**NASA DEVELOP National Program**

**** NASA Marshall Space Flight Center

**Spring 2016**

**Short Title: Lake Victoria Water Resources II**

**Subtitle:** Developing an Automated, Near Real Time System Using NASA Earth Observations to Monitor Aquatic Vegetation over the Winam Gulf in Lake Victoria

**VPS Title:** Catch Me If You Can: Near Real Time Monitoring of Water Hyacinth

**Project Team & Partners**

**Project Team:**

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Africa Flores (SERVIR)

Dr. Joe Ortiz (Kent State University)

**Past or Other Contributors:**

Austin Vacek

**Partner Organizations:**

SERVIR Coordination Office (end-user), POC: Africa Flores; Boundary Organization

SERVIR - Eastern and Southern Africa Hub, (end-user), POC: Dr. Robinson Mugo; Boundary Organization

Regional Centre for Mapping of Resources for Development (RCMRD) (end-user), POC: James Nyaga; Boundary Organization

Makerere University Department of Geomatics and Land Management (end-user), POC: Dr. Anthony Gidudu

**Project Details**

**Applied Sciences National Applications Addressed:** Water Resources

**Study Area:** Lake Victoria in Kenya

**Study Period:** Jan 2013 to Feb 2016

**Earth Observations & Parameters:**

Suomi NPP, VIIRS - surface reflectance, water surface temperature, vegetation detection

Landsat 7, ETM+ - surface reflectance, vegetation detection, chlorophyll-a

Landsat 8, OLI/TIRS - surface reflectance, vegetation detection, chlorophyll-a

**Ancillary Datasets Utilized:**

* RCMRD - *in situ* measurements and observations of the presence of water hyacinth
* Sentinel-2, MSI - surface reflectance, vegetation detection

**Models Utilized:**

* NASA DEVELOP Program Hyacinth-Vegetation Detection Algorithm

**Software Utilized:**

Dnppy Model - Landsat download and pre-processing to TOA reflectance

ENVI Classic/5.0 - raster manipulation/ analysis of Suomi NPP VIIRS

ArcMap 10.3 - raster manipulation/analysis, image enhancement & map creation of Landsat ETM+, OLI, Suomi NPP VIIRS, and Sentinel-2 MSI

Python 2.7/3.3 - automation of Hyacinth-Vegetation detection algorithm and download of Landsat and Sentinel-2

Sentinelsat 0.6.4 Python Package – automation of Sentinel-2 download

**Project Overview**

**80-100 Word Objectives Overview:**

The degradation of water quality in Africa’s Lake Victoria is in part due to proliferation of the invasive plant species *Eichhornia crassipes*, commonly known as water hyacinth. This project applied NASA Earth observations and Python to create an automated process for detection of water hyacinth. These tools will help end-users determine the accuracy of results and automatically download new data for future monitoring. By providing efficient methods for managing water resources, this project illustrates the benefits of using remote sensing to improve the quality of life for communities and businesses dependent on Lake Victoria.

**Abstract:**

Lake Victoria has a surface area of 68,800 square km, making it the largest lake in Africa. The lake is surrounded by Kenya, Tanzania, and Uganda and is home to more than 30 million people, making it one of the most densely populated rural areas in the world. These people rely on the lake for all aspects of their lives, including fishing, agriculture, and industrial applications. However, the increasing population has negatively impacted water quality through sewage, agricultural, and industrial run off. Furthermore, the introduction of *Eichhornia crassipes*, or water hyacinth, has been detrimental to the local communities by blocking fishing access and providing breeding grounds for disease carrying mosquitoes and snails. Ongoing efforts between SERVIR-Eastern and Southern Africa Hub, the Regional Centre for Mapping of Resources for Development (RCMRD), and the Makerere University Department of Geomatics and Land Management have been assessing and monitoring water quality parameters, such as chlorophyll concentration, temperature, and turbidity, for Lake Victoria using the Moderate Resolution Imaging Spectrometer (MODIS) sensor on the Aqua satellite. This project seeks to include the use of Sentinel-2 Multispectral Imager, as well as the Enhanced Thematic Mapper Plus (ETM+), and Operational Land Imager (OLI) sensors on Landsat 7 and 8 satellites, respectively, to assess water hyacinth presence in addition to current monitoring activities. The study will focus on the Winam Gulf region of Lake Victoria in Kenya since this area experiences abundant water hyacinth activity and has been identified by RCMRD as an area of focus. As a continuation of the Lake Victoria Water Resources project from Fall 2015, this project used data previously collected to create an automated model to detect water hyacinth. Additionally, an automated Python script was created to continuously download and process new Sentinel-2 and Landsat images to be utilized by SERVIR, RCMRD, and Makerere University in their water hyacinth monitoring efforts.

**Community Concerns:**

* Eutrophication due to runoff causes water hyacinth to spread rapidly and results in the degradation of water quality in Lake Victoria, which in turn directly affects everyday water usage.
* Water hyacinth growth restricts access to boating docks used for transportation, water extractors for clean drinking water and irrigation use, and fishing which the locals depend on daily.
* Due to its nature of growth, water hyacinth blocks sunlight from the water column resulting in decreased oxygen and nutrient levels, which negatively affect biodiversity throughout the lake.
* *Schistosomiasis* is a devastating tropical parasitic disease. The infectious form of the parasite is secreted by snails living in fresh water, resulting in contamination. Water hyacinth provides physical attachment surfaces, shade, reduced temperature fluctuations, and food for snails carrying the parasite, serving as a breeding ground. Water hyacinth are not free floating and require shallow water for attachment to the lake bottom. These habitat requirements significantly increase the human population exposure and infection risk of *Schistosomiasis.* These areas of the lake shore are where the majority of the physical exposure to lake water occurs through boat launching, fishing, and other activities. As a result, *schistosomiasis* poses a severe threat to populations living near water hyacinth infested waters.

**Current Management Practices & Policies**:

RCMRD is an intergovernmental organization that provides services on a demand driven basis in collaboration with other assisting institutes. Currently, RCMRD is measuring the water quality of Lake Victoria using standard methods (i.e. *in-situ* measurements, observations, etc.). Current methods are considered to be expensive, time consuming, and selective of one area across Lake Victoria. Improvements in remote sensing techniques are ongoing at RCMRD with the collaboration of SERVIR to monitor water quality in Lake Victoria.

**Decision Support Tools & Benefits:**

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| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Multi Sensor Accuracy Assessment  (placeholder name) | Landsat 7 ETM+, Landsat 8 OLI | Presents to end users the accuracy of the Hyacinth-Vegetation algorithm when applied to Landsat 7 and 8 |
| Aquatic Vegetation Detection Script | Landsat 7 ETM+, Landsat 8 OLI | Employs Python scripting to automatically download data for replication of water hyacinth detection process |
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**Project Imagery**

**[TBD]**

**Caption:** TBD. Image Credit: Lake Victoria Water Resources II Team.

**Image:** TBD

**Software Release Requirements**

What category do the tools your project is creating fall within? Category III