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

Case Study-Lake Victoria

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Introduction

- Toxic Cyanobacteria-rich Harmful Algal Blooms (CyanoHABs) , a phenomenon in which the water body e.g. lakes turns **dark blue-green** due to excessive algal growth; potentially harming humans and animal, e.g., Unsightly nuisance, acute liver damage when ingested, irritation, fish deaths, etc.

  - WHO

- Hence, quantifying the spatial distributions of CyanoHABs in L. Victoria on a regular basis is of great significance, which requires high spatiotemporal resolution monitoring abilities- (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 eutrophicating the said region. (Burkholder et al., 2006; MOH)

- Deterioration in water quality initiates ecosystem conflicts, poor economic growth, reduced tourism, poor water quality furthermore baring 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 Source: Courtesy

General and specific objectives

- To monitor and report the occurrence of Harmful Algal Blooms(HABs) and Cyanobacteria in Lake Victoria.

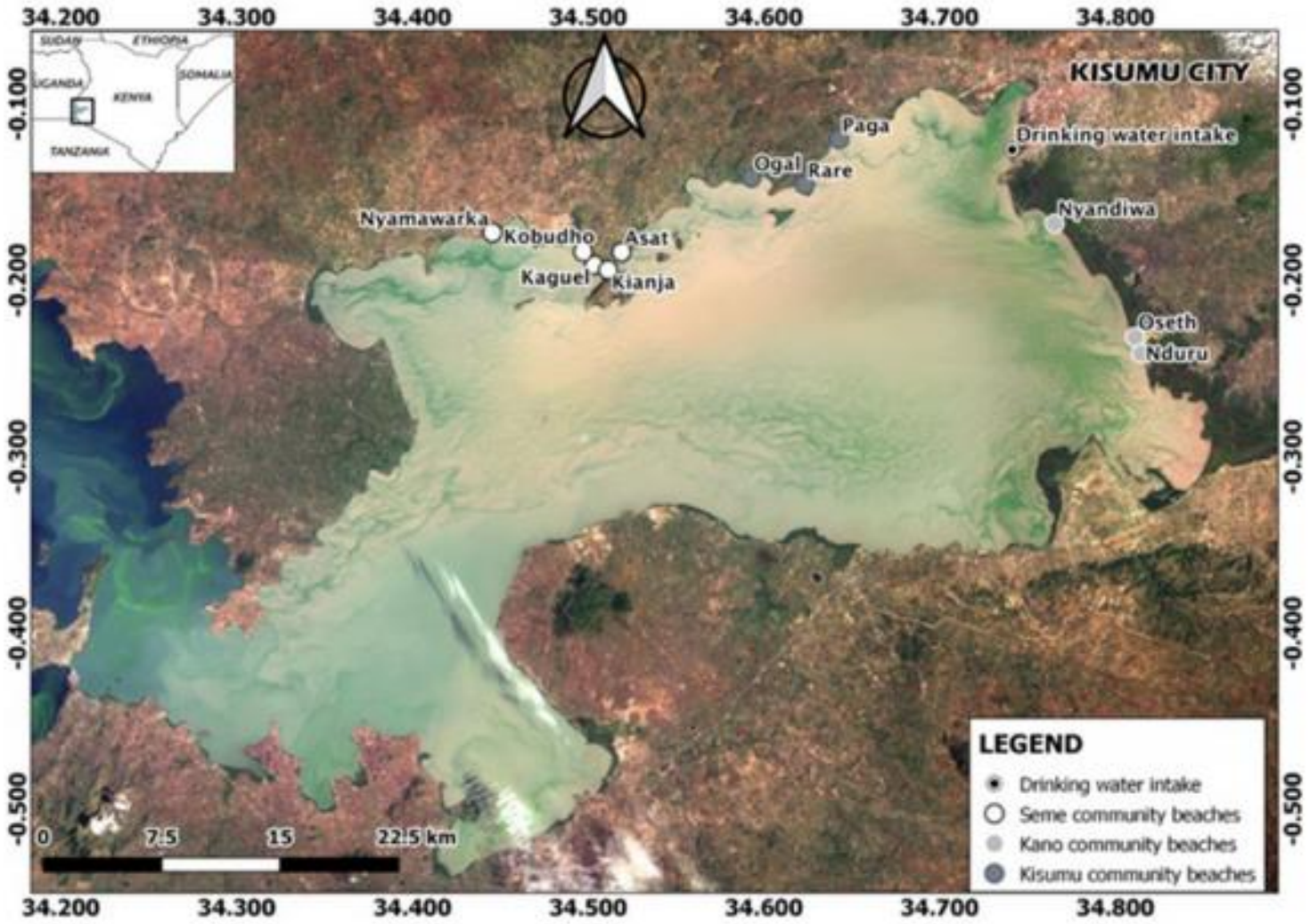
  - To monitor chlorophyl-a(chl-a) concentration & Cyanotoxins from L8 OLI images.
  - To monitor Lake Surface Water Temperature(LSWT) from L8 TIRS images as another HAB indicator in L. Victoria.
  - To develop automated Internet of Things (IoT) *in situ* sensors, Applicable in near real-time to monitor and report geo-tagged Water quality data.

