**NASA DEVELOP National Program**

**Summer 2016 Project Proposal**

**NASA Marshall Space Flight Center**

**East Africa Disasters II**

Assessing Landslide Characteristics and Developing a Landslide Hazard and Susceptibility Map in Malawi

**Project Overview**

***Objective:*** To assess the characteristics of landslide-prone regions of Malawi and to create hazard and susceptibility maps by using NASA Earth observations and other geospatial datasets such as topography, hydrology, and soils.

***Community Concern:*** For disaster risk management to be effective, certain information such as hazard identification, structural vulnerability, and risk assessment, is required. Due to a lack of spatial and temporal information, government officials face challenges in disaster risk management. Documenting known landslides and determining landslide-prone areas are important components for effective disaster risk management.

***National Application Area Addressed:*** Disasters

***Study Location:*** Malawi

***Study Period:*** January 2000 to April 2016

***Advisors:*** Dr. Jeffrey Luvall (NASA at NSSTC), Dr. Robert Griffin (University of Alabama in Huntsville), Eric Anderson (NASA SERVIR Coordination Office at MSFC)

***Source of Project Idea:*** This project is a continuation of the East Africa Disasters project at MSFC. Denis Macharia from RCMRD suggested Malawi as the study area, since there is a need to implement satellite remote sensing for landslide monitoring. This project is directly tied to SERVIR.

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Regional Centre for Mapping of Resources for Development (RCMRD) | Denis Macharia, SERVIR- Eastern & Southern Africa Disaster Lead | End-User | Yes |
| NASA SERVIR Coordination Office at MSFC | Africa Flores, Research Scientist | Collaborator | Yes |
| SERVIR Applied Science’s Team at NASA GSFC | Dr. Dalia Kirschbaum, GPM Applications Scientist | Collaborator | Yes |

***End-User Overview***

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

Currently, RCMRD uses visible evidence from Google Earth, Landsat, ISERV, and Digital Globe imagery to digitize landslide records into a catalog. These records help disaster managers have a better understanding of when and where landslides occur.

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

RCMRD – They have used NASA Earth observations before. The results of this project will contribute to cataloging previously unidentified landslides and provide more information on those that have already been cataloged. This project will also focus on informing the mitigation and preparation aspects, as well as landslide hazards.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

NASA SERVIR Science Coordination Office at MSFC – The Science Coordination Office (SCO) has shown an interest in assessing the characteristics of landslide and landslide susceptibility. They have offered to provide support, collaboration, and share technical expertise for the project. The NASA SERVIR SCO at MSFC is connected to end-users by their hub in Kenya. With this, SERVIR can help disaster risk managers have a better understanding of when and where landslides occur.

SERVIR Applied Sciences Team at NASA GSFC – Dr. Kirschbaum has shown an interest in assessing characteristics of landslides and landslide susceptibility. She has offered support, collaboration, and technical expertise for this project. One of her significant contributions is the Global Landslide Catalog created by Dr. Dalia Kirschbaum, which provides a collection of rainfall-triggered landslides, including the dates and locations of these landslides.

***Boundary Organization Dissemination:***

NASA SERVIR Coordination Office at MSFC – The NASA SERVIR Coordination Office at MSFC is connected with RCMRD through the SERVIR Eastern & Southern Africa Hub. NASA SERVIR and RCMRD will partner together and use the methodologies and results created from this project to assist risk managers in locating landslide prone areas. This will improve their mitigation techniques with the local officials and residents of Malawi.

SERVIR Applied Sciences Team at NASA GSFC – The methodologies and results created from this project will be used to update the Global Landslide Catalog (GLC), which is available to the public and created through the SERVIR Applied Science’s Team at NASA GSFC. This will give the users of the application a better idea of direct variables that cause landslides, as well as locations of landslide prone areas.

RCMRD – RCMRD is connected with the NASA SERVIR Coordination Office at MSFC through the SERVIR Eastern & Southern Africa Hub. RCMRD and NASA SERVIR will partner together and use these methodologies and results created from this project to assist risk managers in locating landslide prone areas. This will improve their mitigation techniques with the local officials and residents of Malawi.

***Project Communication & Transition Overview***

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

Communication will initiate the first week of the term to introduce the team and determine if there have been any changes to the desired end-products. The team will ask the project partners how often they would like to receive project updates; however, it is usually once every two weeks.

***Transition Approach:***

The end products will be handed off to RCMRD and the SERVIR Applied Science’s Team at NASA GSFC via e-mail, due to their location. However, the end products will be handed off to the NASA SERVIR Coordination Office at MSFC in person. Software release will not be required. These end-products will be used to better understand what triggers a landslide, determine which areas are susceptible to landslides, and an estimate on how many people are potentially at risk of being affected by a landslide. Partners will use these end products to help with mitigation and preparation aspects, as well as to identify landslide hazards.

