
Spatiotemporal modelling & automated *in-situ* sensors to monitor Harmful Algal Blooms(HABs)

Case Study-Lake Victoria



Presenter:

Name: OKELLO, JACOB OKOMO

Reg. No: ENC222-0149/2017



Introduction

- Toxic Cyanobacteria-rich Harmful Algal Blooms (CyanoHABs) , a phenomenon which turns water bodies **dark blue-green** due to eutrophication; potentially **harming humans and animal**, e.g., Unsightly nuisance, acute liver damage when ingested, irritation, **massive fish deaths**, etc.
- WHO
- Hence, quantifying the **spatial distributions of CyanoHABs** in L. Victoria is of great significance, which requires high spatiotemporal resolution monitoring. (Sitoki et al., 2012)
- There however exists that niche to support the space observations with a near-real time **geointelligent in-situ monitoring and reporting system**.

Problem statement

- The **rapidly escalating demographics** along L. Victoria riparian reserves has negatively impacted water quality through deposits of agricultural, industrial runoff and sewer refuse **eutrophication** the said region. (Burkholder et al., 2006; MOH)
- Deterioration in water quality initiates ecosystem conflicts, poor economic growth, reduced tourism, poor water quality furthermore barring achievement of **SDG 6 & 14**- Clean Water and Sanitation.
- **Coupling** wide spread spatiotemporal monitoring, and automated in-situ sensors will play a big deal in return. This would inform the **Govt. and the general public the affected zones**, calling for immediate remedy actions.

Justification



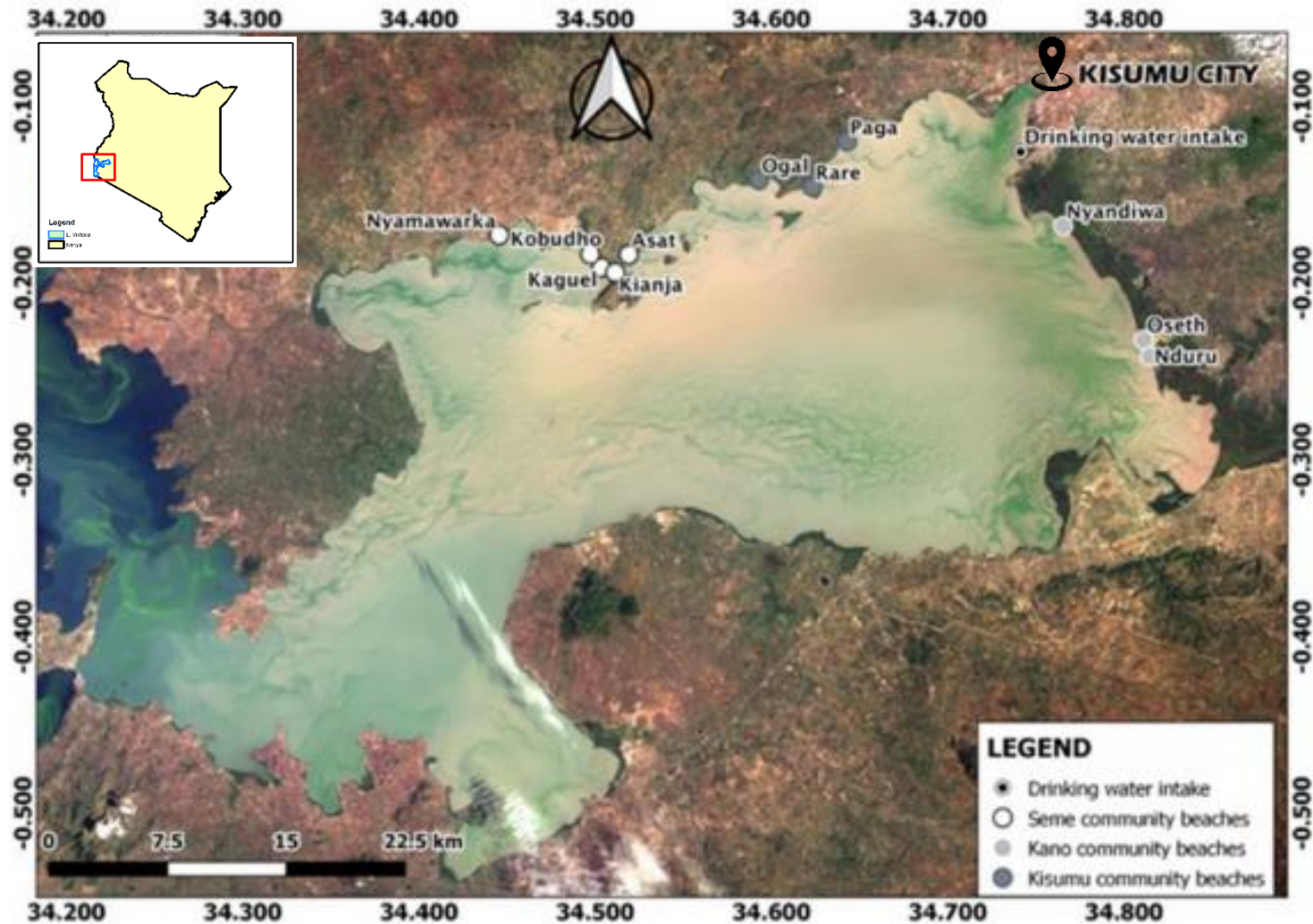
Image Sources: Standard Media KE, KMFRI, allAfricawaters