Overall Methodology : Data and Materials

Data Type	Source	Role/Use
Landsat 8 OLI (30m, 16 days)	Google Earth Engine (2015-2020)	Spatiotemporal HAB Monitoring
Landsat 8 TIR (100m, 16 days)	Google Earth Engine (2015-2020)	Lake Surface Water Temperature Monitoring(LSWT)
Meteorological Data	Kenya Marine & Fisheries Research Institute-KMFRI (2015-2020)	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

Study Area


34.200
34.300
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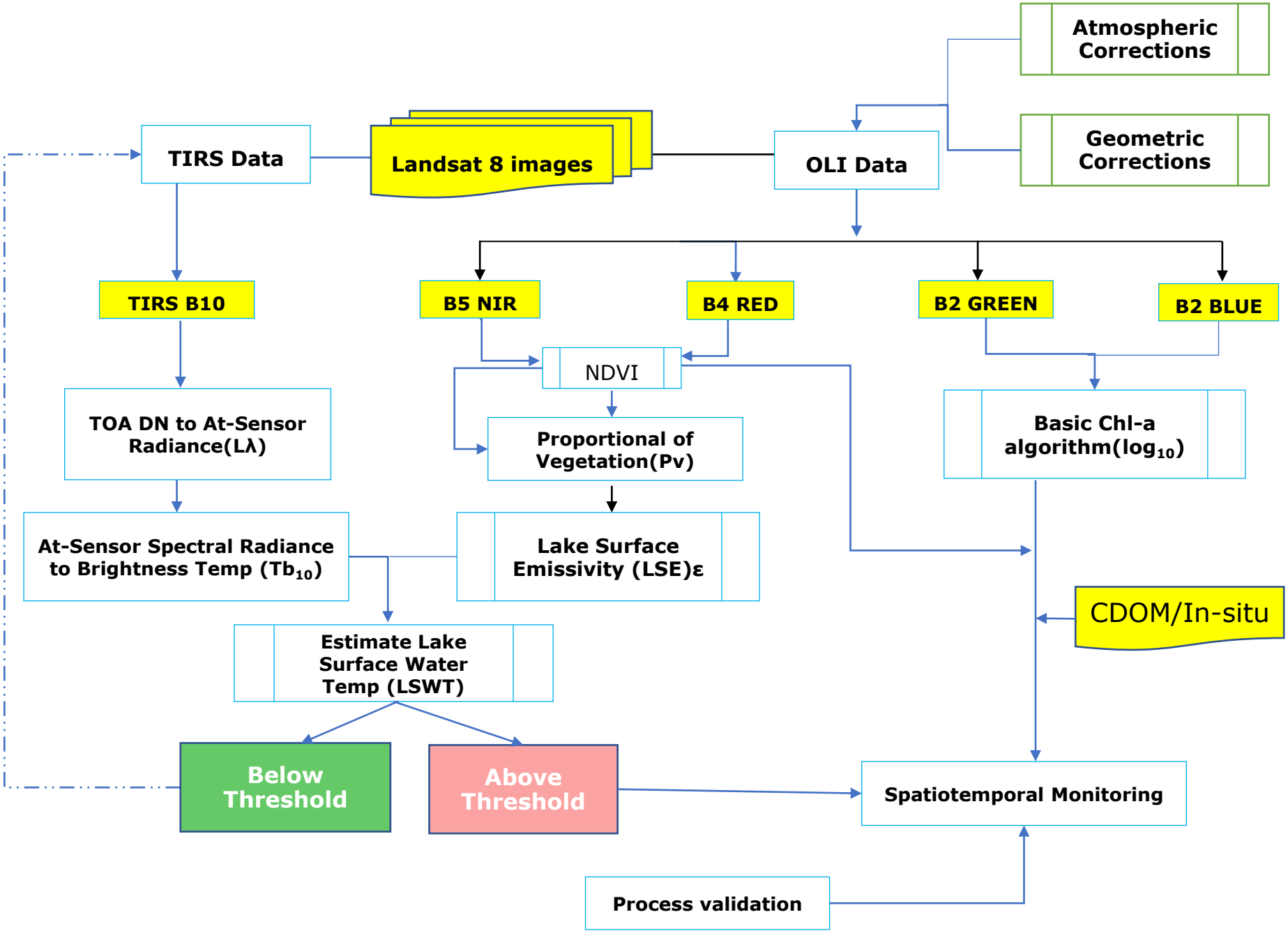
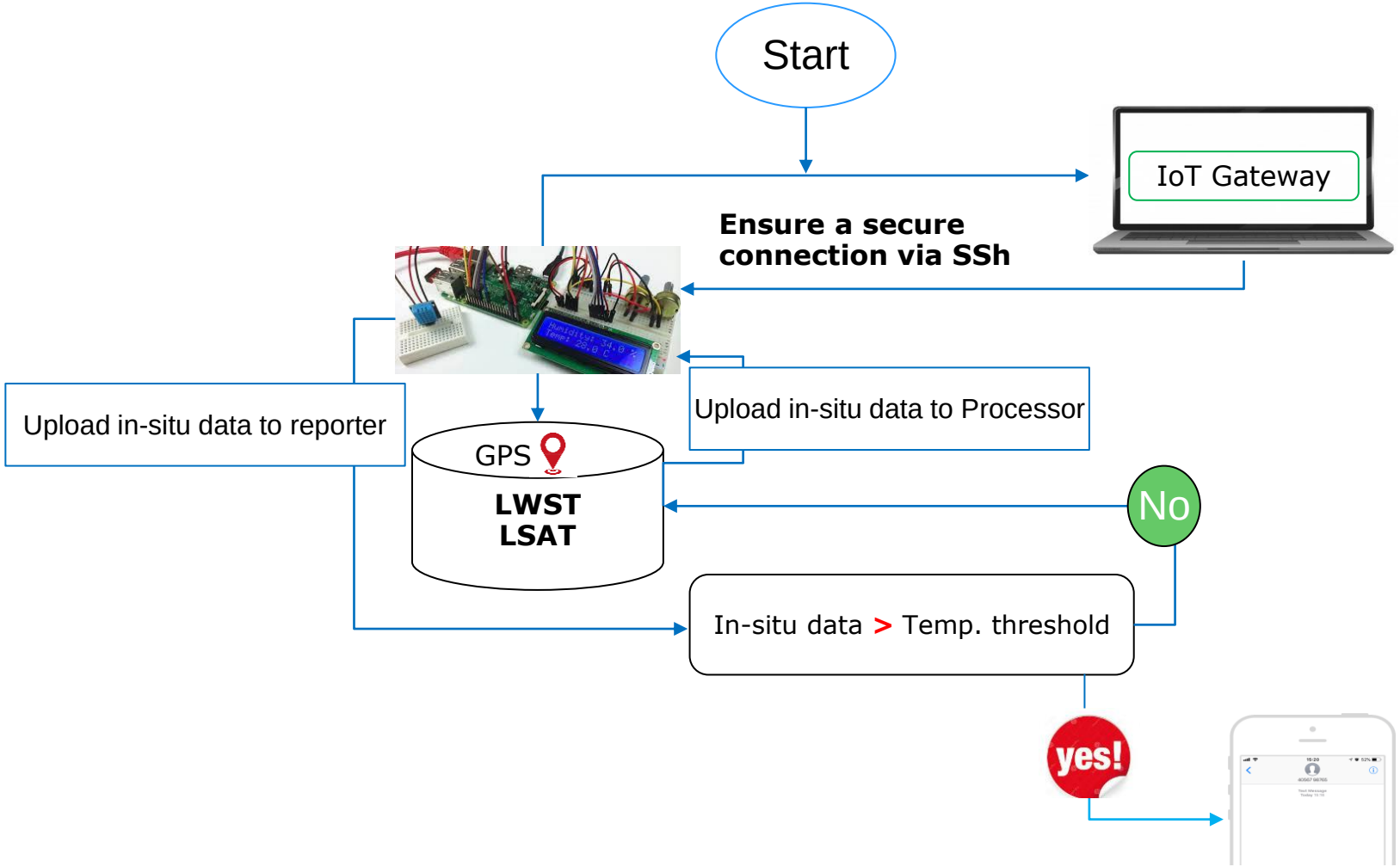
-0.500
SUDAN
ETHIOPIA
UGANDA
KENYA
SOMALIA
TANZANIA
KISUMU CITY
Paga
Drinking water intake
Ogal
Rare
Nyandiwa
Nyamawarka
Kobudho
Asat
Kaguel
Kianja
Oseth
Nduru
LEGEND
Drinking water intake
Seme community beaches
Kano community beaches
Kisumu community beaches
0
7.5
15
22.5 km


