**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**NASA Marshall Space Flight Center**

**Rwanda Ecological Forecasting**

*Utilizing NASA Earth Observations to Classify Wetland Extent in Western Rwanda in Support of United Nation Sustainable Development Goals*

**Project Overview**

***Project Synopsis*:** Reliable data and spatial analysis are key to successful wetlands conservation and monitoring efforts. This project aims to utilize the Landsat series to classify wetland extent and change in Rwanda, as well as forecast the future extent of wetlands in the country. In collaboration with the University of Bonn’s DeMo-Wetlands project, this study would compare Landsat and Sentinel-derived mapping products and combine to provide a comprehensive approach for monitoring wetlands in response to the UN Sustainable Development Goals (SDGs). The team will explore the use of Google Earth Engine to create land cover classifications, along with the TerrSet Geospatial Monitoring System Land Change Modeler to forecast extent. Project partners will use this methodology for future assessment for SDG reporting and protection of Rwanda’s wetlands.

***Community Concern:*** Wetlands are important to ecosystems because they provide freshwater, regulate hydrological processes, and reduce erosion. Degradation of Rwandan wetlands is becoming more apparent due to increasing of industrial and urban growth. Western Rwanda is covered by lush forests and hydrologic networks, making it even more important to protect the natural vegetation from encroaching development. Wetland protection will ensure the presence of freshwater to communities, impede soil degradation, and safeguard local biodiversity.

***Source of Project Idea:*** Lawrence Friedl of NASA’s Applied Sciences Program introduced DEVELOP to Adrian Strauch from the University of Bonn after meeting at a GEO Work Programme Symposium. They discussed collaboration with DEVELOP relating to SDG monitoring and further conversations with DEVELOP culminated in this project. The National Program Office then directed the project to the NASA Marshall Space Flight Center node.

***National Application Areas Addressed:*** Ecological Forecasting

***Study Location:*** Rwanda

***Study Period:*** 2007 – 2017; Forecasting to 2030

***Advisors:***

Dr. Jeffrey Luvall (NASA Marshall Space Flight Center)*,* Dr. Robert Griffin (University of Alabama in Huntsville), Leigh Sinclair (University of Alabama in Huntsville, Information Technology and Systems Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Rwanda Environment Management Authority (Rawanda) |  | End-User | No |
| NASA SERVIR Science Coordination Office at MSFC | Africa Flores, Eastern & Southern Africa Science Coordination Lead  Emily Adams, Eastern & Southern Africa Research Associate | Collaborator | No |
| Regional Centre for Mapping of Resources for Development (RCMRD) | Dr. Robinson Mungo , Earth Observations Lead | End-User | Yes |
| Group on Earth Observations, GEO-Wetlands Initiative | Adrian Strauch, Univ. of Bonn, co-lead  Lammert Hilarides, Wetl. Intern., co-lead  Ania Grobicki, Ramsar Sec., co-lead | Collaborator | No |

***End-User Overview***

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

In 2009, a national wetland map was developed by the Rwanda Environment Management Authority (REMA). The map is not openly available and the methodology used to create the map is not clear. In personal correspondence with REMA, it was mentioned that improved information on national wetland extent and their biodiversity is needed. SDG reporting will require an updated baseline and continuous monitoring, and remote sensing could contribute to achieving this.

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

*Rwanda Environment Management Authority (Rwanda) –* Rwandan authorities use Earth observation data and auxiliary data (e.g. soil maps) for national planning and therefore the necessary capacity already exists within the country and partner organizations. Capacity building would be useful to ensure that new products and methods will be taken up on a national level. The level of required capacity building and training materials will be determined in the early phase of the project in cooperation with the DeMo-Wetlands project and GEO-Wetlands.

*Regional Centre for Mapping of Resources for Development (RCMRD) –* RCMRD often uses NASA Earth observations. These products can add to their research of Rwanda and be disseminated from them to contribute to the current management practices of preserving wetlands in western Rwanda.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Group on Earth Observations, GEO-Wetlands Initiative* – The GEO Wetlands Initiative together with RSS (Remote Sensing Solutions), is currently working on a parallel project to develop products on wetland delineation and characterization in Rwanda using Sentinel data. Their research will complement the project, allowing for comparison between Landsat and Sentinel datasets and a comprehensive, multi-sensor methodology to support SDG reporting.

*NASA SERVIR Science Coordination Office at MSFC* – The NASA SERVIR Science Coordination Office at MSFC has done extensive research in the area of Rwanda and can offer expertise and guidance throughout the completion of the project. They will also serve as a liaison to decision makers in the country.

***Dissemination by Boundary Organizations*:**

The University of Bonn’s DeMo-Wetlands Project is aiming to collaborate with RCMRD to host a training in country with stakeholders. This would include methodologies and case studies from the DEVELOP project and the DeMo-Wetlands Projects. The University of Bonn has connections with multiple organizations in Rwanda, as does RCMRD. Stakeholders involved in the training would include land managers, conservation managers, and sustainable development managers. The DeMo-Wetlands Project and especially the GEO-Wetlands Initiative will ensure that the results and developed methods and training materials will be kept available for users on a long-term basis.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Communication will be initiated during the interim by the Center Lead, who will establish a time and date for the team to conduct their preliminary briefing. The project lead will introduce the team to the partners and determine if there have been any deviations to the desired end products. They will continue meet with the project partners over teleconferences or email throughout the term.

