting soil samples from farms in the Chesapeake Bay region. Data from both partners could also be used by the teams during the term to validate areas of coastal change. Furthermore, if time allows, the team could expand this project by mapping salt deposits along the shoreline using Landsat and NAIP (National Agriculture Imagery Program) imagery. Currently, Dr. Pinki Mondal has been using Landsat scenes and NAIP imagery to accomplish this in coastal environments. If DEVELOP returns to onsite work for the 2022 Summer term, participants could have the opportunity to visit field sites, advisors, and potentially project partners.

***References:***

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 Dublow, J. Cornwell D.H., Andreasen D., Staley, A., Tully, K., Geden, K., Epanchin-Niell, R. (2019). State of Maryland Plan to Adapt to Salwater Intrusion and Salinzation. Maryland Department of Planning.

Tully, K. (September 2020). Farming on the fringe: climate change and coastal farms. *TEDxGreatMills* <https://www.ted.com/talks/kate_tully_farming_on_the_fringe_climate_change_and_coastal_farms>

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