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

Case Study-Lake Victoria

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Reg. No: ENC222-0149/2017

Final Presentation

Introduction

- HAB is a phenomena which turns water bodies dark blue-green due to eutrophication; potentially harming humans and animals e.g., massive fish deaths, etc.as lately observed in eutrophicated L. Victoria riparian.
  (Hecky et al., 2010)

- Development, stability, and density of the phenomenon affect some environmental factors Lake Surface Air Temperature (LSAT), Sea Surface Temperature (SST) & Water surface spectral signatures *(Tang et al, 2006)*

- The status quo only provides for the higher authority to solely rely on calls/information from the locals after the condition is a total mess without relying on any near real-time space-based or in-situ monitoring system.

- Therefore, there's need to come up with a quick response methodological approach to use space-based techniques and in-situ sensors to detect and alert the near-real time occurrence of HABs

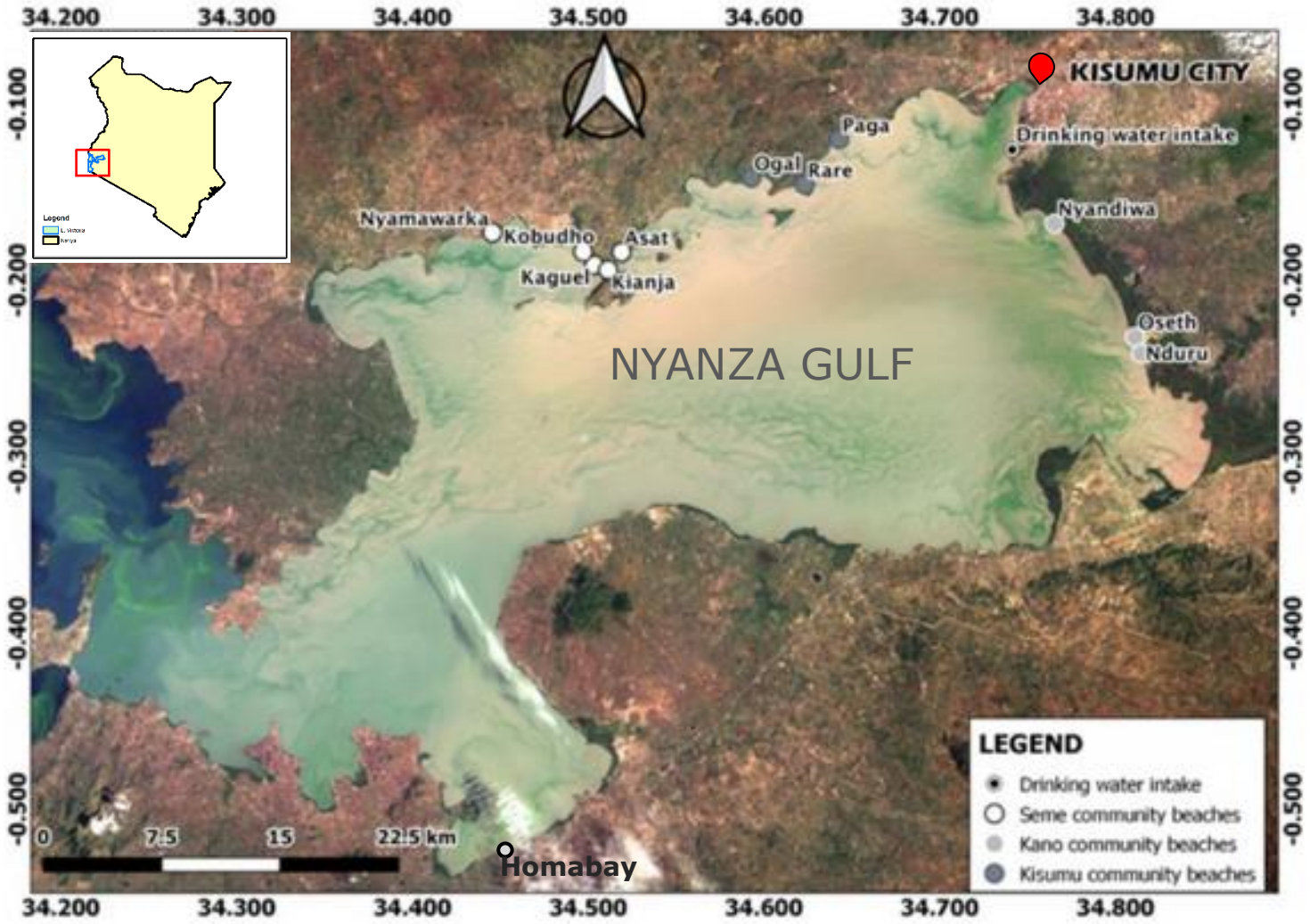
- Coupling wide spread spatiotemporal monitoring, and automated *in-situ* system will play a big deal in return. This would inform the Govt. and the general public the affected zones, calling for immediate remedy actions.

General and Specific objectives

- To detect, monitor and report the occurrence of Harmful Algal Blooms(HABs) in Lake Victoria, Kisumu basin from 2015 to 2020 and beyond.

