Introduction

Nooriza Maharani

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1 RS Learning Diary

This is a Quarto book to document my learning journey in **Remote Sensing Cities and Environments** course during my time at CASA UCL 24/25, offering insights learned, its applications, and my own reflections. The module is based on Dr Andrew Maclachlan github page [here].

*For those of you who also want to learn Geographic Information Scicene beyond 'typical GIS' Software, as in use R-Studio, you could also visit his other github page [here].

1.1 Introduction

Hi, I'm Nooriza, a student currently pursuing a Master's degree in Urban Spatial Science at UCL. I have an academic background in Geography with a specialization in Regional Development Studies and have several substantial work experience in government consultancies in Indonesia.

1.2 Why do I choose this module?

The reason I take Remote Sensing course is my desire to know *how it feels to be a bird, seeing things from above, and to see the unseen.* Don't we agree that remote sensing offers perspectives far beyond what our human eyes can naturally perceive?

source : Biomimicry and Birds

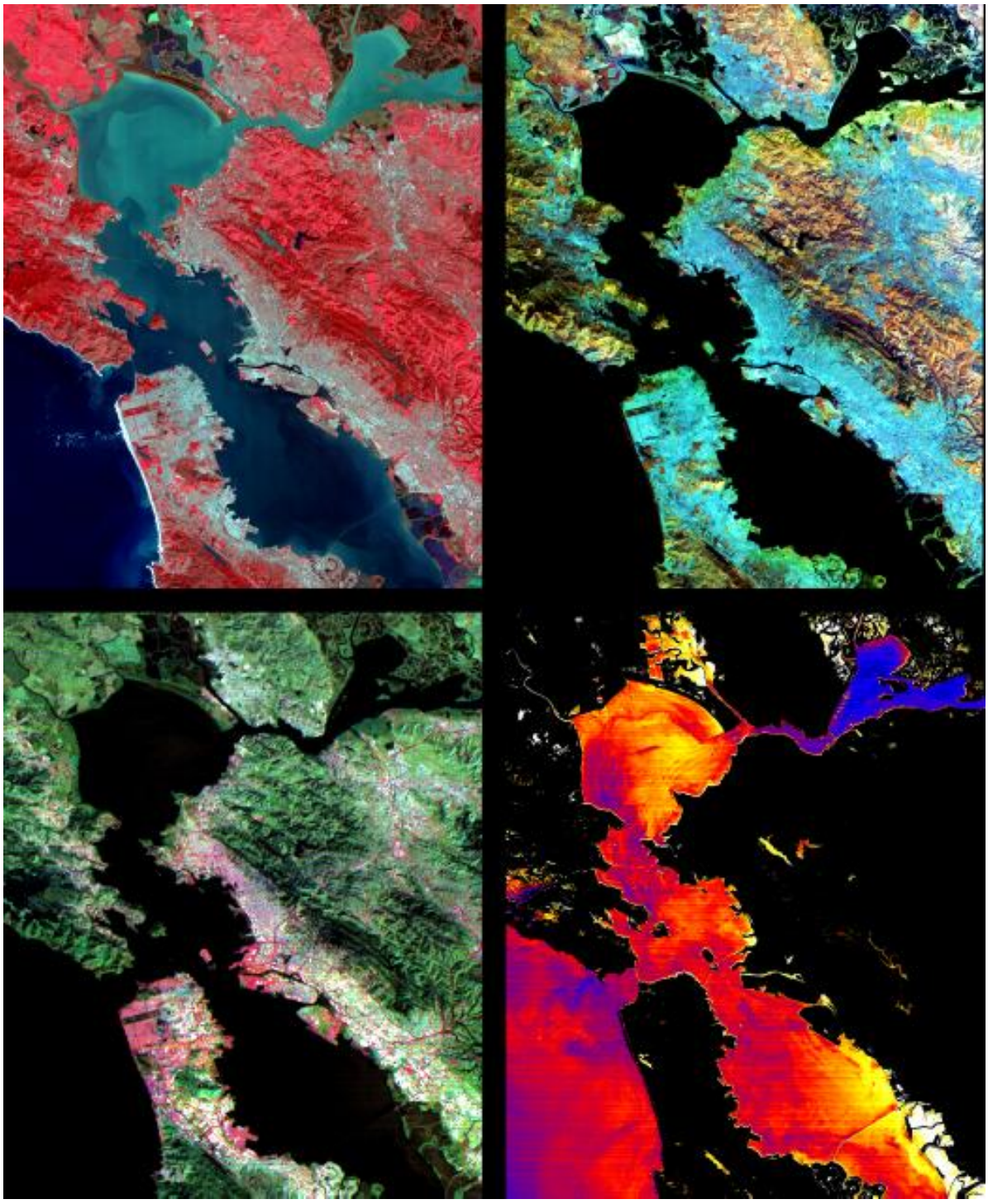
source : NASA/JPL

For example the ASTER images of San Fransisco Bay above, it highlights different object such as vegetation (upper left); soil & rocks in mountainous area (upper right); urban materials (lower left) ; and water temperature (lower right).

Meanwhile, practically, learning this course will, hopefully, help me address the challenges I faced during my previous work in Indonesia. For example, while working on a project focused on healthcare accessibility across hundreds of small islands, we struggled to obtain

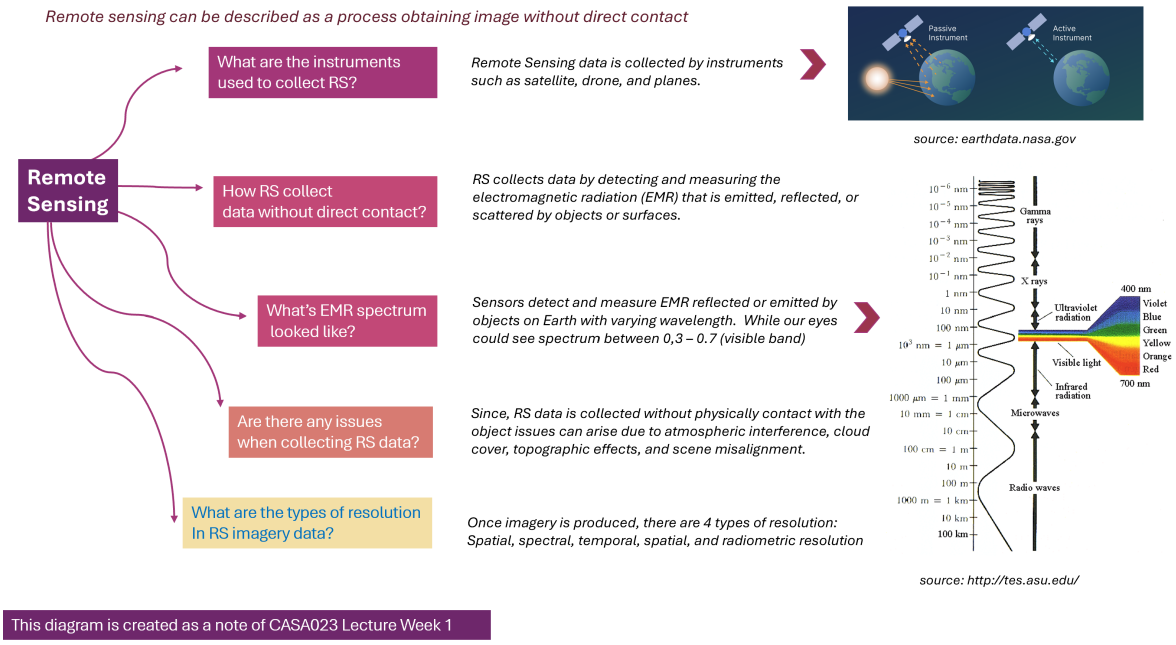
real-time data to identify which islands were inhabited and which were not. Additionally, we faced challenges in determining which islands had ports suitable for docking ships. I believe that applying remote sensing data is both cost- and time-efficient in helping the government maintain more precise and up-to-date data, which is particularly important in world's largest archipelago country like Indonesia.