General and specific objectives

- To detect, monitor and report the occurrence of Harmful Algal Blooms(HABs) and Cyanobacteria in Lake Victoria.
 - To monitor chlorophyll-a(**chl-a**) concentration from L8 OLI images.
 - To monitor Lake Surface Water Temperature(**LSWT**) from L8 TIRS images as another HAB indicator in L. Victoria.
 - To **develop** automated Internet of Things (IoT) *in situ* sensors, Applicable in near real-time to monitor and report **geo-tagged** Water quality data.

Study Area

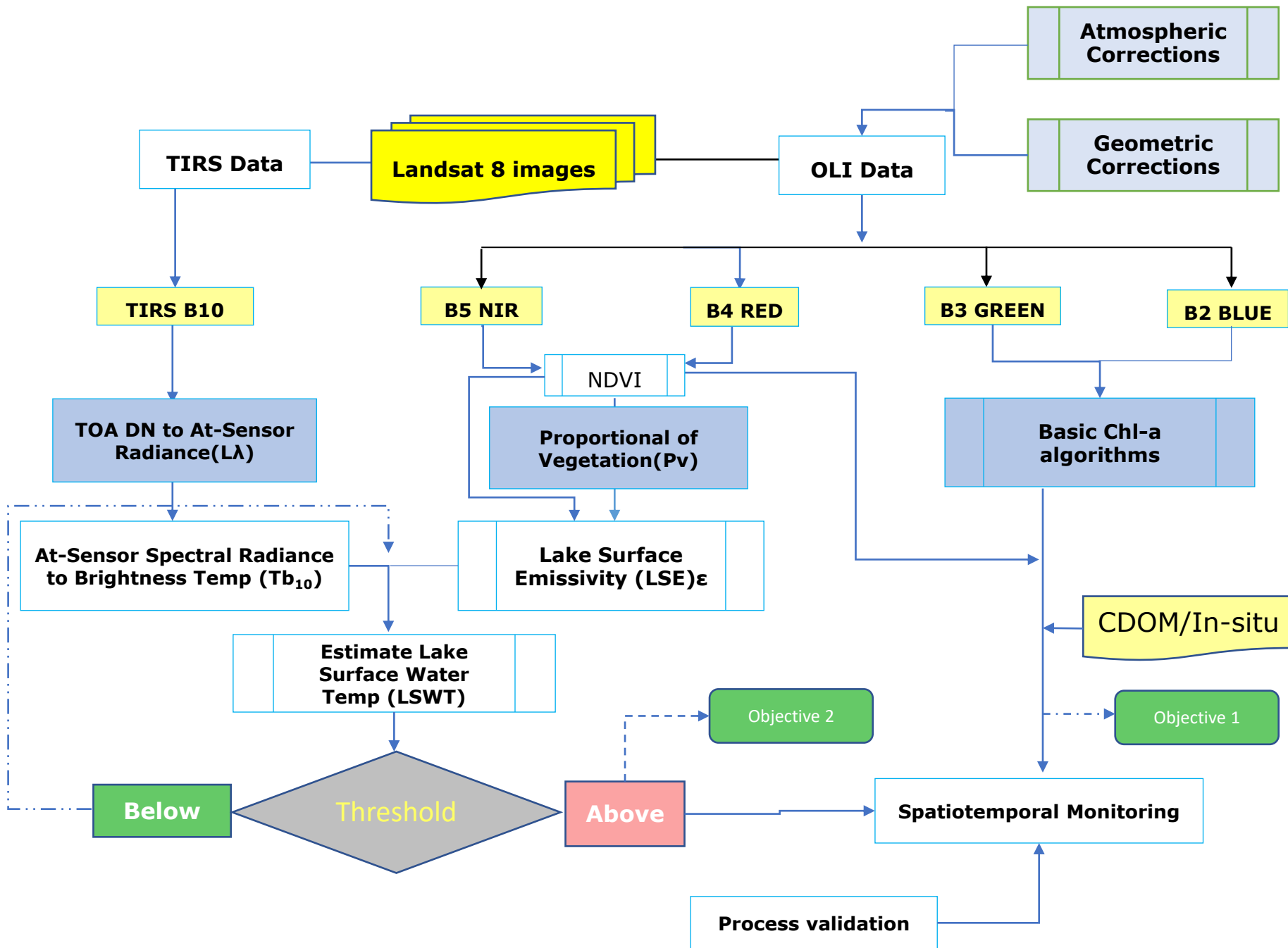


Overall Methodology : Data and Materials

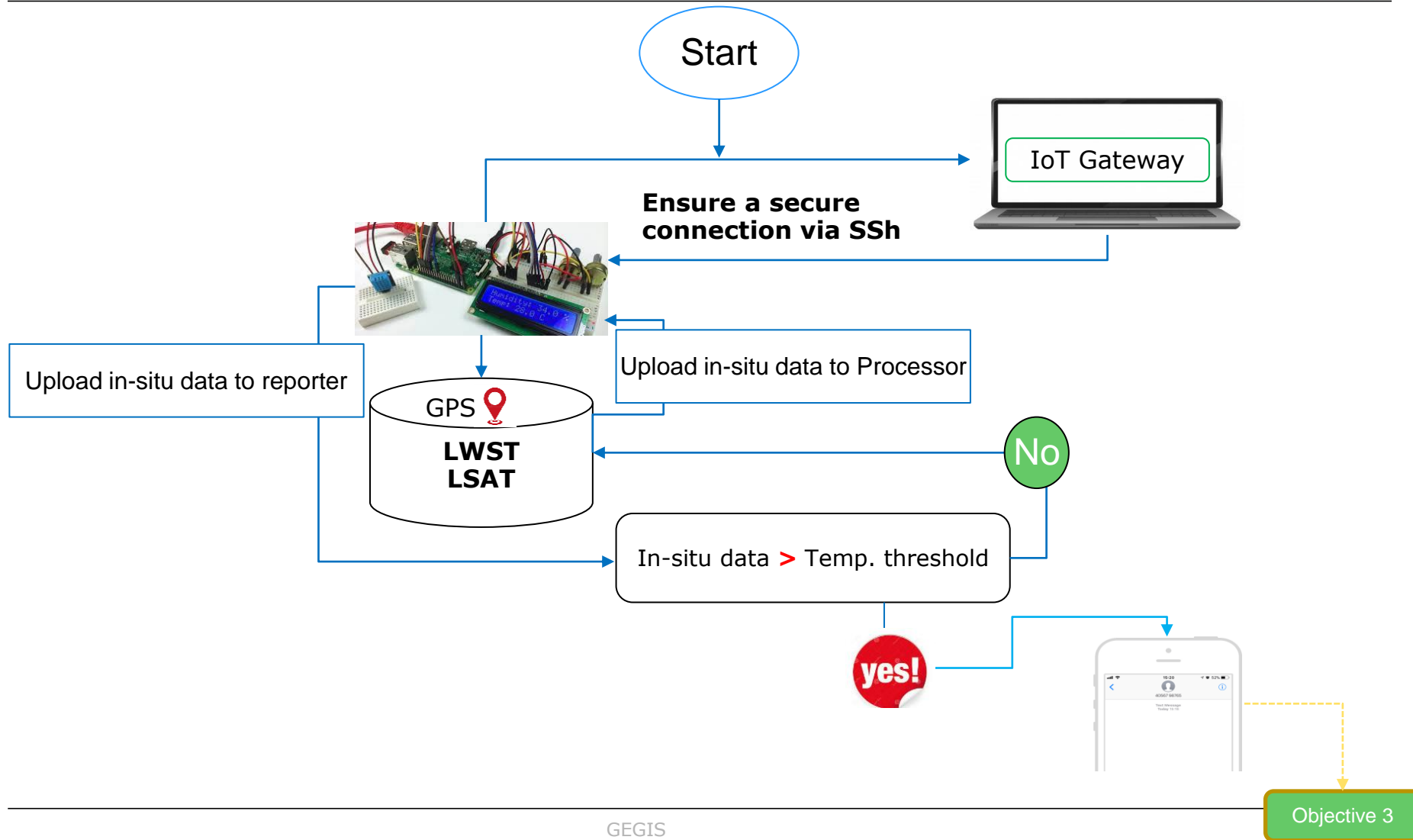


Data Type	Source	Role/Use
Landsat 8 OLI (30m, 16 days)	Google Earth Engine (2015-2021)	Spatiotemporal HAB Monitoring
Landsat 8 TIR (100m, 16 days)	Google Earth Engine (2015-2021)	Lake Surface Water Temperature Monitoring(LSWT)
Meteorological Data	Kenya Marine & Fisheries Research Institute-KMFRI (2015-2021)	Water Quality assessment
Shapefiles	Geodatabase of Global Administrative areas-GADM	Delineate the Study area
In-Situ Data	In-situ Sensors 2021 Onwards	Continued In-Situ Algal Monitoring

Tool/Material	Role	Availability
Google Earth Engine (GEE)	Geocomputation & Processing	Freely Available
QGIS, R & Python	Further Analysis & Maps	Free
Microcontroller & Sensors	In-Situ data Monitoring	Local Purchase
KiCAD	Design the Schematics & basic Circuits	Free & Open source