***Transition Plan*:** Hand off of methodologies and end products will be done electronically after a virtual presentation of the team’s results over video call or teleconference. Results and methodologies will then be further distributed by the DeMo-Wetlands Project, GEO-Wetlands Initiative, and RCMRD to stakeholders in the country.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 Operational Land Imager (OLI)** | Surface Reflectance | Landsat 8 OLI Surface Reflectance will be used to classify wetlands in western Rwanda. |
| **Landsat 7 Enhanced Thematic Mapper Plus (ETM+)** | Surface Reflectance | Landsat 7 ETM+ Surface Reflectance will be used to classify wetlands in western Rwanda. |
| **Shuttle Radar Topography Mission (SRTM) Version 3** | Digital Elevation Model | Elevation data will be used to aid in land cover classifications. |
| **Sentinel-2 Multispectral Instrument (MSI)** | Surface reflectance | Sentinel-2MSI Surface Reflectance will be used to classify wetlands in western Rwanda. |

***Modeling:***

TerrSet Geospatial Monitoring System Land Change Modeler (POC: Dr. Kenton Ross, NASA Langley Research Center)

***Software & Scripting:***

Google Earth Engine API – land classification of imagery

Esri ArcGIS – raster manipulation and analysis, image enhancement and map creation

Exelis ENVI – raster manipulation, analysis, and image enhancement

TerrSet – forecast modelling

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Wetland Extent Time Series** | The project partners will use this time series to help understand the extent of the wetlands, and quantify wetland extent for SDG indicator reporting, and potentially identify areas that require additional preservation practices. | Landsat 7, Landsat 8, and SRTM v3 will be used to create classification of wetlands to create a time series. | N/A |
| **Wetland Change Maps** | These change maps will help the partners assess areas where wetlands have been declining. | The Wetland Extent Time Series Maps will be used to calculate the change between years. | N/A |
| **Wetland Prediction Map** | The Prediction Map will be used to help pinpoint areas that will need to be closely monitored in future years. | The Wetland Change Maps will be used to forecast future extents. | N/A |

***End-User Benefit*:** The methodology created by this project can potentially be used by Rwandan authorities to generate statistics for reporting progress towards SDG Goal 15.2, Sub Indicator 1: Annual average percent change in forest area over most recent available 5 year period. This project also can help improve understanding of wetlands in Rwanda, their change over time, and potential extent in the future. Using Google Earth Engine, this project provides a replicable methodology and a tool to continuously monitor wetland extent which will support conservation efforts into the future. The results of this project will directly contribute to the GEO-Wetlands initiative and by this support the GEO Work Programme 2017-2019 and GEO-Wetlands will ensure that results remain available and are promoted for potential end-users.

**Project Timeline & Previous Related Work**

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

***Multi-Term Objectives:***

* **Term 1 (Proposed Term):** 2017 Summer (MSFC) – Rwanda Ecological Forecasting I
  + This term will consist of classifying wetlands in western Rwanda using Landsat 8 OLI, Landsat 7 ETM+, and SRTM-v3. Wetland extent maps, change maps, and a prediction map will be created over the course of the term. The use of Google Earth Engine will allow for continuous and efficient monitoring of wetland extent by the project partners. This information will hopefully help in the prevention of urban development in this vital land. The team will also collaborate with De-Mo Wetlands project to compare results. The structure of this methodology will be carried on into the second term.
* **Term 2:** 2017 Fall (MSFC) – Rwanda Ecological Forecasting II
  + The second installment of this project will be using the same tools as the first term to create a new classification of wetlands for eastern Rwanda. Since the geography of Rwanda differs as one travels from east to west, the same classification algorithm for western Rwanda will not be applicable and a new method will be developed for this region. Wetland extent time series, change maps, and a prediction map will be created during this term for Eastern Rwanda. The team will again compare results with De-Mo Wetlands project.

***Related DEVELOP Work:***

2016 Fall (UGA) – Eastern India Ecological Forecasting: A Multi-Sensor Approach to Enhance the Prediction of Mangrove Biophysical Characteristics in Bhitarkanika Wildlife Sanctuary and Chilika Lagoon, Odisha, India

2016 Summer (LaRC) – Everglades Ecological Forecasting: Examining the Applicability of NASA Earth Observations and Google Earth Engine to Monitor and Forecast Mangrove Health and Extent in the Florida Everglades

2016 Fall (LaRC) – Everglades Ecological Forecasting II: Utilizing NASA Earth Observations to Enhance the Capabilities of the Everglades National Park to Monitor and Predict Mangrove Extent to Aid Current Restoration Efforts

2014 Spring (WC) – Rwanda Agriculture: Utilizing NASA’s Earth Observations to Estimate Rice Yield and Study Soil Erosion in Rwanda