**NASA DEVELOP National Program**

****International Research Institute for Climate and Society

**Summer 2015**

**Short Title: Malawi Disasters**

**Subtitle:** Applications of Flood Definitions and NASA Earth Observations to Create a Flood Forecasting Methodology

**VPS Title:** The Flash Factor: Creating a Flood Forecasting Framework

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

Dr. Pietro Ceccato (Lead, Environmental Monitoring Program, international Research Institute for Climate and Society, The Earth Institute, Columbia University)

**Past or Other Contributors:**

Jerrod Lessel

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**Partner Organizations**

Red Cross/Red Crescent Climate Centre (RCRCCC), Boundary Organization, POC: Erin Coughlan

Malawi Red Cross Society, End-User, POC: Hastings Kandaya

**Project Details**

**Applied Sciences National Applications Addressed:** Disasters

**Study Area:** Malawi

**Study Period:** December 2014 to February 2015

**Earth Observations & Parameters**

Aqua and Terra, MODIS - Water body delineation (DFO flood product)

Aqua and Terra, LANCE MODIS - Flood detection (NRT-GFM flood product)

TerraSAR-X, SAR - Flood detection

RADARSAT, SAR - Flood detection

RADARSAT-2, SAR - Flood detection

TRMM, PR - Rainfall

TRMM, TMI - Rainfall

TRMM, VIRS - Rainfall

Aqua, AMSR-E - Rainfall

Defense Meteorological Satellite Program (DMSP) satellites, Special Sensor Microwave Imager (SSM-I) - Meteorological data

Aqua, AMSU-A - Rainfall

EUMETSAT METOP, Advanced Scatterometer (ASCAT) Soil Water Index

**Ancillary Datasets Utilized**

* NOAA Climate Prediction Center (CPC) Morphing Technique - Rainfall
* Malawi Spatial Data Portal (MASDAP) – Land use/Land cover
* International Research Institute for Climate and Society (IRI) Data Library – Observed rainfall, 6-day extreme rainfall forecasts

**Models Utilized**

* University of Maryland/University of Washington Dominant river tracing-Routing Integrated with VIC Environment (DRIVE) model

**Software Utilized**

ArcGIS - Raster manipulation/analysis, map creation of Dartmouth Flood Observatory, NASA NRT-GFM Flood Mapping Products, TerraSAR-X, RADARSAT, RADARSAT-2, and ground truth data

**Project Overview**

During extreme climate events, such as the January 2015 Malawi flood disaster, humanitarian organizations rely on Earth observation (EO) data to evaluate impact and design response programs. This project built on the previous analysis of various EO flood detection products and incorporated specific flood definitions to better identify impacts of flash floods versus riverine floods. These definitions will then be incorporated into a methodology to better monitor and forecast flash flood events in vulnerable areas.

**Abstract**

The African country of Malawi experiences a strong seasonal rainy season stretching from October to April, which provides about 95% of its annual precipitation. In addition to this high seasonality, about 20% of Malawi’s land cover is comprised of surface water from Lake Malawi, one of the Great African Lakes. These unique features contribute to the country’s increased vulnerability to riverine floods and flash floods. In January 2015, extended periods of extreme rainfall caused a series of flood events throughout Malawi, which resulted in the displacement of over 230,000 residents and caused 276 fatalities. In order for local authorities and humanitarian agencies to provide post-disaster relief, these organizations often rely on remotely-sensed satellite data to evaluate initial disaster impact and design response programs. In partnership with the Malawi Red Cross, this project aimed to expand on the findings from previous research in Spring 2015 by first comparing ground-truth data (locations of shelter site of internally displaced people (IDPs) and origins of IDPs) with previous term data and second, by integrating European Space Agency (ESA) remotely sensed data to explore the potential predictive capabilities of soil moisture for flash flood detection. In addition to data from NASA sensors (MODIS, TRMM, SSM-I and AMSU-A data), this project incorporated ASCAT data from ESA. The results of this study will increase the ability to forecast and monitor flood events, benefiting organizations involved with disaster relief efforts in Malawi and potentially allowing for more efficient response and allocation of emergency flood relief efforts.

**Community Concerns**

* January 2015 floods in Malawi resulted in 276 deaths, 153 people missing, and over 230,000 people displaced. The affected population is in urgent need of nutritional supplies, shelter, and drinkable water.
* Due to the spatial and temporal characteristics of flash floods, flood detection products are rarely able to identify them. Communities affected by the flash floods may be overlooked by disaster responders, or delay relief aid.
* Potential to improve flash flood detection and prediction using satellite products is not only vital for local preparation, but also for enhancing the efficiency of relief aid delivery.

**Current Management Practices & Policies**

Remote regions in Africa often have sparse meteorological and ecological satellite and ground data. Project partners in this region rely heavily on remotely sensed rainfall data from TRMM as it increases the temporal and geospatial scales of projects. Data from NASA satellites and sensors (e.g. Aqua MODIS, Terra MODIS and TRMM) enable humanitarian organizations, including Red Cross, working in these regions to better evaluate the impact extent and develop response programs.

**Decision Support Tools & Benefits**

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| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Flash Flood Monitoring Framework | TRMM, MODIS, Aqua, Terra, TerraSAR-X, RADARSAT, RADARSAT-2, ASCAT, EUMETSAT METOP-A, EUMETSAT METOP-B | Malawi Red Cross and other humanitarian decision makers will be better equipped to develop more effective response programming. |

**Project Imagery**

**Caption:** ​​Maps of Malawi showing various data from January 15th, 2015: Output of an unsupervised iso-cluster analysis of soil moisture, land use/land cover and soil moisture.

Image Credit: Malawi Disasters II Team.

**Image:** 