Feel free to explore my site to learn more about my learning experience. Hope it helps!



2 Getting to Know Remote Sensing

2.1 Summary



Meanwhile, this week practical is introducing 2 sources of imagery :

1. a. Landsat-8

   The Landsat 8 satellite has a 16-day revisit cycle, meaning it can capture imagery of the same location every 16 day. This period would be advantageous to monitor changes at moderate pace, as its revisit time is every 16 days.

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- b. Sentinel 2A

  Sentinel 2 revisits the earth every 5 days (using both satellite A and B), meaning that it provides frequent observations and make it suitable to monitor rapid changes.

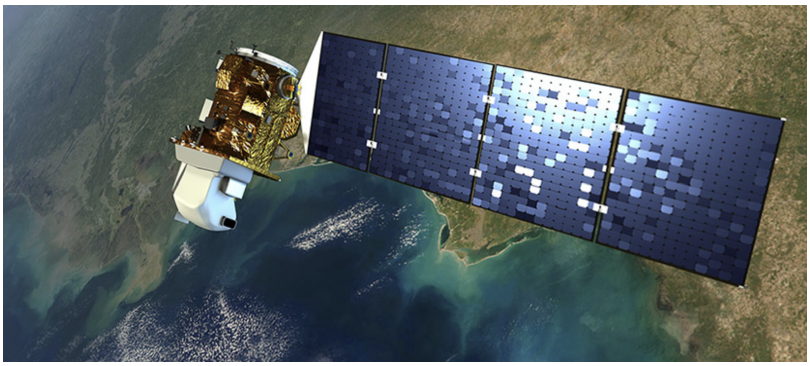


Figure 2.1: Copyright © NASA

Figure 2.2: Copyright © ESA and AIRBUS Defence & Space.

- Each has their own characteristics, while Sentinel-2A has 10m spatial resolution Landsat-8 has 30m resolution. If we want to compare its spectral resolution we have to either upgrade or downgrade, usually downgrading the higher spatial resolution of Sentinel-2 (10m) to match Landsat's (30m) is the preferred approach.

2.2 Application

In what ways can we use Sentinel and Landsat data?

- Sentinel-2 (operated by ESA) has *13 spectral bands* across a wide range of wavelengths, which are especially useful for vegetation monitoring, land cover classification, and agricultural applications.
- Landsat 8 (operated by NASA and USGS) has *11 spectral bands*, which cover a similar range of wavelengths to Sentinel-2 but with fewer bands. Landsat 8 provides excellent coverage for land monitoring and vegetation studies as well.

They both could be used to vegetation monitoring, well……..are they really that difference?

- Sentinel-2 has more bands overall, with additional Red Edge bands, a higher spatial resolution (10m for key bands), and a Water Vapor band. This makes it more suited for ***detailed vegetation analysis***, agricultural monitoring, and atmospheric studies. In the paper…..
- Landsat 8, while having fewer bands, provides excellent coverage with a broader range of SWIR bands, and the addition of two thermal infrared bands makes it strong for land surface temperature and other ***thermal analyses***.

Real world application of Sentinel and Landsat 8

- **Landsat-8 application on detecting of vegetation evolution across China**

  This paper explores 30 years of landsat archive data (spaning of landsat 5 to 8) on 2.125 city to monitor the vegetation evolution. Han et al. (2025) use reflective bands such as Blue, green, red, NIR and SWIR (1 and 2) and highlighting vegetation characteristics using NDVI, EVI, and OSAVI. The NDVI and RGB bands were further processed to derive texture variables, including variance, contrast, entropy, angular second moment, and correlation. These texture metrics capture spatial patterns and fine-scale structural details of urban vegetation that may not be visible through spectral bands alone. I genuinely believe this finding has the potential to serve as a framework for evaluating the implementation of the government's long-term plan or the integration of policies across different administrations, which is often difficult to assess due to the extended time frame and transitions between ruling administrations.

