Remote-Monitoring of Harmful Algal Bloom Via Marine Toxin Biosensor Integrated LoRA for Food Security

Dr. Nadiah Husseini Zainol Abidin

Department of Computer and Communication Systems Engineering
Faculty of Engineering, Universiti Putra Malaysia

hza_nadiah@upm.edu.my

Fisheries Dept: Do Not Eat Shellfish From Kelantan For Now Due To Toxins https://says.com/my/news/fisheries-dept-bans-shellfish-from-sungai-geting-due-to-red-tide

Cover image via Murai MY & New Straits Times

The Kelantan Fisheries Department (JPNK) has imposed an immediate ban on molluscs from Sungai Geting, Tumpat due to a suspected 'red tide'

A 'red tide' is a common term used for uncontrolled algae bloom that is harmful to humans.

According to Bernama, JPNK director Nazri Ishak said that **the sale and harvest of shellfish, such as oysters, cockles, and clams, are prohibited as of October until further notice.**

"An analysis by the Fisheries Biosecurity Lab shows that molluscs from the area are contaminated with saxitoxin from harmful algae, *Alexandrium minutum*," he said.

"If consumed, the contaminated molluscs can cause poisoning and pose a threat to human health," he said in a statement on Monday, 11 October.

Fisheries Dept: Do Not Eat Shellfish From Kelantan For Now Due To Toxins

Customers are advised to ask for the origin of the shellfish they are buying.

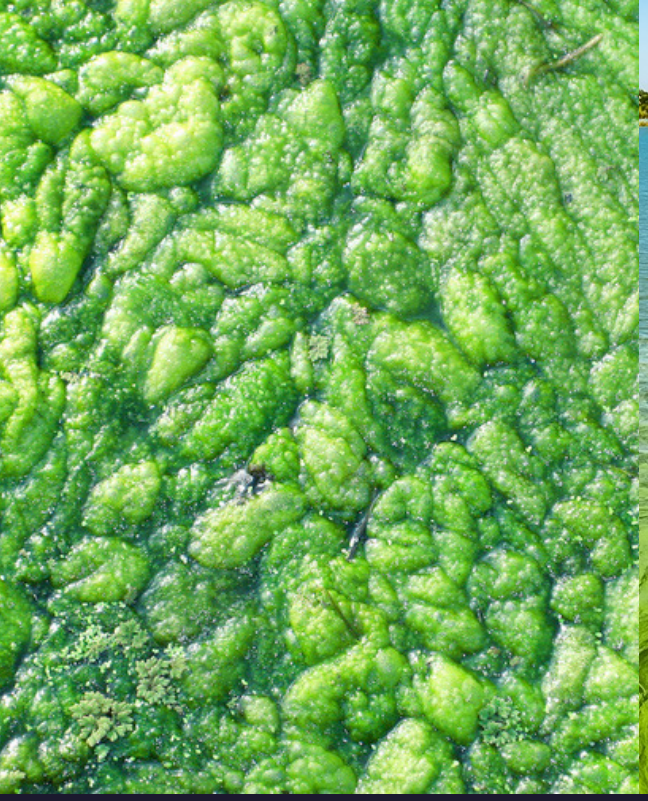
By May Vin Ang — 14 Oct 2021, 05:45 PM — Updated 28 days ago

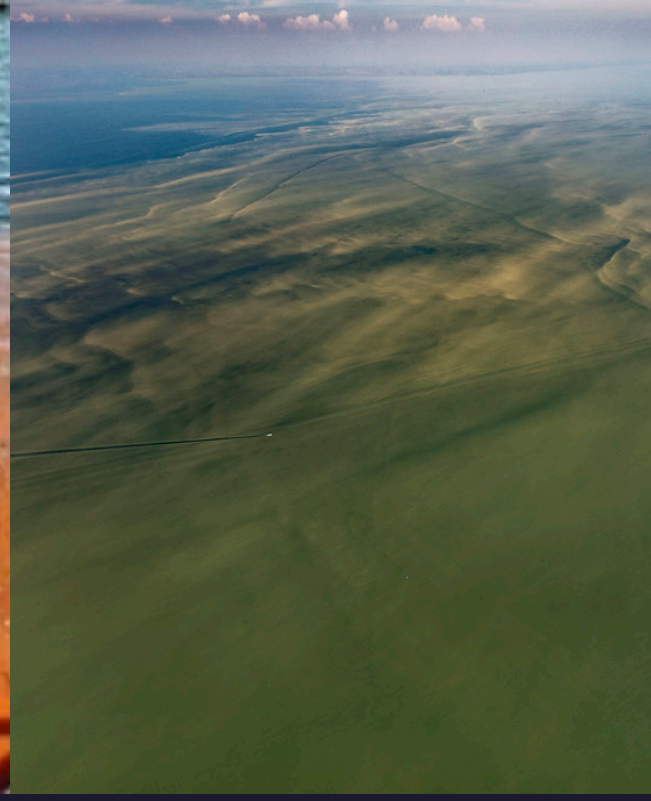
#news #kelantan #shellfish #foodpoisoning #health #informative #environment

Cover image via Murai MY & New Straits Times

The ban was initially on the shellfish from one area, but now the ban is on the shellfish from the entire state!!