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

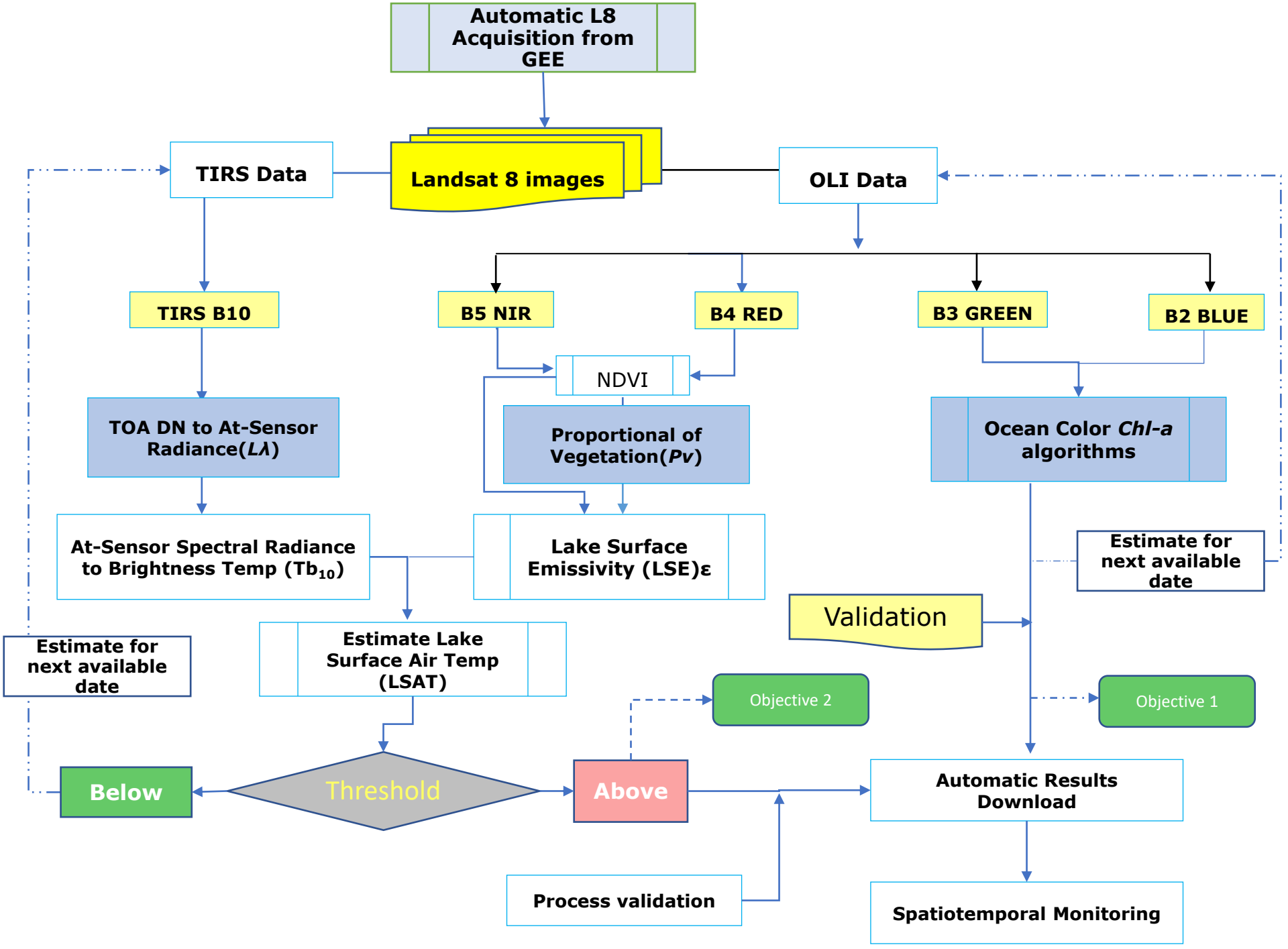
Study Area: Lake Victoria Nyanza Gulf



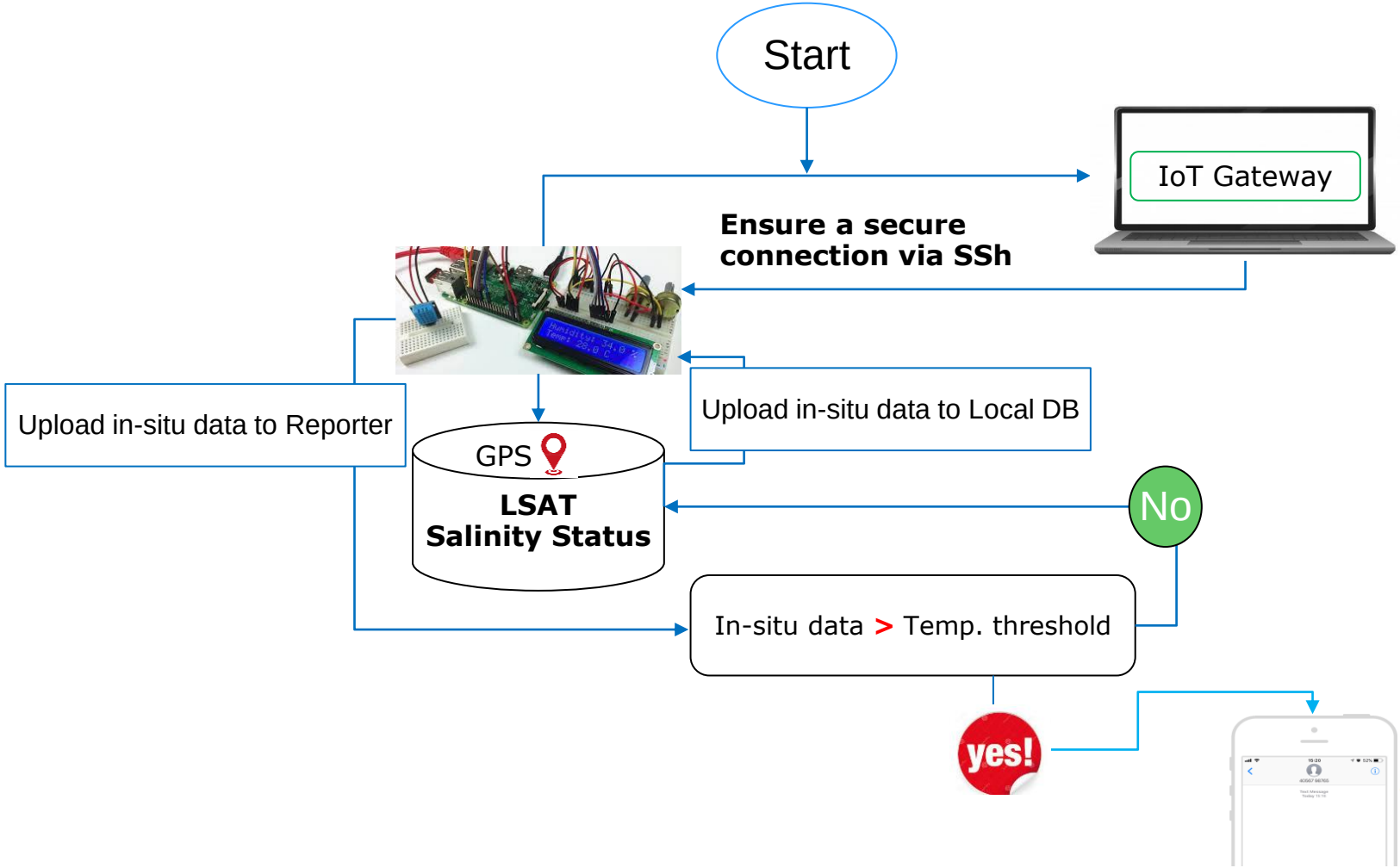
Data and Materials

Data Type	Source	Role/Use
Landsat 8 OLI (30m, 16 days)	USGS (2015-2021)	Spatiotemporal HAB Monitoring
Landsat 8 TIR (100m, 16 days)	USGS (2015-2021)	Lake Surface Air Temperature (LSAT) Monitoring.
Field Data	Kenya Marine & Fisheries Research Institute-KMFRI (2015-2020)	Previous HAB events
In-Situ Data	In-situ System 2021 Onwards	Continued *In-Situ* Algal Monitoring

Tool/Material	Role	Availability
Google Earth Engine (GEE)	Geocomputation & Processing	Freely Available
ArcMap, R & Python	Further Analysis & Maps	
Microcontroller & Sensors	In-Situ data Monitoring	Local Purchase


Automatic L8 Acquisition from GEE
Landsat 8 images
TIRS Data
OLI Data
TIRS B10
B5 NIR
B4 RED
B3 GREEN
B2 BLUE
NDVI
TOA DN to At-Sensor Radiance(Lλ)
Proportional of Vegetation(Pv)
Ocean Color Chl-a algorithms
At-Sensor Spectral Radiance to Brightness Temp (Tb10)
Lake Surface Emissivity (LSE)ε
Estimate for next available date
Validation
Estimate for next available date
Estimate Lake Surface Air Temp (LSAT)
Objective 2
Objective 1
Below
Threshold
Above
Automatic Results Download
Process validation
Spatiotemporal Monitoring

