**NASA DEVELOP National Program**

**Spring 2016 Project Proposal**

**Wise County Clerk of Court’s Office**

**African Great Lakes Weather II**

Utilizing NASA Earth Observations to Identify Indicators to Help Predict Deadly Storms over African Great Lakes

**Project Overview**

***Objective:*** To identify indicators predicting powerful storms over the African Great Lakes to help those who use the lake, and the people in countries neighboring it, to prepare for and mitigate damage and casualties.

***Community Concern:*** The African Great Lakes are a major food source for neighboring countries. Population densities are very high along the shoreline with millions of people depending on the lakes for fishing, tourism, and agriculture. According to Chamberlain et al., storms which occur over Lake Victoria, one of the largest African Great Lakes, lead to multiple fatalities every year. An article published by CNN cites this yearly fatality count at approximately 5,000 people. These deaths are mainly attributed to fisherman who are caught on the lake as a result of little warning that a severe storm is developing. As a result, Lake Victoria has been named by some as the world’s most dangerous lake. In addition, these storms gather enough intensity to cover and affect many nearby countries. There is a need for methods to provide early warning to fisherman and citizens in nearby countries.

***National Application Areas Addressed:*** Weather, Disasters, Ecological Forecasting

***Study Location:*** African Great Lakes - Lake Victoria, Lake Tanganyika, Lake Malawi, Lake Turkana, Lake Albert, Lake Rukwa, Lake Mweru, Lake Kivu, Lake Edward (Burundi, Democratic Republic of Congo, Kenya, Rwanda, Tanzania, Uganda)

***Study Period:*** January 2005 – December 2015: Time segments around major storm events in the African Great Lakes study area

***Advisors:*** Dr. Kenton Ross (NASA DEVELOP), Dr. Dwayne Cecil (Global Science Technology Inc.), Mr. Kristopher Bedka (NASA Langley Research Center’s Climate Science Branch), Prof. Bob VanGundy (University of Virginia’s College at Wise)

***Source of Project Idea:*** Kristopher Bedka is doing a study showing how major storms originate from African Great Lakes. He suggested that DEVELOP could assist in these efforts by trying to locate indicators that started the storms and helping find a way to estimate when another storm is in the making.

**Partner Overview**

***Partner Organizations:***

Kenya Meteorological Department (End-user, Boundary Organization; POC: John Mungai and Vincent Sakwa, Weather Forecasters)

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

The strategy of KMD is to maintain an efficient telecommunications system for rapid collection and dissemination of meteorological information required for national and international use in accordance with the World Meteorological Organization (WMO) and the International Civil Aviation Organization (ICAO) procedures. It provides meteorological and climatological services to agriculture, forestry, and water resources management. Their services also help with shipping in the western Indian Ocean by issuing cyclone warnings for the safety of ships. Currently, they depend heavily on *in situ* data from the weather stations, along with climate prediction models and EUMETSAT (European Organization for the Exploitation of Meteorological Satellites) data.

***NASA Earth Observations Capacity:***

Kenya Meteorological Department – Currently, they are not using NASA Earth observations to provide any of these services. However, the Overshooting Tops database developed by Kristopher Bedka will help enhance their decision making by analyzing it along with data from NASA Earth observations.

***Collaborator & Boundary Organization Support:***

Kenya Meteorological Department – The vision of KMD is to become a leading, world class, operational forecasting center and scientific institution that provides optimum contribution to improved quality of life. As part of this vision, they provide meteorological and climatological services for the purpose of agriculture, forestry, water resources management, and other factors, and help people lead a better life. The results from this project will help them provide better services to the people involved.

***Communication Plan & Transition Approach:***

We had a Skype meeting with our partner along with Dr. Ross, Kristopher Bedka and Ashutosh Limaye from SERVIR on September 29, 2015. We are planning to have a meeting with our partners once a month through video conferencing. At the end of the term, the tech paper and other deliverables will be emailed to them and a presentation will be done through Skype. They are planning to include the tools in their decision making process as soon as possible.

***End-User Benefit:***

Currently, our end-users rely heavily on *in situ* data from weather stations, along with climate prediction models and EUMETSAT data. Incorporating the data from NASA Earth observations, along with the Overshooting Tops database from Kris, will help create a tool that can be used by our partners to save a lot of time and money. It will also make sure that people living in the affected areas get adequate early warnings of storms to help ensure their safety.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Aqua** | AIRS | Temperature, water vapor, weather forecasting |
| **TRMM** | LIS | Lightning pulses |
| **GPM** | DPR | Rainfall |
| **Meteosat 8, 9** | SEVIRI | Infra-red imaging |

***NASA Earth Observations Use:***

*Aqua (AIRS)* – can provide information on the temperature and humidity of the air over the African Great Lakes, which relates to the stability and moisture of air that is important to the creation of storms.

*TRMM (LIS)* – Analysis of optical pulses from the LIS sensor can be used as an auxiliary baseline in conjunction with overshooting tops to indicate hazardous storm activity.

*GPM (DPR)* – GPM launched in early 2014 carrying Dual-Frequency Precipitation Radar that will provide data for the recent years after TRMM was discontinued.

*Meteosat (SEVIRI)* – The Hazardous Storm Event Database (HSED) consisting of the overshooting top detections were immediately derived from these 15 minute infrared images

***Ancillary Datasets:***

Modern Era Retrospective-Analysis for Research and Applications (MERRA); *In situ* rain, humidity, and temperature from weather stations; CMORPH and QMORPH data from Climate Prediction Center, NOAA; Temperature data from Giovanni Database; ISS Rapidscat data products

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

|  |  |  |
| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Storm Density Map | Helping depict the typical location and strength of weather factors | *In situ* weather stations and radar |
| Early Warning System | Weather forecasting and warnings to citizens and fishermen | *In situ* weather stations and radar |

*Density Maps* – Data from each of the satellites listed above will be studied for locations of highest and lowest concentration of individual parameters. These maps can be used to identify the strength and location of the different weather factors involved.

*Early Warning System* – Data from each of the satellites listed above will be studied for patterns, put into charts, and compared to see how they correlate during each weather event. An average range can be taken from each environmental factor to help estimate when another storm may be ready to happen when those factors come into average ranges.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 3Terms: 2015 Fall to 2016 Summer

***Multi-Term Objectives:***

* **Term 1** – Participants determined when major storms took place based on historical reports, news, and also through partner inputs. The team downloaded data for a few days before and during the weather event, and then noted the measurements of each environmental aspect before and after the storm. They found correlations between the data collected and also calculated the typical range in values present for each environmental aspect that was present before and during each weather event**.**
* **Term 2 (Proposed Term)** – As there are diverse data products that will be used, the team will spend considerable time getting acquainted with each sensor’s unique capabilities and functional requirements. They will look at the typical ranges in measurement for the environmental aspects in play and develop their own model or system that can be used with recent data to see the likelihood of a storm in the near future. The team will look for a model to use in creating an early warning system or create a new model based on findings from term 1.
* **Term 3** – The final term will focus on consolidating all the results into a tangible early warning system that could be utilized by the partners. All the results, along with tutorials will be handed over to the partners through video conferencing. A possibility of arranging a webinar for interested local organizations will be considered.

**Project Needs/Requests**

***Participants Requested:*** 5

***Software & Scripting:***

ArcGIS - Image enhancement, raster manipulation, and map creation of various data collected from satellites listed above

Python - Conversion of data types/formats, batch processing in ArcGIS

MatLab – Data analysis, creating contours

TerrSet’s Earth Trends Modeler – Rapidly assessing long term climate trends, seek recurrent patterns in space and time