Fisheries Dept: Do Not Eat Shellfish From Kelantan For Now Due To Toxins, https://says.com/my/news/fisheries-dept-bans-shellfish-from-sungai-geting-due-to-red-tide

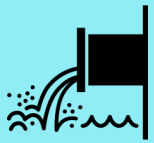


Harmful algal bloom (HAB)

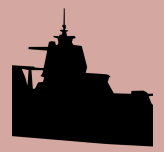
- Colonies of algae — simple plants that live in the sea and freshwater — grow out of control and produce toxin
- Commonly known as “red tide”- but HABs do not just paint the water red; some turn the water cloudy, brown or foamy.
- The discoloration in the water is most visible in the morning. As the day warms up, the mass of microalgae will sink down to avoid extreme heat.
- High possibility of recurrence once area is afflicted.
- Tend to occur in sheltered places with restricted water movements, such as lagoons, ports and embayment.

Harmful Algal Bloom: Causes



increase of nutrients in water ‘eutrophication’

Climate changes



Transport by Oceangoing Ships and Coastal Boats.

Other causes : pollution, food web alterations, water flow modifications.

HAB Effects

Primary effects

Contamination of drinking water

Deterioration of aquatic ecosystem

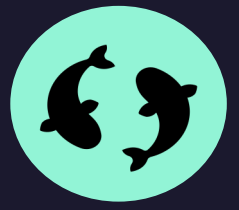
Degradation of air quality

Contamination of shellfish

Secondary effects

Threat on human health

Killing of marine mammals



Massive fish mortality

Regional economy decline

Nazri said red tides commonly occur in Sungai Geting due to hot weather and other factors

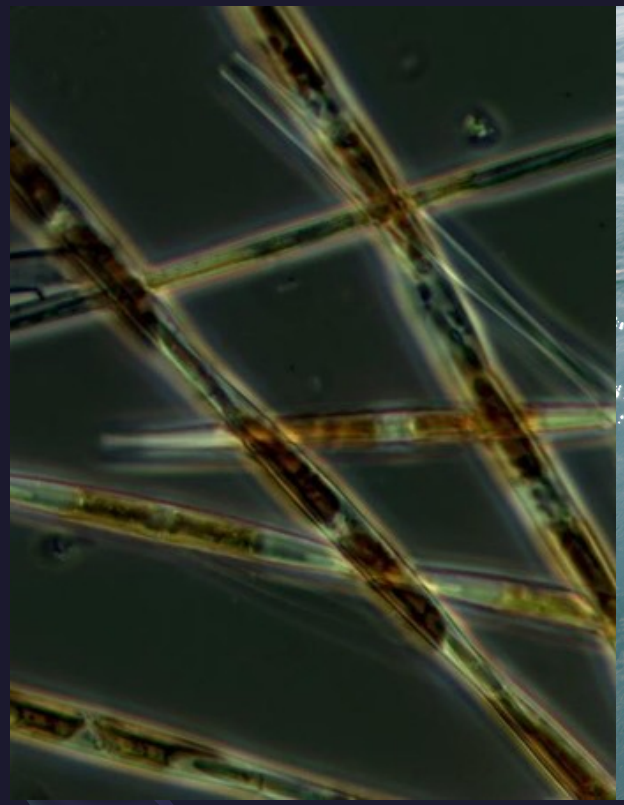
He explained that molluscs are filter feeders and if they filter matter like algae to a high level, consuming them **can cause food poisoning**.