Atmospheric Corrections
Geometric Corrections
TIRS Data
Landsat 8 images
OLI Data
TIRS B10
B5 NIR
B4 RED
B2 GREEN
B2 BLUE
NDVI
TOA DN to At-Sensor Radiance(Lλ)
Proportional of Vegetation(Pv)
Basic Chl-a algorithm(log10)
At-Sensor Spectral Radiance to Brightness Temp (Tb10)
Lake Surface Emissivity (LSE)ε
CDOM/In-situ
Estimate Lake Surface Water Temp (LSWT)
Below Threshold
Above Threshold
Spatiotemporal Monitoring
Process validation

Overall methodology



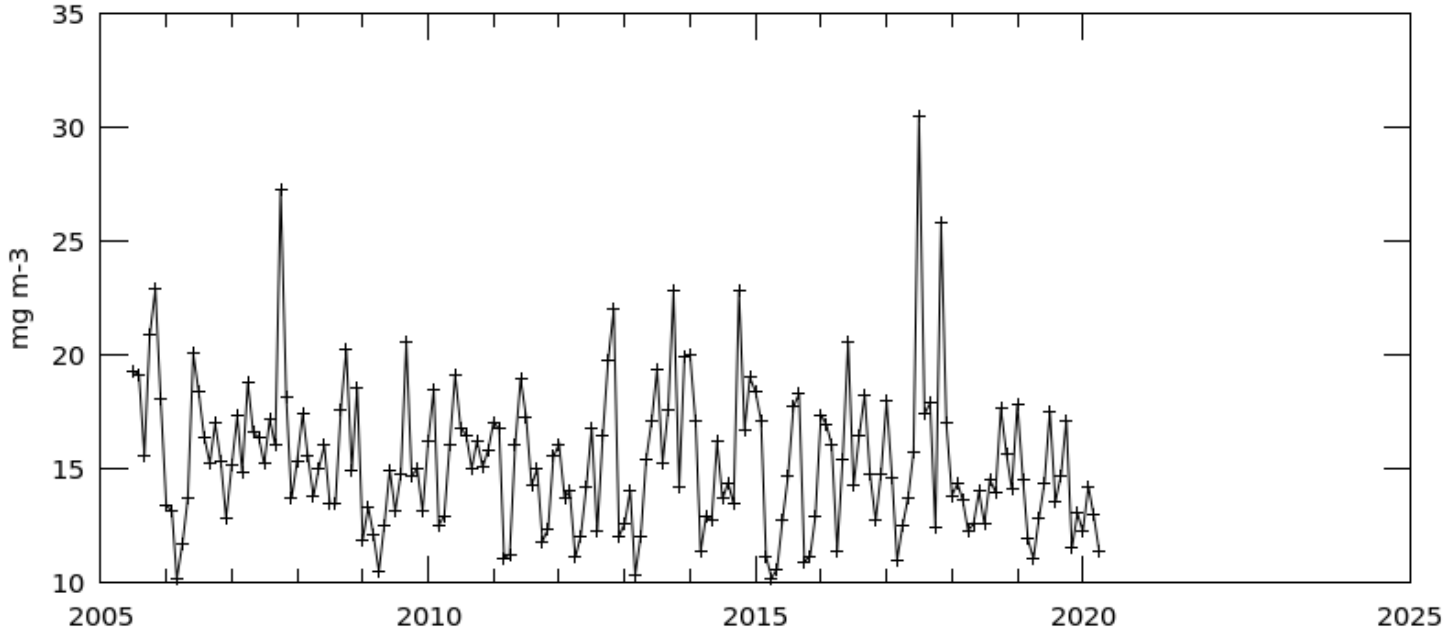
Expected Results

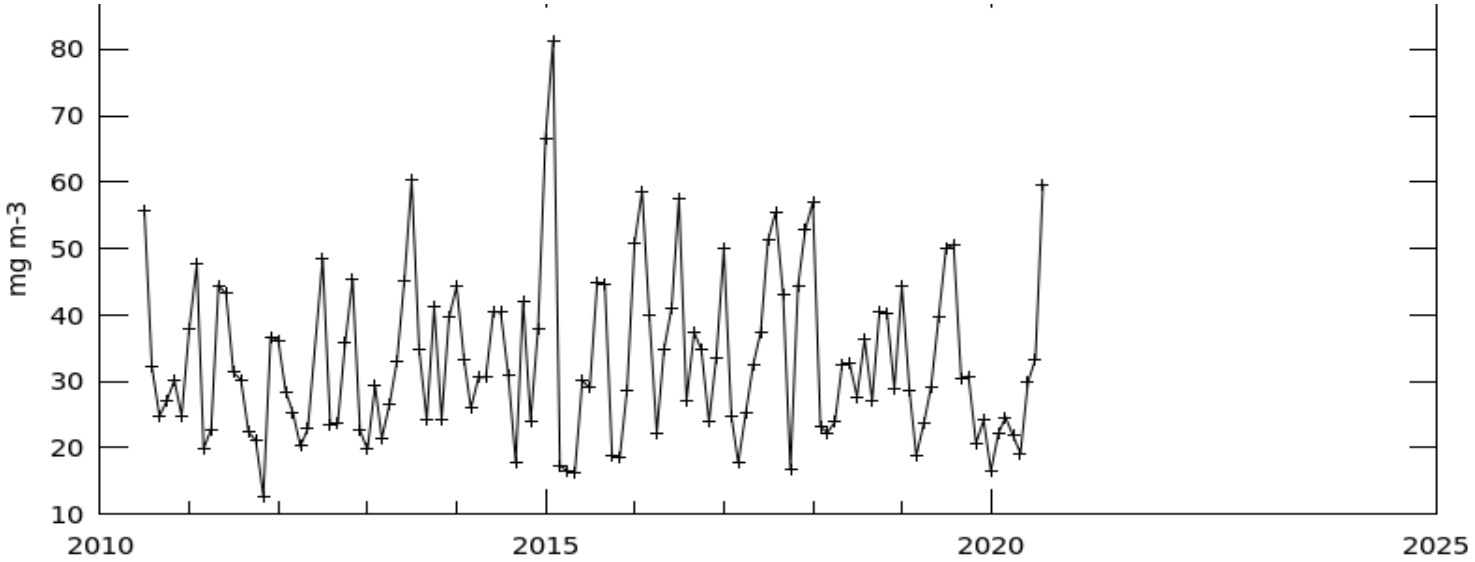
I. Chlorophyl-a Geographical Maps associating the occurrence of the Harmful Algal Blooms and Cyanobacteria.