Overall methodology for IoT system



Objective 3

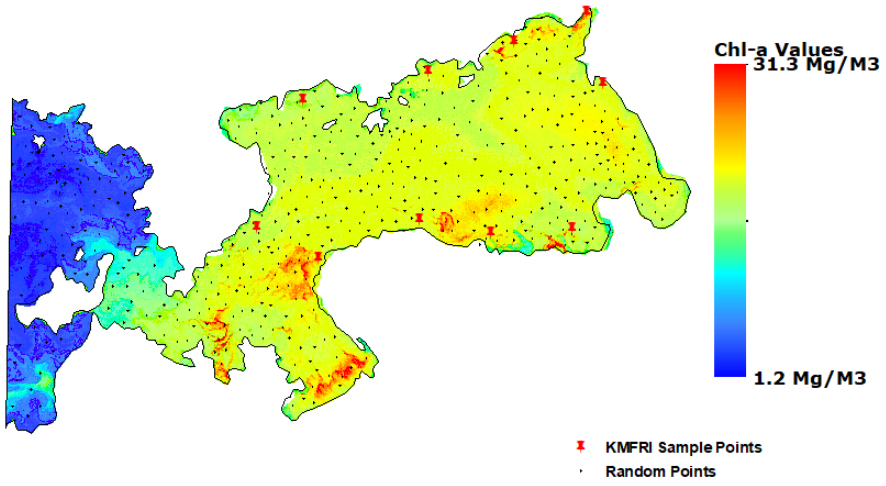
HAB reported dates, from 2015

Year	Date and Month	Reporting body
2015	12th January, 22nd February	Nasa Earth data, KMFRI
2016	23rd Feb	KMFRI
2017	04th September	Africa great Lakes
2018	27th January	KMFRI, Nasa Earth Data
2019	18th August	KMFRI
2020	29th August,	KMFRI
2021	No Data	None Reported

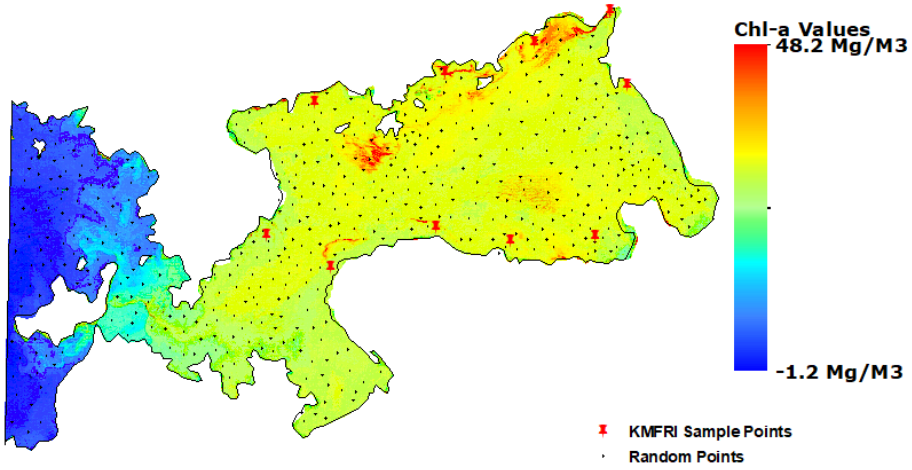
Table 3: HABs reported in Lake Victoria, (KMFRI, NASA Earth Data)