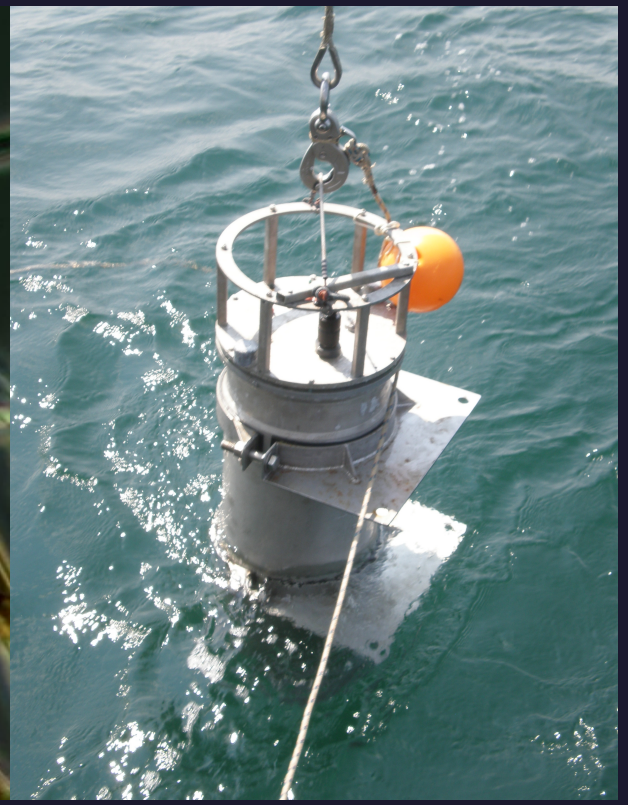
"We will do weekly testing until they are safe to eat," he said.

He added that the harvesting of molluscs is also prohibited until the investigation is over and safety is guaranteed.

Fisheries Dept: Do Not Eat Shellfish From Kelantan For Now Due To Toxins. https://says.com/my/news/fisheries-dept-bans-shellfish-from-sungai-geting-due-to-red-tide

Locating and monitoring HABs in the USA





- In 2015, they used **satellite imageries** to gather color data from freshwater bodies during scans of the Earth.
- Based off this information, state and local agencies can provide the public with public health advisories.
- Another recent method involves the use of **underwater sensors on buoys** or attached to unmanned underwater vehicles.
- Every 20 minutes, as the water stream passes a laser/microscope, an image is taken whenever algal pigment is detected.
- A computer analyzes the image to identify the algal cell, counts the HAB cells.

What is harmful algal bloom, https://www.noaa.gov/what-is-harmful-algal-bloom

Current HAB monitoring methods in Malaysia:

Water sampling in the Straits of Johor confirmed a bloom of the microalgae Karlodinium australe during the fish kills in Tanjung Kupang, Johor.

- Performed by the ***Fisheries Biosecurity Division***
- Sampling is performed once every 3 months and testing is conducted in labs.
- Frequent sampling is only performed after bloom is detected

CELL COUNT (MICROSCOPE)

IDENTIFICATION OF SPECIFIC MICROORGANISM (MICROSCOPE)

DETECTION OF TOXIN

MICE-BIOASSAY

Toxic tides: risks from harmful microalgae, https://www.thestar.com.my/News/Environment/2014/04/07/Toxic-tides-Risks-from-harmful-microalgae/

