**NASA DEVELOP National Program**

NASA Goddard Space Flight Center

**Fall 2015**

**Short Title: Himalaya Disasters III**

**Subtitle:** Utilizing a Landslide Identification Product and a Real-time Rainfall Detection Tool for Enhanced Landslide Detection in Nepal

**VPS Title:** SLIP Sliding Away

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

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**Past or Other Contributors:**

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**Partner Organization:**

International Centre for Integrated Mountain Development (ICIMOD), Collaborator and End-User, POC: Sebastian Wesselman and Deo Raj Gurung

**Project Details**

**Applied Sciences National Applications Addressed:** Disasters

**Study Area:** Nepal

**Study Period:** Feb 2000 - Nov 2015

**Earth Observations & Parameters:**

TRMM, TMI – rainfall measurements

GPM, GMI – rainfall measurements

SRTM, 1 Arc-Second Global - topography

Terra, ASTER, Global DEM – topography

Terra, MODIS – land Cover, permanent water, and leaf area index (LAI)

Landsat 8, OLI – landslide identification

**Ancillary Datasets Utilized:**

* Dr. Dalia Kirschbaum’s Global Landslide Catalog – landslide locations
* ICIMOD’s Landslide Dataset 1992-2010 - visually assessed manually digitized landslides
* ICIMOD’s Lithology Dataset - geology
* USGS Landscan 2011 - population
* USGS HydroSHEDS - rivers
* OpenStreetMap - roads
* ISRIC SoilGrids 1km - soil properties
* Polar Geospatial Center and the Byrd Polar and Climate Research Center—Nepal SETSM 20 m and 2 m DEMs, topography

**Models Utilized:**

* NASA Landslide Hazard Assessment Model
* NASA Susceptibility Model

**Software Utilized:**

Python - Automation of Landslide Detection, Real-time Precipitation Monitoring

R - Statistical analysis and testing of methods for Landsat imagery and precipitation trends

ArcGIS - Raster manipulation/analysis, image enhancement & map creation

MATLAB - TRMM/GPM processing

**Project Overview**

**80-100 Word Objectives Overview:**

Through previous DEVELOP research, the Sudden Landslide Identification Product (SLIP) and the Detecting Real-time Increased Precipitation (DRIP) product were developed to locate and predict rainfall-induced landslide event information. The objective of this study was to validate the results of SLIP and DRIP and to assess their global prediction capabilities. The other objective of this study was to develop a web-based data portal that can host SLIP and DRIP and will allow our end-users to collect and download landslide event and rainfall event information.

**Abstract:**

Nepal is a hotspot for landslide activity due to its mountainous topography, complex terrain, and monsoon rains. Previous DEVELOP terms combined NASA Earth observation data from Landsat 8, Shuttle Radar Topography Mission (SRTM), Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), Tropical Rainfall Measuring Mission (TRMM) and the Global Precipitation Measurement Mission (GPM) with various ancillary datasets to create two products for use in the region: the Sudden Landslide Identification Product (SLIP), and Detecting Real-time Increased Precipitation (DRIP). SLIP will help identify landslides in near real-time using Landsat 8 and elevation products, as well as provide damage assessments by mapping landslides automatically after a disaster such as the Gorkha earthquake in May 2015. DRIP will monitor precipitation levels extracted from the GPM-IMERG 30-minute product to create alerts when current rainfall levels exceed calculated threshold values. SLIP and DRIP were also integrated to provide a more comprehensive landslide notification system for the region. The objective of this study was to validate the results of SLIP and DRIP and to assess their global prediction capabilities, and to develop a web-based data portal that can host SLIP and DRIP and will allow end-users to collect and download landslide and rainfall event information.

The DRIP-SLIP model combination will be used by the International Centre for Integrated Mountain Development (ICIMOD) to: 1) protect and manage ecosystems and villages in Nepal, 2) prevent future loss of life and infrastructure due to landslides, and 3) reduce poverty through integrated natural resource management and regional cooperation.

**Community Concerns:**

* Landslides cause hundreds of fatalities and cost millions of dollars in Nepal and the Himalayan region annually.
* In August 2014, heavy rains caused several landslides in 18 districts throughout Nepal. A total of 29,680 people were displaced, and a total of 53 people died.
* Landslides are a significant hazard, as seen in the 2015 M7.8 Gorkha earthquake, and increase in frequency and severity during the summer monsoon. Landslides have caused hundreds of deaths in 2015.
* The numbers of landslides occurring in Nepal are currently underestimated due to the association of landslides with other disaster events and occurrence of landslides in unpopulated areas.

