**NASA DEVELOP National Program**

**Fall 2016 Project Proposal**

**NASA Langley Research Center**

**Everglades Ecological Forecasting II**

Examining the Applicability of NASA Earth Observations and Google Earth Engine to Monitor and Forecast Mangrove Heath and Extent in the Florida Everglades

**Project Overview**

***Objective:*** To conduct a spatial analysis using NASA Earth observations and Google Earth Engine to create a replicable methodology that will map and monitor mangrove forest health and extent in the Everglades National Park.

***Community Concern:*** One of the world’s most threatened ecosystems are mangrove forests. Mangrove forests provide extensive ecosystem services including serving as a transition zone between terrestrial and marine ecosystems. These salt-tolerant, tropical forests also provide specialized habitat for diverse wildlife and serve as nurseries for a variety of aquatic life. Furthermore, the complex root structures assist in stabilizing shorelines by trapping sediment and detritus from terrestrial habitats. Due to changing environments, pollution, and human alterations of the land, the health and extent of mangroves continues to decline. Also, the global spatial extent of mangroves makes it difficult to map shifting locations and monitor their health.

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

***Study Location:*** Everglades National Forest, Florida

***Study Period:*** 1995-2016; Forecasting to May 2030

***Advisors:*** Dr. Kenton Ross (NASA DEVELOP National Program Science Advisor), Dr. Hans-Peter Plag (Old Dominion University (ODU), Mitigation and Adaptation Research Institute (MARI)), Dr. Marguerite Madden (University of Georgia)

***Source of Project Idea:*** Communication between DEVELOP and MARI was initiated after conversation with a previous DEVELOP participant, who was a graduate student of Dr. Plag. Through conversation, a need was identified to assist in creating a method for mangrove mapping while utilizing Google Earth Engine.

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| National Park Service, Everglades National Park (ENP) | Jed Redwine, Ecologist, South Florida Natural Resources Center | End-User | No |
| Group on Earth Observations (GEO) Blue Planet Initiative (BPI) | Dr. Hans-Peter Plag | End-User | No |
| Mitigation and Adaptation Research Institute (MARI) | Dr. Hans-Peter Plag | Collaborator | Yes |

***End-User Overview***

***End-User’s Current Decision Making Process:***

Everglades National Park - The most recent land cover maps of the Everglades created by the Everglades National Park date to 1999. These maps were created from aerial photography and were not created specifically with mangroves in mind. Global mangrove maps have been created using Landsat scale imagery but have not been updated since 2011. Both of these resources lack a mechanism for being updated routinely. As a result, decision-making is based on dated map products, and project partners do not have imagery to illustrate the effects on management and restoration efforts.

Group on Earth Observation Blue Planet Initiative – GEO BPI is currently focusing on how NASA Earth observations may be used to address various Sustainable Development Goals; however, they do not currently use NASA EOS in their research.

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

NPS Everglades National Park – ENP has some awareness of NASA Earth observations but they are not currently using them for land use/land cover analysis.

Group on Earth Observations Blue Planet Initiative – GEO BPI is currently trying to develop a methodology to routinely and efficiently monitor global mangrove extent. They are not currently using NASA Earth observations directly to achieve this goal; rather, they are utilizing a mangrove database based on Landsat 30m data for 2000 from the USGS.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

MARI – Dr. Plag will be providing support as a science advisor on the project, as well as identifying potential improvements for the tutorial and deliverables after the first term of this project.

***Boundary Organization Dissemination:***

Mitigation and Adaptation Research Institute (MARI) – MARI will disseminate the methodology from the project to their partners in the Group on Earth Observations (GEO) Blue Planet Initiative (BPI) (since Dr. Plag represents both institutions). The partners will then use the methodology and information to monitor mangrove extent and health internationally.

***Project Communication & Transition Overview***

***In-Term Communication Plan:***

The team will email weekly updates to the partners to ensure that they are aware of the teams’ progress. Phone calls will be conducted every other week to ensure that any questions that may come up can be addressed, and so the partner can then ask any questions they may have. The main point of contact for this project will be Jed Redwine of the NPS. Dr. Plag will be the main POC for the SDG portion of this project.