Results: Chl-a concentration maps

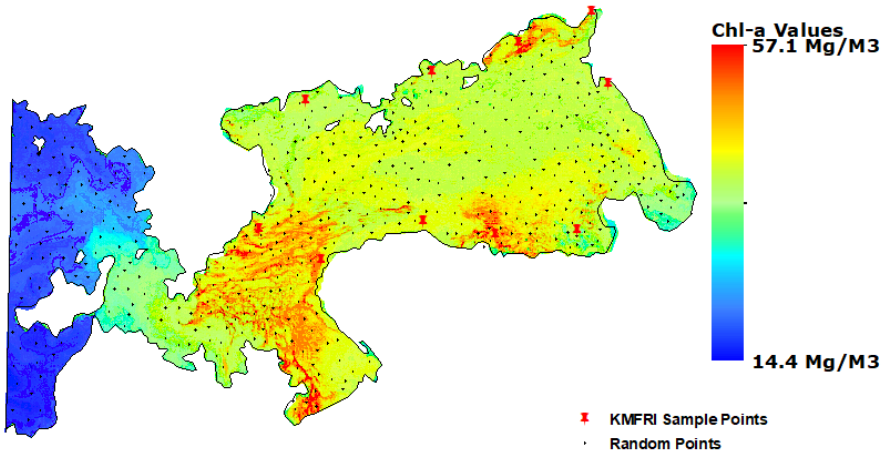
12th January 2015



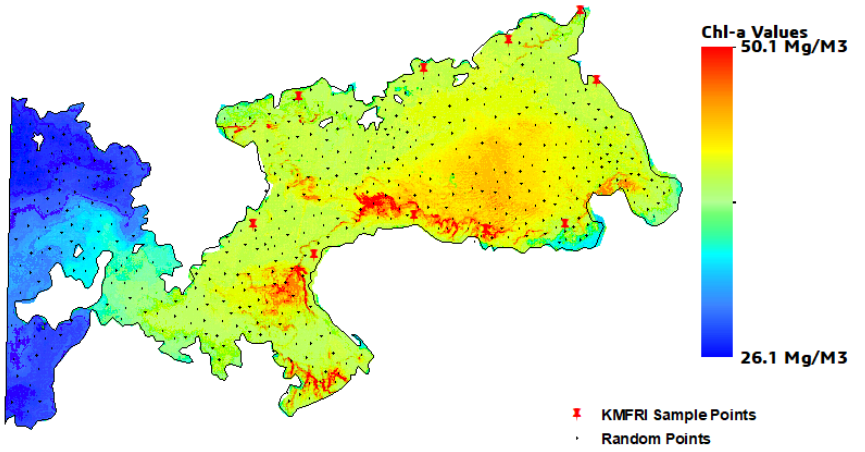
23rd Feb 2016



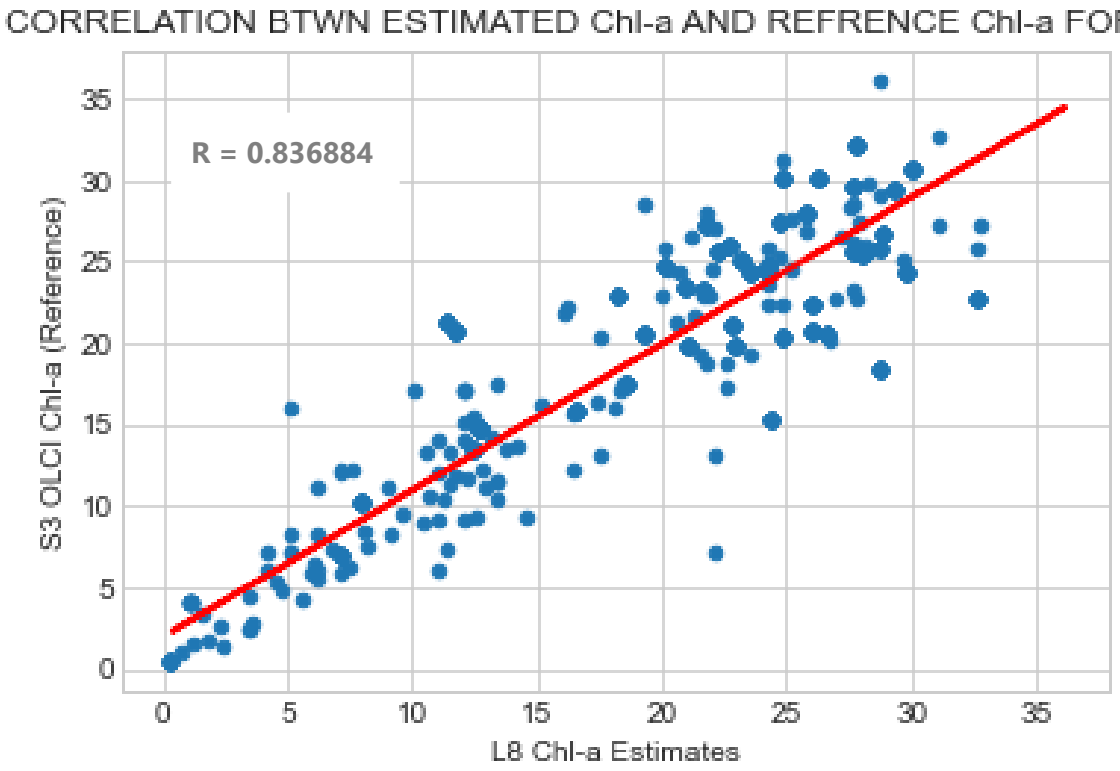
04th September 2017



27th January 2018