Monitoring of HAB: our plan

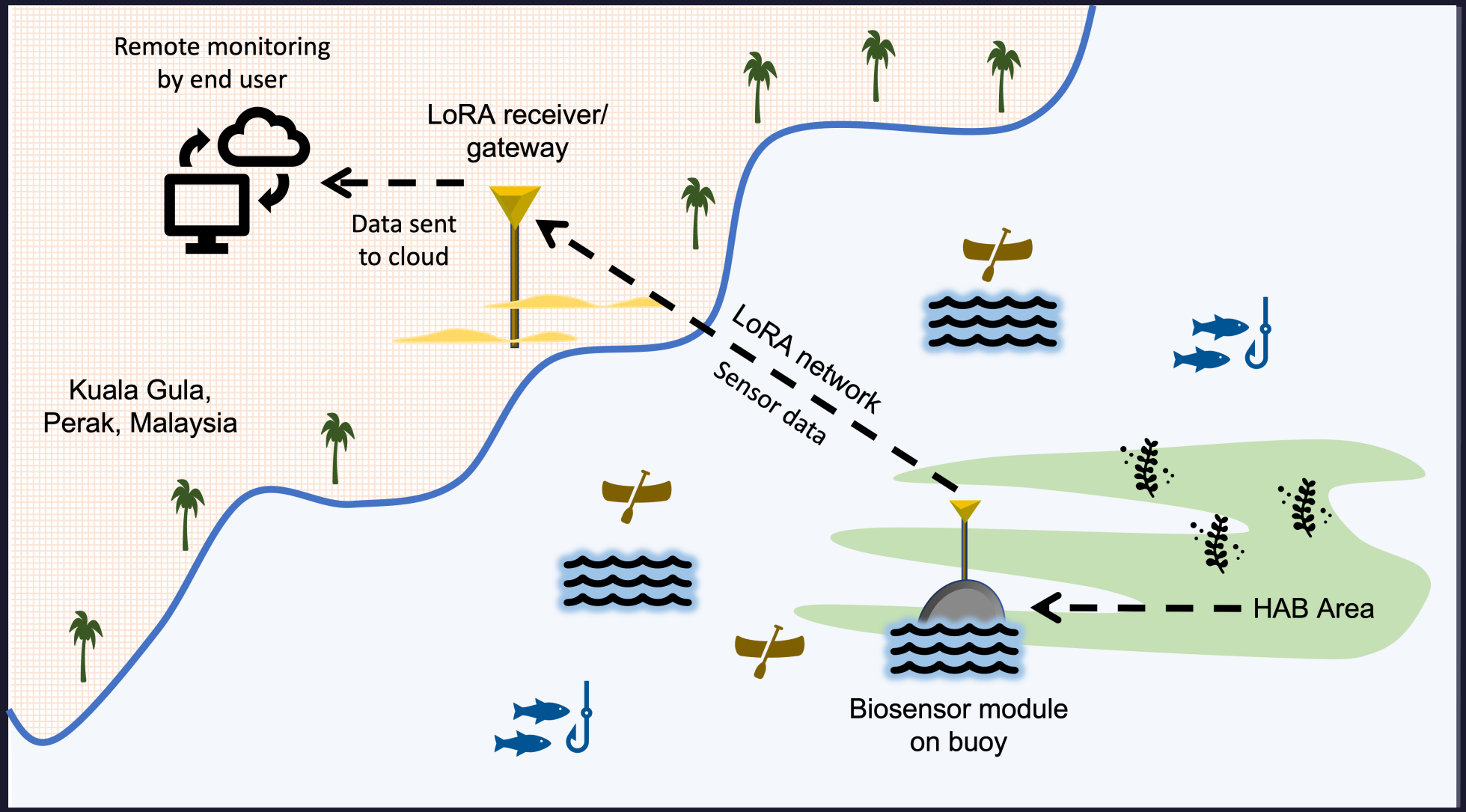
1) To station LoRa receivers at the identified costal site

2) To integrate marine-grade sensors on buoy

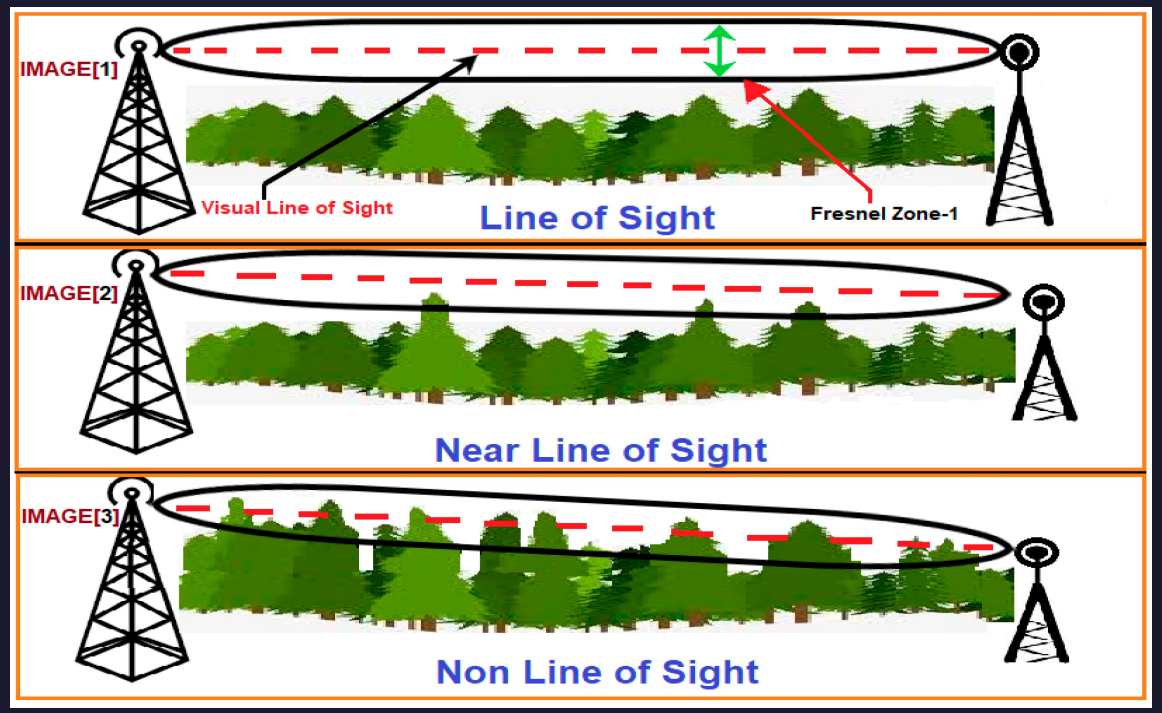
3) To integrate the packaged sensor-buoy with LoRa and establish communication protocol.