II. Lake Surface Water Temperature(LSWT) Maps associating the presence of HABs.

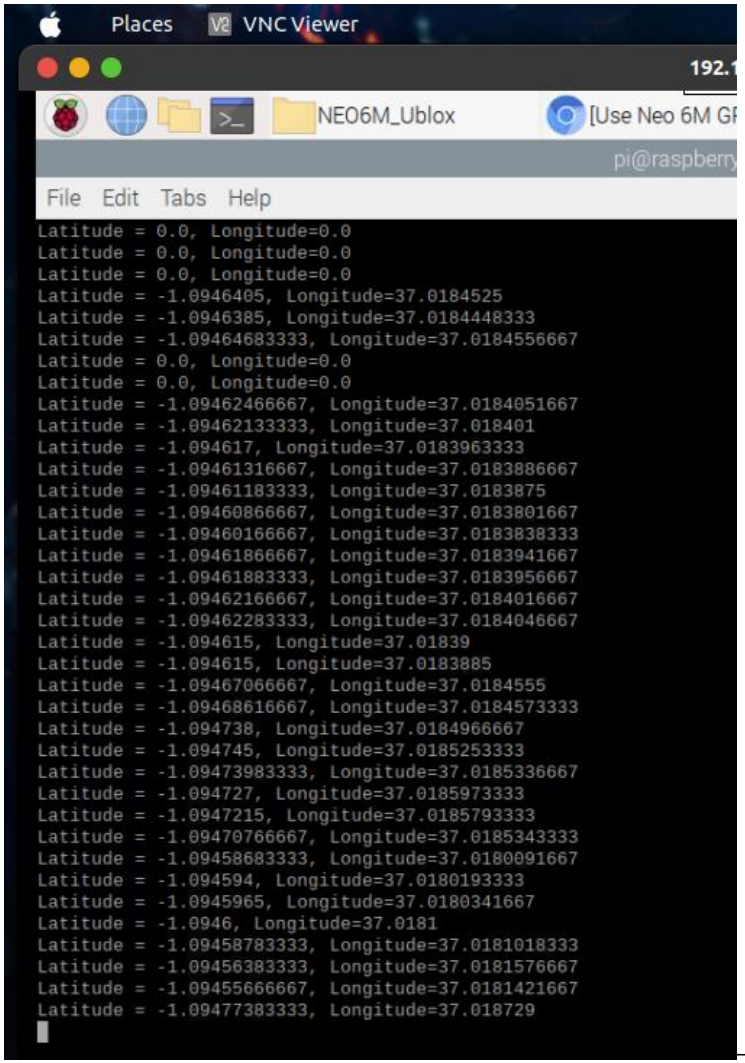
III. Autonomous system that monitors and reports geo-tagged data in near-real time the *in-situ* status from the sensors.

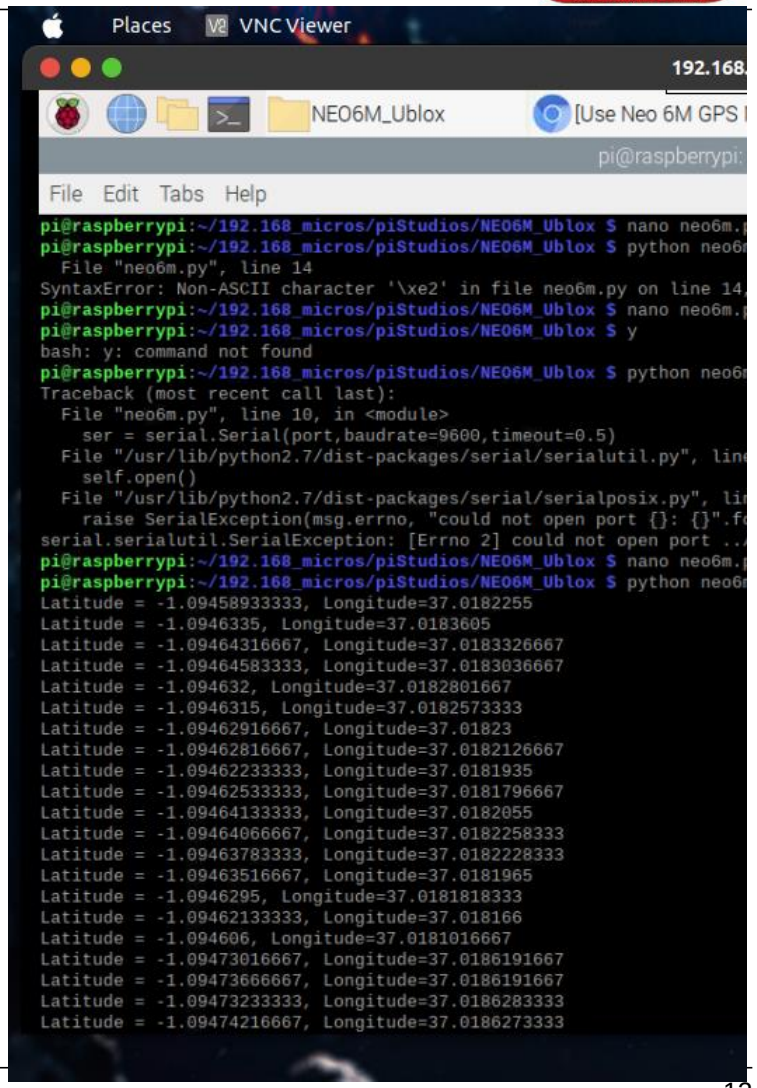
SAMPLE RESULTS: Time series Average of Chl-a conc. monthly 4-Km MODIS L3m





Sample Results: Obtaining GPS Location for Sensors





Project Timeline

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

Thank you for your attention! Questions?