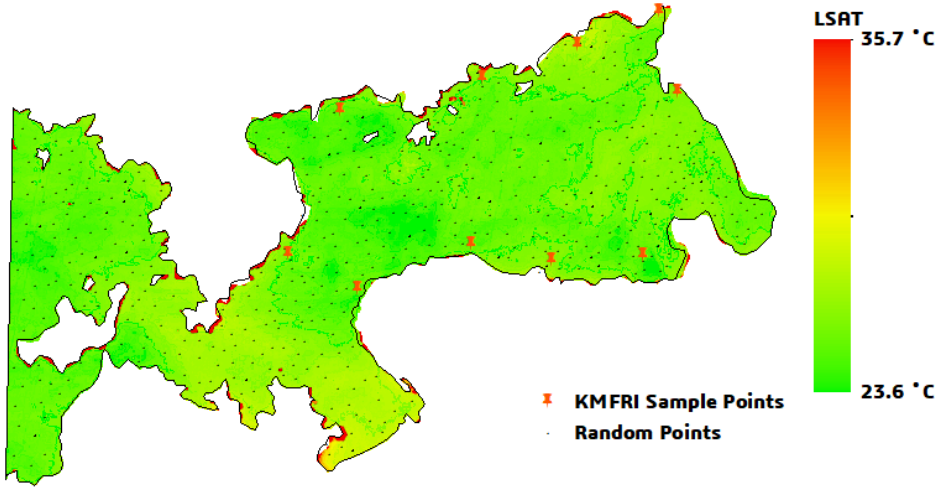
Accuracy Assessment of Chl-a Estimates



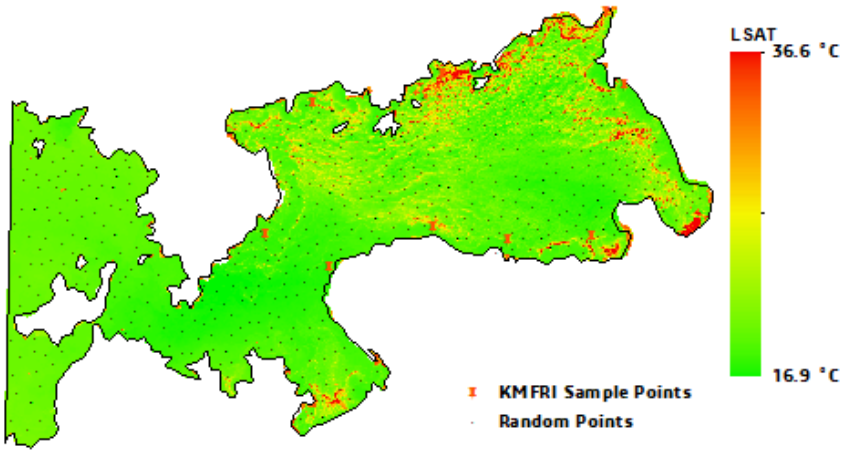
Year	Correlation Co-eff’
2015	0.836884
2016	0.883304
2017	0.891017
2018	0.843381
2019	0.899546
2020	0.900772