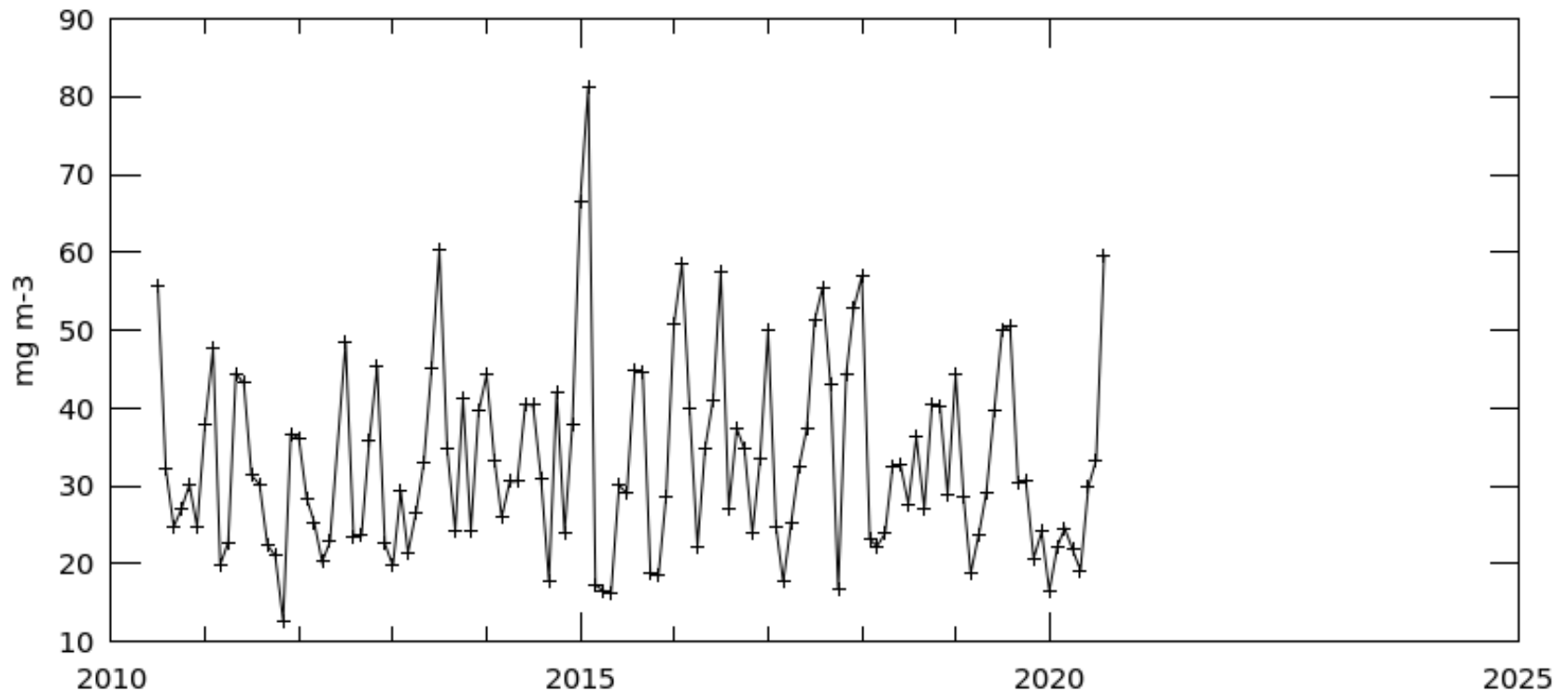
Overall methodology



Expected Results

- I. Chlorophyll-a Geographical **Maps** associating the occurrence of the Harmful Algal Blooms and Cyanobacteria.
- II. Lake Surface Water Temperature(**LSWT**) Maps associating the presence of HABs.