4) To deploy remote-monitoring of HAB system for data collection.

5) Remote-monitoring data visualization on dashboard



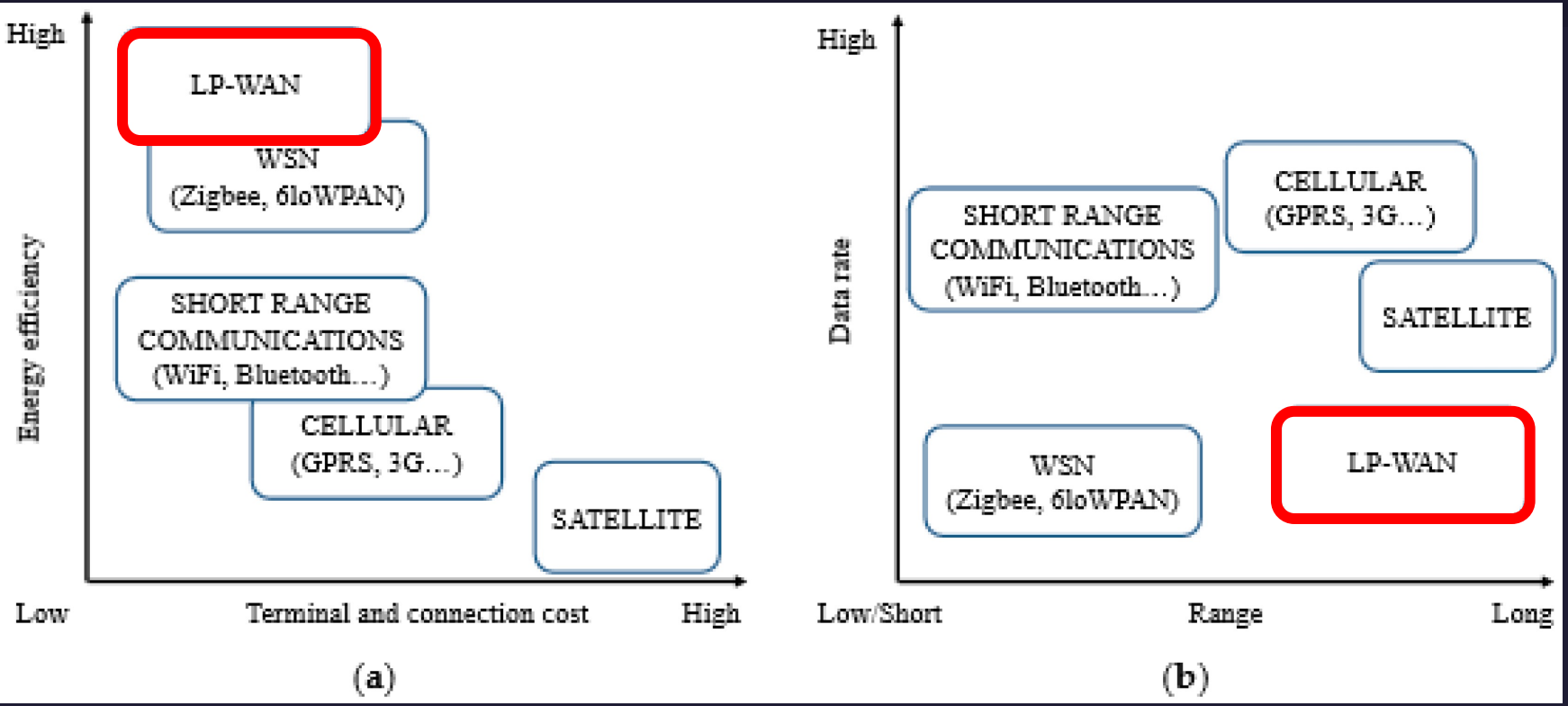
Long-Range Communication Network (LoRA)



- Low Power Wide Area Networks (LP-WAN)
- LoRa provides for long-range communications: up five kilometers in urban areas, and up to 30 kilometers in rural areas (with good line of sight).
- Best suited for applications that require long-range that have low power requirements and that collect small amounts of data.
- For areas of minimal coverage and communications infrastructures such as maricultural sites

Jebril, Akram H., Aduwati Sali, Alyani Ismail, and Mohd Fadlee A. Rasid. "Overcoming limitations of LoRa physical layer in image transmission." *Sensors* 18, no. 10 (2018): 3257.