**Current Management Practices & Policies**:

The International Centre for Integrated Mountain Development (ICIMOD) is an intergovernmental organization that serves eight regional entities located within the Hindu Kush Himalayan region, including Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. Through partnerships with regional institutions, ICIMOD is able to serve as a regional hub that provides its end-users with knowledge and insight into how climate change and globalization impact the fragile mountainous ecosystems. ICIMOD oversees a variety of programs that were constructed to generate innovative forecasting products. While ICIMOD has a variety of resources and projects, few efforts have been made to use remotely sensed information to document precise landslide locations and estimate potential landslide conditions in the region. Many existing models rely on reporting which can reduce the spatial accuracy as well as introduce underreporting biases.

**Decision Support Tools & Benefits:**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Sudden Landslide Identification Product (SLIP) | Landsat 8 OLI | SLIP detects new landslides by comparing from a previous Landsat scene to a newer scene. Events are catalogued and added to a landslide database for the Nepal and Himalayan region. Cataloging landslide events will help ICIMOD better classify landslide susceptibility. |
| Detecting Real-time Increased Precipitation (DRIP) | GPM GMI, TRMM TMI | DRIP detects areas that have experienced anomalously high precipitation accumulation. DRIP will help ICIMOD better prepare for landslide events by issuing landslide warning in near real-time. |
| Landslide Hazard Assessment Web Portal | Landsat 8 OLI, GPM GMI, and TRMM TMI | The landslide hazard assessment web portal will provide ICIMOD with a GUI interface to download landslide and rainfall event data in near real-time and historical capacities. |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements**

What category do the tools your project is creating fall within? [Category IV]

If your decision support tools fall within Category IV, fill out this section:

**Software Title:** DEVELOP SLIP and DRIP Landslide Detection Package

**Software Abbreviation:** DRIP-SLIP

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**Brief Description of the Software:** The DRIP-SLIP package will be used to functionalize common programming tasks regarding landslide and rainfall anomaly detection through the use of NASA data products. It will include functions for processing satellite data and will assist in rainfall induced landslide analysis. DRIP-SLIP will output two images. The first image will display a 24-hour rainfall total, and the second image will display landslide event information derived from SLIP.

**Type of Code:** *Source Code*

**Will the software include any embedded computer databases?** *Yes*

**Does the software use or call any open software or libraries?** *Open Source*

**List the software or libraries used, under what license they were obtained, and the URL for the license in the table below:**

|  |  |  |
| --- | --- | --- |
| **Name** | **License** | **License URL** |
| Python 3.4 | Open source license | <https://www.python.org/download/releases/3.4.0/license/> |
| R version 3.0.2 (2013-09-25) - "Frisbee Sailing" | Open source license | <https://www.r-project.org/Licenses/GPL-3> |

**Full Software Description and Plan**

**Introduction/Objective:**

Currently landslide event databases are limited in scope and size due to non-reporting biases. The DRIP-SLIP software addresses the issue of inaccurate and limited landslide event database creation by providing a non-biased way to identify rainfall induced landslides through the use of NASA Earth observation information.

**Applications and Scope:**

This software will be used to identify rainfall induced landslide events, which in turn will be used to develop more accurate landslide prediction models.

**Capabilities:**

While most landslide detection studies are conducted using expensive software and high resolution imagery with considerable human training of classification datasets, this software automatically scans imagery from Landsat 8, at a fine to moderate resolution and determines areas that might be new landslides. This is important to help increase the temporal latency for landslide products that emergency managers, planners, and scientists are able to use in their work.

**Interfaces:**

The script currently runs from the command line, simply calling the name of the file ‘DRIP-SLIP.py’ to run. The user also has the option to manipulate the script in order to find the exact path/row of the Landsat scenes and dates they require.

**Assumptions, limitations, & Errors:**

The scripts will only work as well as their underlying algorithms. While the DRIP and SLIP algorithms are fully functional, they will likely be undergoing editing as future verification and validation trains the algorithms’ improvements. The script is python-based, and runs from the command line--it would be beneficial to have the script invoked from the website where the DRIP-SLIP outputs will be hosted. This will help users get and visualize information more quickly, as well as provide those with limited programming experience more accessibility to the models.

**Testing:**

The DRIP-SLIP model will be tested by visual inspection of Landsat 8 and World-View 2 images, along with supporting information from the Global Landslide Catalog (GLC). The script will be tested with use from different team members and is implemented on the Open Science Data Cloud server.