- III. **Autonomous** system that monitors and reports **geo-tagged temperature** data in near-real time from the ***in-situ*** sensors.

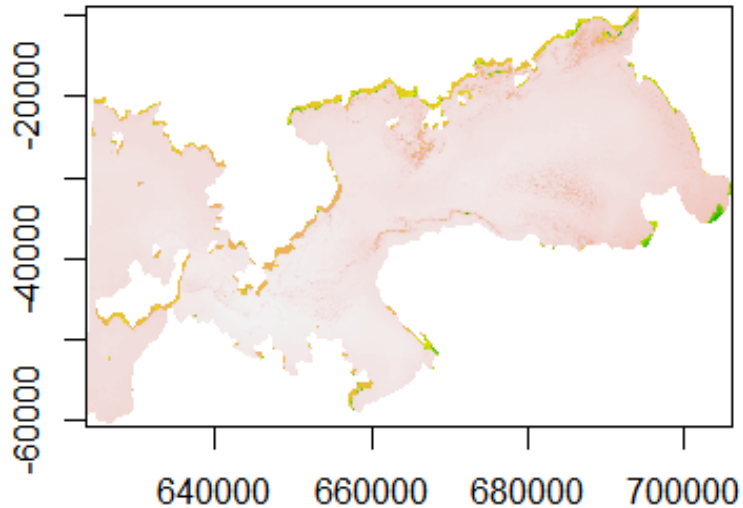
SAMPLE RESULTS: Time series Average of Chl-a conc. monthly 4-Km MODIS L3m



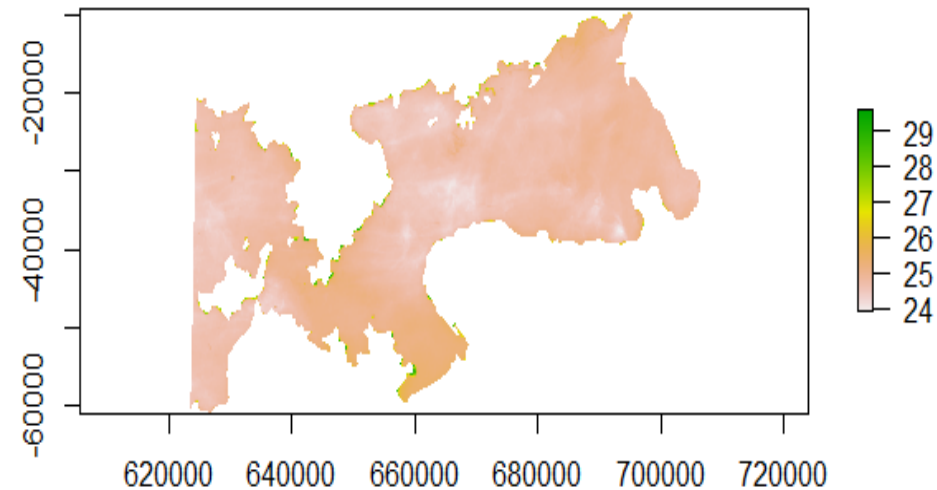
L8 2015: No Bloom Reported (cl-g map) Vs LSWT Map at Bloom Event.