Benefits of LoRA



- wide coverage
- low bandwidth
- Ultra-low power consumption
- Minimal infrastructure
- Low operational cost

Jebril, Akram H., Aduwati Sali, Alyani Ismail, and Mohd Fadlee A. Rasid. "Overcoming limitations of LoRa physical layer in image transmission." *Sensors* 18, no. 10 (2018): 3257.

HAB monitoring based on chemical and physical parameters

Monitoring parameters:

- Fluorometer – detects Chlorophyll α to show productivity of plankton
- Biosensor - saxitoxin

- Spike in Phosphorus (P)
- Spike in Nitrogen (N)
- Drop in dissolved oxygen (DO) – indicates massive decay of algae
- Temperature
- Water discoloration (image)

Kuala Gula Mariculture site, in state of Perak selected

- *Harmful Algal Bloom causes death of caged fishes*
- In June 2020, massive fish die-offs were reported in approximately 20 fish cages due to HAB
- the HAB from the site also travelled to the waters of Bagan Panchor
- Wild-fishes were not affected, can easily swim away from the HAB affected site

>> EDISI > PERAK > Ledakan alga punca ikan sangkar mati

Ledakan alga punca ikan sangkar mati

NOOR AINON MOHAMED | | 16 Jun 2020

Zaki (dua dari kiri) meninjau kerja penandaan 11 lot kebun kerang di Jeti Perikanan di Parit Haji Dolah, Kampung Sungai Tiram, Lekir hari ini.

SITIAWAN - Kira-kira 20 ikan sangkar dilaporkan mati akibat kehadiran spesies plankton atau dikenali sebagai ledakan alga *Cochlodinium* yang di tinggi di kawasan Kuala Gula di Kuala Kurau, Bagan Serai semalam.

Algal Bloom Causes Death of Caged Fishes, https://www.sinarharian.com.my/article/88074/EDISI/Perak/Ledakan-alga-punca-ikan-sangkar-mati

Current funds for the project

24,000 USD

?

Thank you

Terima kasih

ありがとうございました

APPENDIX

References

- Algal Bloom Causes Death of Caged Fishes, https://www.sinarharian.com.my/article/88074/EDISI/Perak/Ledakan-alga-punca-ikan-sangkar-mati
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- Hii, Kieng Soon, Monaliza Mohd-Din, Zhaohe Luo, Suh Nih Tan, Zhen Fei Lim, Li Keat Lee, Sandric Chee Yew Leong et al. "Diverse harmful microalgal community assemblages in the Johor Strait and the environmental effects on its community dynamics." *Harmful Algae* 107 (2021): 102077.
- Fisheries Dept: Do Not Eat Shellfish From Kelantan For Now Due To Toxins, https://says.com/my/news/fisheries-dept-bans-shellfish-from-sungai-geting-due-to-red-tide
- Jebril, Akram H., Aduwati Sali, Alyani Ismail, and Mohd Fadlee A. Rasid. "Overcoming limitations of LoRa physical layer in image transmission." *Sensors* 18, no. 10 (2018): 3257.
- What is harmful algal bloom, https://www.noaa.gov/what-is-harmful-algal-bloom
- Toxic tides: risks from harmful microalgae, https://www.thestar.com.my/News/Environment/2014/04/07/Toxic-tides-Risks-from-harmful-microalgae/

Other HAB afflicted areas in Malaysia

- Lumut, Perak and Penang

  there have been blooms of Ceratium furca, which does not produce toxins

  can still lead to fish die-offs too as the decomposition of the large mass can deplete the water of oxygen

- Jasin in Melaka and Batu Lintang in Kedah (shellfish farming)

- Sebatu, Melaka

  three people became ill after eating farmed mussels from this area

  years later that Alexandrium tamiyanavichi (HAB) was confirmed as the toxin producer.