**Letters of Support:** NASA SERVIR Coordination Office at MSFC, Africa Flores, Research Scientist

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI** | Visible and Near Infrared (VNIR) Reflectance | Landsat 8 OLI data will provide scenes of the study area and will be used to visually pinpoint specific landslide initiation points and debris run out areas, using the GLC and media reports as starting points. |
| **GPM IMERG** | Precipitation | GPM IMERG will provide information regarding rainfall measurements near the time of a landslide occurrence. This will help determine the threshold for the amount of rainfall needed for landslide initiation. |
| **SRTM-v2 C-Band** | Digital Elevation Model | The C-Band from SRTM-V2 data will provide high-resolution 30m elevation data, newly released for the African continent. This will provide a more accurate assessment of slope, elevation, aspect, and other variables derived from digital elevation models. |
| **SMAP** | Soil moisture | SMAP will provide 3km soil moisture data. This will help determine the threshold for the amount of soil moisture needed for landslide initiation. |

***Ancillary Datasets:***

NASA SERVIR – Global Landslide Catalog – Dates and locations of landslides

Oak Ridge National Library LandScan – Population data – Population density and locations

Google Earth – Worldview data – Locate landslides

***Models:***

Princeton University Maximum Entropy Distribution Model (MaxEnt) (POC: Daryl Ann Winstead, MSFC Assistant Center Lead)

Fuzzy Logic Model (POC: Leigh Sinclair, MSFC Center Lead)

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

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Updated Global Landslide Catalog | This will show the dates and locations of landslides in Malawi. This will help project partners understand where landslide prone areas are and what characteristics can trigger a landslide. New dates and locations of landslides will be added to their current catalog. | Datasets and sensors involved will be Landsat 8 OLI and Worldview data from Google Earth. These sensors will be used to locate landslides. The historical time slider will also be used to estimate a date of occurrence. | N/A |
| Landslide Susceptibility Map | This will show which areas are susceptible to a landslide. The project partners will use this to help with mitigation and preparation aspects. | Datasets and sensors involved will be Landsat 8 OLI, GPM IMERGE, and SRTM-v2. Thresholds of variables, such as slope, elevation, distance to streams, and distance to roads, will be determined. Once the thresholds are determined, they will be put into the Fuzzy Logic Model in ArcMap 10.3 and the MaxEnt model. | N/A |
| Landslide Hazard Map | This will give an estimate of how many people are potentially at risk of being affected by a landslide. The project partners will use this to help with mitigation and preparation aspects. | Datasets involved will be the Oak Ridge National Library LandScan population data. The Landslide Susceptibility Map and the population data will be intersected to see how many people are potentially at risk of being affected by a landslide. | N/A |

***End-User Benefit:***

The results of this project will contribute to cataloging previously unidentified landslides and will provide more information on those that have already been cataloged throughout Malawi. This project will also inform the mitigation and preparation aspects, as well as landslide hazards. These end products will be used to help disaster risk management efforts, land-use planning, and understanding what conditions may trigger a landslide.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2015 Summer (Start) to 2016 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2015 Summer (MSFC) – East Africa Disasters
  + The East Africa Disasters team created a Landslide Hazard Map and a Landslide Susceptibility Map for Rwanda and Uganda in both 30m and 90m spatial resolutions. The team also performed a preliminary assessment between TRMM, GPM, and CHIRPS data and updated SERVIR’s Global Landslide Catalog. Project partners were updated about the project at least once every other week via email, teleconference, or in person. The end-products were handed off to the project partners both by email and in person.
* **Term 2 (Proposed Term):** 2016 Summer (MSFC) – East Africa Disasters II
  + The objectives for the second term of this project are to create a Landslide Hazard Map and a Landslide Susceptibility Map for Malawi, as requested by the project partners. To do this, the team will be using the methodology from the previous term, as well as the MaxEnt model. The team will also be updating SERVIR’s Global Landslide Catalog for this area. The project partners will be updated about the project at least once a week every other week. The end-products will be handed off to the project partners both by email and in person.

***Related DEVELOP Work:***

2015 Fall (GSFC) – Himalaya Disasters: Utilizing a Landslide Identification Product and a Real-Time Rainfall Detection Tool for Enhanced Landslide Detection in Nepal

2015 Summer (GSFC) – Himalaya Disasters II: Expanding Upon Landslide Identification Product and Hazard Assessment Model Capabilities for Enhanced Landslide Detection in the Koshi River Basin

2015 Spring (GSFC) – Himalaya Disasters: Utilizing a Landslide Identification Product and a Hazard Assessment Model for Enhanced Landslide Detection in Nepal’s Koshi River Basin

2014 Fall (ICIMOD/MSFC) – Pakistan Disaster: Impact Assessment of Attabad Lake Disaster on Agriculture and Associated Food Security in Gilgit Baltistan

**Project Needs/Requests**

***Participants Requested:*** 4

***Software & Scripting:***

ArcGIS – Raster Processing/Manipulation, Vector Data Processing, Map Creation of Landsat 8 OLI, GPM IMERG, SRTM-v2, and SMAP L-Band Radiometer/Radar

ENVI – Raster Processing/Manipulation of Landsat 8 OLI and Other Imagery

R/ MyStat/ or similar – Statistical Analysis of Landslide Points and Potential Explanatory Factors

**Notes & References:**

***References:***

Dr. Dalia Kirschbaum’s journals: Evaluation of a preliminary satellite-based landslide hazard algorithm using global landslide inventories and a global landslide catalog for hazard applications: method, results, and limitations