Additionally, biweekly communication with Dr. Marguerite Madden will ensure continued advising.

***Transition Approach:***

MARI/GEO BPI - The decision support tools will be handed over to the MARI and GEO BPI via Dr. Plag. An in-person workshop will be conducted with Dr. Plag so he will be able to demonstrate the tool to any individuals from the BPI. He will then work with MARI and GEO BPI to implement these tools in mapping mangrove forest extent throughout other areas in the world.

ENP - A hand off will occur virtually with the ENP staff. We will also conduct a workshop with the ENP staff to show them how to utilize the GEE interface in the future. The software release process for the script developed by the team began in the summer 2016 term, and could potentially be completed as early as the late fall, which would coincide with the end of the fall term.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 5, 7, & 8** | Land Cover | To determine the extent of the mangrove forests |
| **Setinel-1a, and 2** | Land Cover | To determine the extent of the mangrove forests |

***Ancillary Datasets:***

USGS National Hydrography Dataset – Assist with land cover classification

USDA Web Soil Survey – Assist with land cover classification

Google Earth Engine NAIP imagery – assist with land cover classification

Dr. Madden’s 1996 study LiDAR imagery – assist with land cover classification

***Models:***

TerrSet Geospatial Monitoring and Modeling System Land Change Modeler (POC: Dr. Kenton Ross, DEVELOP National Science Advisor)

***Software & Scripting:***

ArcGIS – Map creation

IDRISI TerrSet – Forecasting model

Google Earth Engine – Land classification of Landsat imagery

**Decision Support Tool & End-Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Current Mangrove Extent Map | The partner will use this to help better understand the extent of the mangroves and identify areas that require better monitoring practices | Landsat 5, 7, and 8 and Sentinel-2 will be used to create the map(s) | 3 |
| Mangrove Extent Change Maps | The partner will use this to help assess areas where mangrove forests have been declining | Dr. Madden’s Everglades Map (1999); Global maps of Mangrove (ESRI, 2011) and Current Mangrove Extent Map | N/A |
| Mangrove Forecasting Maps | The partner will use this to help plan mangrove protection policies | Dr. Madden’s Everglades Map (1999); Global maps of Mangrove (ESRI, 2011) and Current Mangrove Extent Map | N/A |
| Tutorial | The partner will use the methodologies developed during the project to apply to other study areas | Google Earth Engine in conjunction with Landsat 5, 7, and 8 | N/A |
| Mangrove Extent Change Maps (seasonal) | The partner will use this to better understand long-term changes in mangrove cover over different seasons | Landsat 5, 7, and 8 |  |

***End-User Benefit:***

This project will help the ENP determine areas of mangrove forest to protect. The methodology developed in Google Earth Engine will allow for continuous and efficient mangrove extent monitoring by the GEO BPI and by ENP.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: Summer 2016 (Start) to Fall 2016 (Completion)

***Multi-Term Objectives:***

* **Term 1:** Summer 2016 (LaRC) – Everglades Ecological Forecasting
  + Determine methodology for using Google Earth Engine to create current mangrove extent maps, change maps and forecast maps.
* **Term 2 (Proposed Term):** Fall 2016 (LaRC) – Everglades Ecological Forecasting II
  + Expand methodology to include entire coastline and potentially update to GRTS sampling method.
  + Design a workshop for handoff to MARI.
  + Update methodology to align with SDG targets
  + Update Mangrove extent change maps to include seasonal differences
  + Increase time step to every 5 years (from 10 years)
  + Update cloud masking percentile to reduce prejudicing toward flooded/saturated zones

***Related DEVELOP Work:***

Summer 2013 (LaRC) – Myanmar Ecological Forecasting: Utilizing NASA Earth Observations to Monitor, Map, and Forecast Mangrove Extent and Deforestation in Myanmar for Enhanced Conservation

Fall 2014 – Spring 2015 (LaRC) – Great Lakes Climate: Monitoring the Impacts of Climate Change and Decreasing Water Levels on Wetlands in the Great Lakes Region of North America