Non Bloom



Bloom, LSWT °C



Obtaining GPS Location, Air Temp and Relative Humidity from Sensors.

```

pi@raspberrypi:~/192.168_micros/piStudios/NEO6M_Ublox $ nano neo6m.py
pi@raspberrypi:~/192.168_micros/piStudios/NEO6M_Ublox $ python neo6m.py
File "neo6m.py", line 14
SyntaxError: Non-ASCII character '\xe2' in file neo6m.py on line 14,
pi@raspberrypi:~/192.168_micros/piStudios/NEO6M_Ublox $ nano neo6m.py
pi@raspberrypi:~/192.168_micros/piStudios/NEO6M_Ublox $ y
bash: y: command not found
pi@raspberrypi:~/192.168_micros/piStudios/NEO6M_Ublox $ python neo6m.py
Traceback (most recent call last):
  File "neo6m.py", line 10, in <module>
    ser = serial.Serial(port,baudrate=9600,timeout=0.5)
  File "/usr/lib/python2.7/dist-packages/serial/serialutil.py", line
    self.open()
  File "/usr/lib/python2.7/dist-packages/serial/serialposix.py", line
    raise SerialException(msg.errno, "could not open port {}: {}".fo
serial.serialutil.SerialException: [Errno 2] could not open port ...
pi@raspberrypi:~/192.168_micros/piStudios/NEO6M_Ublox $ nano neo6m.py
pi@raspberrypi:~/192.168_micros/piStudios/NEO6M_Ublox $ python neo6m.py
Latitude = -1.09458933333, Longitude=37.0182255
Latitude = -1.0946335, Longitude=37.0183605
Latitude = -1.09464316667, Longitude=37.0183326667
Latitude = -1.09464583333, Longitude=37.0183036667
Latitude = -1.094632, Longitude=37.0182801667
Latitude = -1.0946315, Longitude=37.0182573333
Latitude = -1.09462916667, Longitude=37.01823
Latitude = -1.09462816667, Longitude=37.0182126667
Latitude = -1.09462233333, Longitude=37.0181935
Latitude = -1.09462533333, Longitude=37.0181796667
Latitude = -1.09464133333, Longitude=37.0182055
Latitude = -1.09464066667, Longitude=37.0182258333
Latitude = -1.09463783333, Longitude=37.0182228333
Latitude = -1.09463516667, Longitude=37.0181965
Latitude = -1.0946295, Longitude=37.0181818333
Latitude = -1.09462133333, Longitude=37.018166
Latitude = -1.094606, Longitude=37.0181016667
Latitude = -1.09473016667, Longitude=37.0186191667
Latitude = -1.09473666667, Longitude=37.0186191667
Latitude = -1.09473233333, Longitude=37.0186283333

```

```

pi@raspi-53 ~/sensors/dht11 $ time sudo ./dht11 -r 10
1, humidity: 44.0 | temperature: 23.0
2, humidity: 43.0 | temperature: 23.0
3, humidity: 44.0 | temperature: 23.0
4, humidity: 44.0 | temperature: 23.0
5, humidity: 43.0 | temperature: 23.0
6, humidity: 43.0 | temperature: 23.0
7, humidity: 43.0 | temperature: 23.0
8, humidity: 43.0 | temperature: 23.0
9, humidity: 43.0 | temperature: 23.0
10, humidity: 43.0 | temperature: 23.0

real    0m11.710s

```

Project Timeline



	June - July	August	Sep	Oct	Nov	Dec
Chl-a	Literature Rev (Restructure)	Data Acquisition Preliminary results	Chl-a spatiotemporal Maps			
LSWT	Literature Rev (Restructure)		LSWT spatiotemporal Maps			
IoT	Literature Rev. Acquire all sensors	Unit tests	Long Range comm.		Full Data Acquisition and Dissemination	

Thank you for your attention! Questions?