Harmful algal blooms

	HARMFUL MICROALGAE	LOCATION	IMPACT
2001	*Alexandrium minutum*	Tumpat, Kelantan	Shellfish contamination six hospitalised, one death
2002	*Prorocentrum minimum*	Johor Baru, Johor	Water discolouration
2003-2004	*Cochlodinium polykrikoides*	Kota Kinabalu, Sabah	Fish kills
2005	*Cochlodinium polykrikoides*	Kota Kinabalu, Sabah	Water discolouration
2006	*Cochlodinium polykrikoides*	Kuching, Sarawak, Kota Kinabalu, Sabah	Fish kills
2007	*Neoceratium furca*	Pangkor, Lumut, Penang	Water discolouration
2009	*Pyrodinium bahamense*	Kota Kinabalu and surrounding areas	Shellfish contamination
2013	*Pyrodinium bahamense*	West coast, Sabah	Shellfish contamination, 3 deaths, over 40 hospitalised

The Team

Members

1. Dr. Nadiah Husseini Zainol Abidin (Photonics/sensor)
2. Prof. Ir. Dr. Aduwati bt. Sali (LoRa/satellite comm)
3. Prof. Dr. Alyani bt. Ismail (LoRa/antenna & propagation)
4. Prof. Madya Dr. Syamsiah bt. Mashohor (AI & image processing)
5. Dr. Zuraidah bt. Zan (Photonics/optical communications)
6. Prof. Madya Dr. Natrah Fatin Mohd Ikhsan (Aquaculture)
7. Datin Dr. Nurul Adilah Binti Abdul Latiff (LoRa/wireless communication)

Collaborators

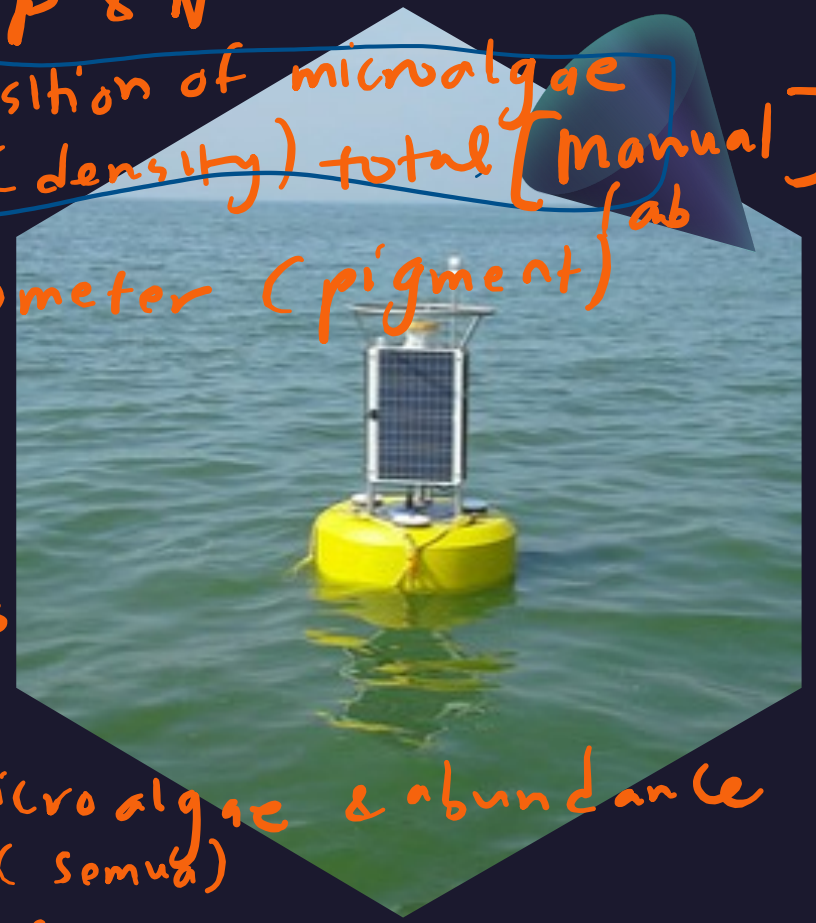
- National Instruments Malaysia (Funder)
- Fisheries Research Institute, Department of Fisheries Malaysia. (HAB expert - Puan Roziawati Mohd Razali)

Where should we start?

- Possible sites
  - Places previously afflicted by HABs
  - Places with fish and shellfish farms.
  - places with restricted water movements, such as lagoons, ports and embayments
- Monitoring parameters:
  - Turbidity for cell count : not accurate as any suspended material will contribute to turbidity
  - pH: algal bloom causes fluctuation in pH especially morning and evening
  - Spike in ammonia (nitrogen)
  - Drop in dissolved oxygen (DO) from massive decay of algae
  - Temperature
  - Water discoloration

Sensing parameter

- multi-parameter sensor (auto)
- chlorophyll a (abundance) [lab]
- Total P & N
- composition of microalgae (density) total [manual]
- fluorometer (pigment) (lab)