Results (b): High LSAT recorded during bloom Events

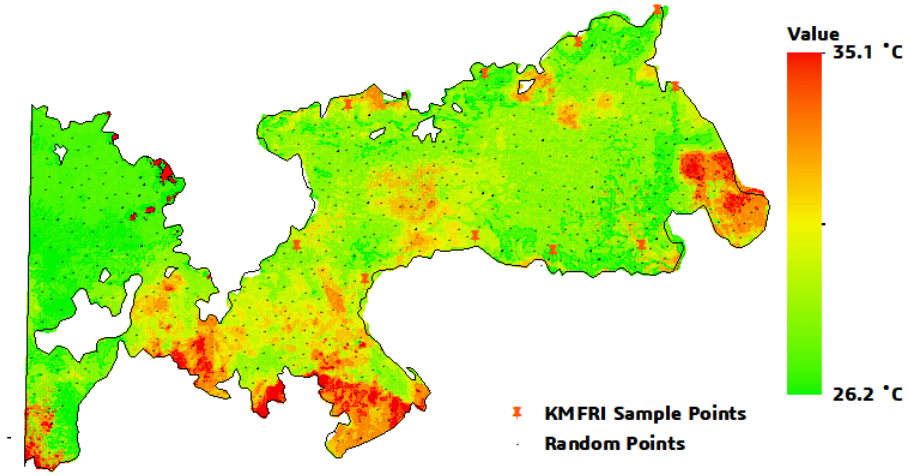
12th January 2015



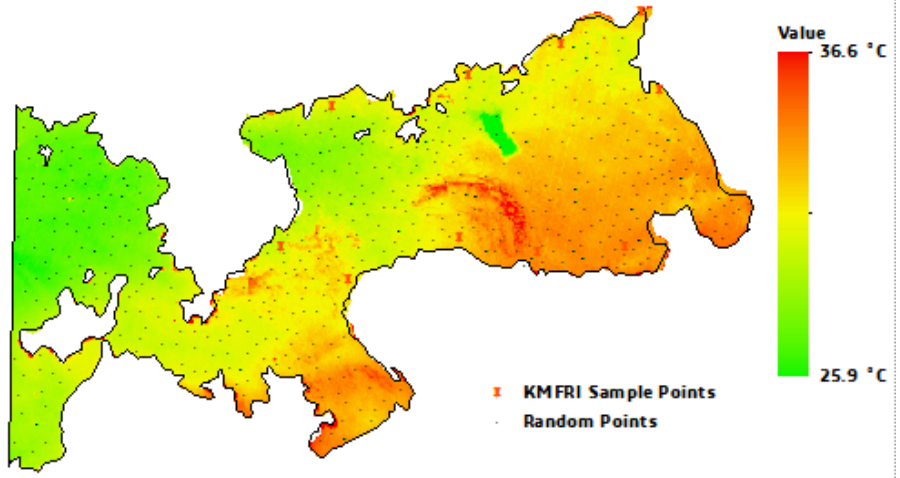
23rd February 2016



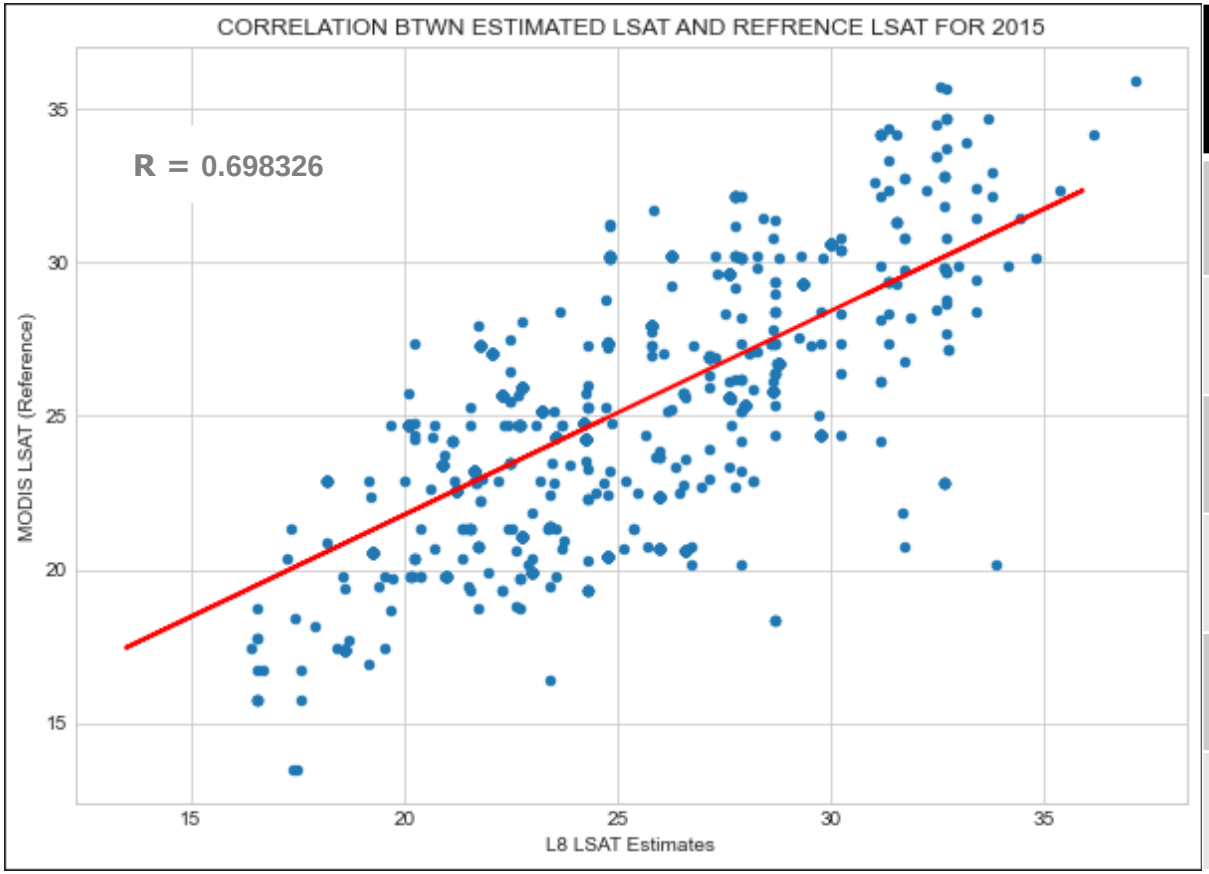
04th September 2017



27th January 2018

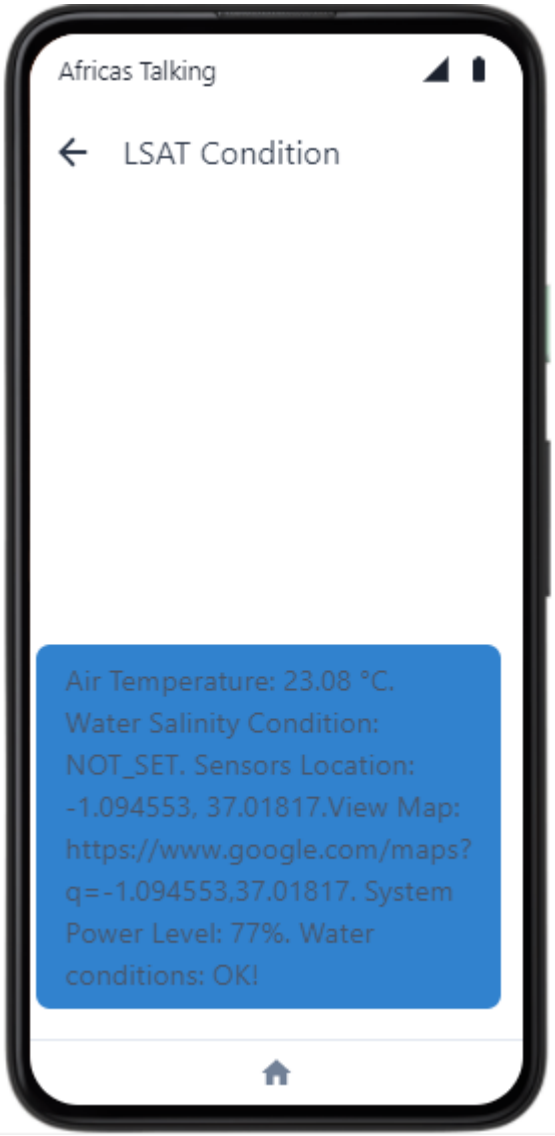


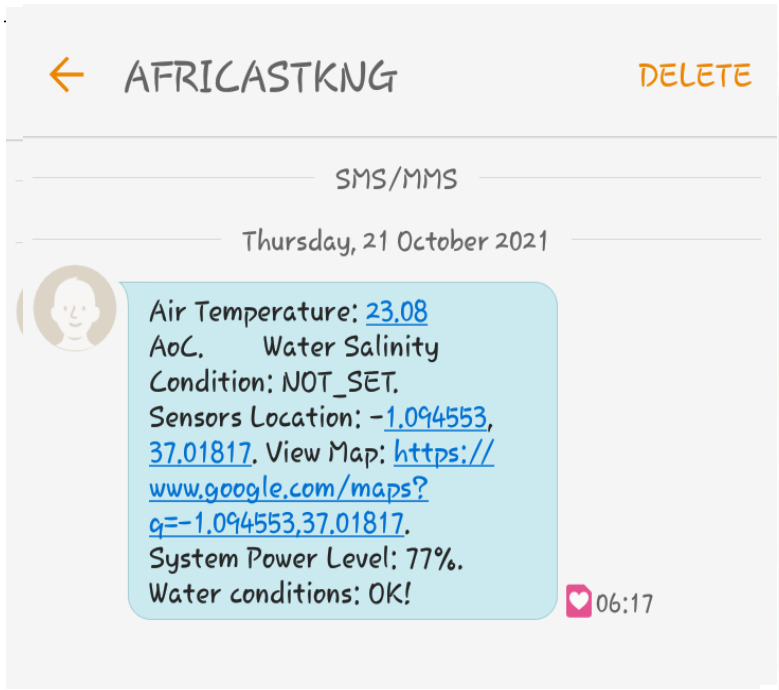
Accuracy Assessment of LSAT Estimates

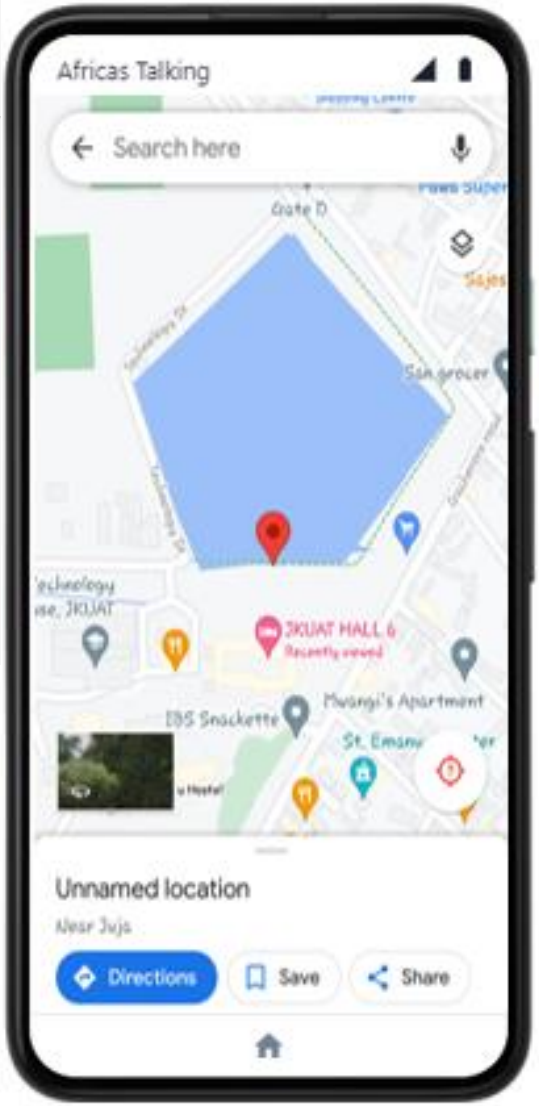


Year	Correlation Co-eff’
2015	0.698326
2016	0.71064
2017	0.691017
2018	0.713381
2019	0.71546
2020	0.70726

Obtaining Information from Sensors: GPS Location, System Condition, Air Temperatures







Discussions

- The max. Chl-a values ranged from 31, 48, 57 and 50 Mg/ M^3 which are significantly above the optimal (1 to 20Mg/ M^3) in a non-turbid water body like Lake Victoria.

- Corresponding LSAT Maps were generated for the reported HAB dates and reported to have risen to ~35°C and ~36°C in HAB events unlike aprox. ~25°C for normal conditions.

- The chl-a and LSAT estimates were validated with well known products and found to correlate from 69% to 90%.

Conclusions and Recommendations

- Wide spread chl-a concentration maps were generated from the proposed methodology to monitor HABs.
- Corresponding LSAT maps were as well generated from the and reportedly, the LSAT rose on bloom events.
- Chl-a and LSAT estimates were validated
- Autonomous In-situ IoT system was developed and tested in local University water bodies and found capable of relaying near-real time geotagged data.

Recommendation

- Authorities like KMFRI to avail detailed HAB stats, availability of Salinity sensor

Thank you for your attention! Questions?