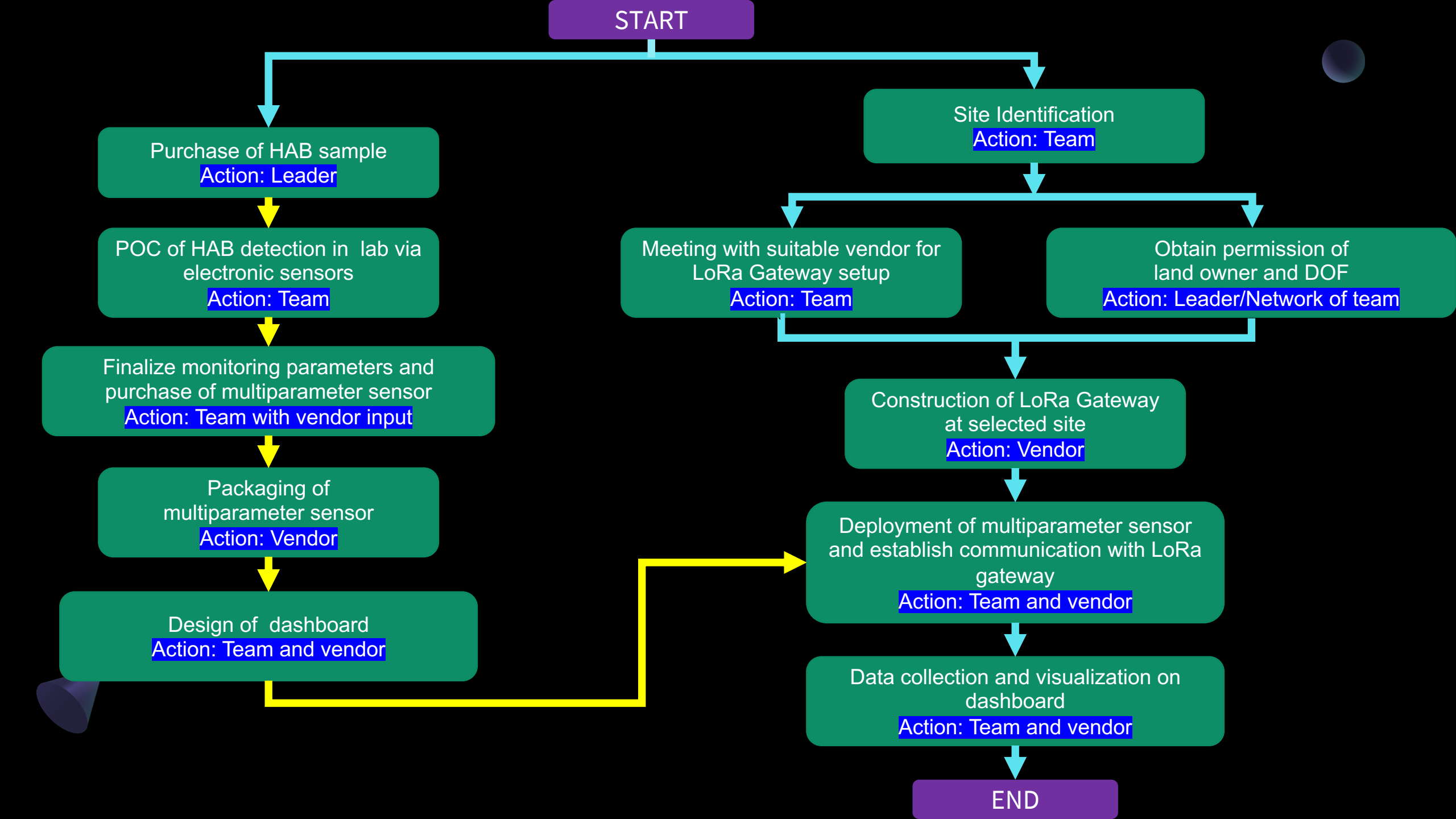


not accurate

total nitrogen & phosphorus (after)

(during & after)

- composition of microalgae & abundance
- chlorophyll a (semua)
  - productivity of plankton


START
Purchase of HAB sample
Action: Leader
POC of HAB detection in lab via electronic sensors
Action: Team
Finalize monitoring parameters and purchase of multiparameter sensor
Action: Team with vendor input
Packaging of multiparameter sensor
Action: Vendor
Design of dashboard
Action: Team and vendor
Site Identification
Action: Team
Meeting with suitable vendor for LoRa Gateway setup
Action: Team
Obtain permission of land owner and DOF
Action: Leader/Network of team
Construction of LoRa Gateway at selected site
Action: Vendor
Deployment of multiparameter sensor and establish communication with LoRa gateway
Action: Team and vendor
Data collection and visualization on dashboard
Action: Team and vendor
END