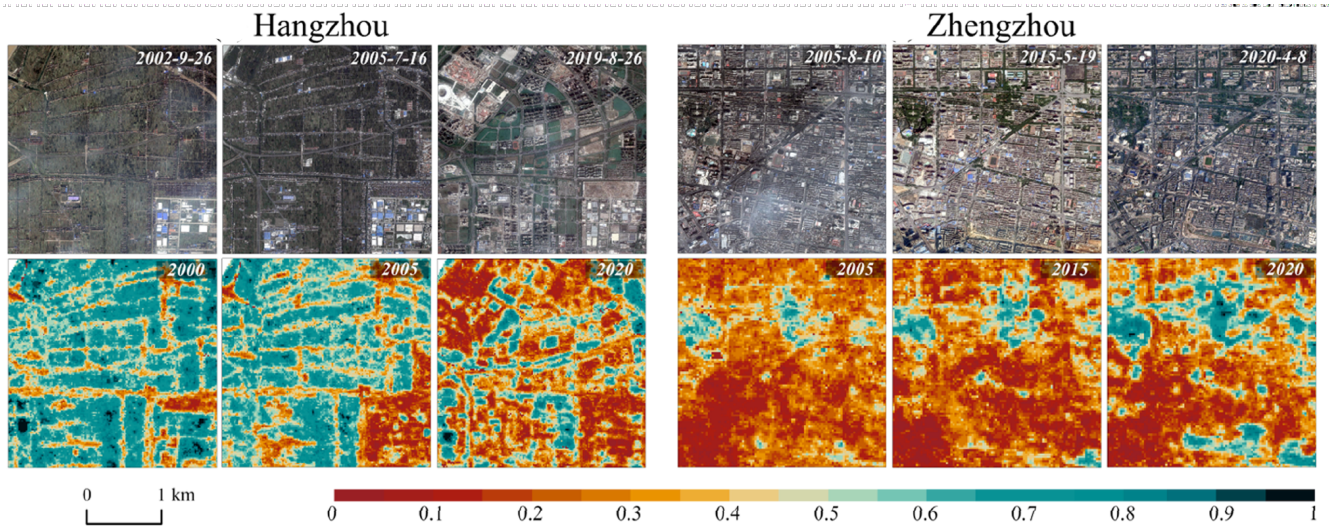


Figure 1: A sample result shows urban vegetation degradation in Hangzhou and an increase in vegetation in Zhengzhou. source : (Han et al. 2025).

- **Sentinel-2 application on plastic debris detecting on coastal area, Brazil**

  In this study, Nivedita et al. (2024) use 4 sensors of Sentinel Data to detect floating debris. After floating debris is detected they analyze spectral signature to differentiate trash by measuring the mean values of spectral signature of plastic and other materials (such as foam or seaweeds. This research, as part of monitoring marine pollution, could identify critical areas for conservation supports.

  Figure 2: Plastic Debris Detection. Source : (Nivedita et al. 2024)

2.3 Reflection

After exploring the application of the two selected satellites, I have concluded that remote sensing data is particularly effective for analyzing large-scale and long-term variations. It can also help mitigate the high costs of manual data collection across vast regions.

This insight made me reflect on a similar challenge in my country, Indonesia, the world's largest archipelago. The country needs to identify which small islands are inhabited in order to provide essential services to all of them. To address this, I'm considering using night imagery data as a tool to distinguish inhabited islands from uninhabited ones. The night time would indicate anthropogenic activities that are associated with light at night

2.4 References

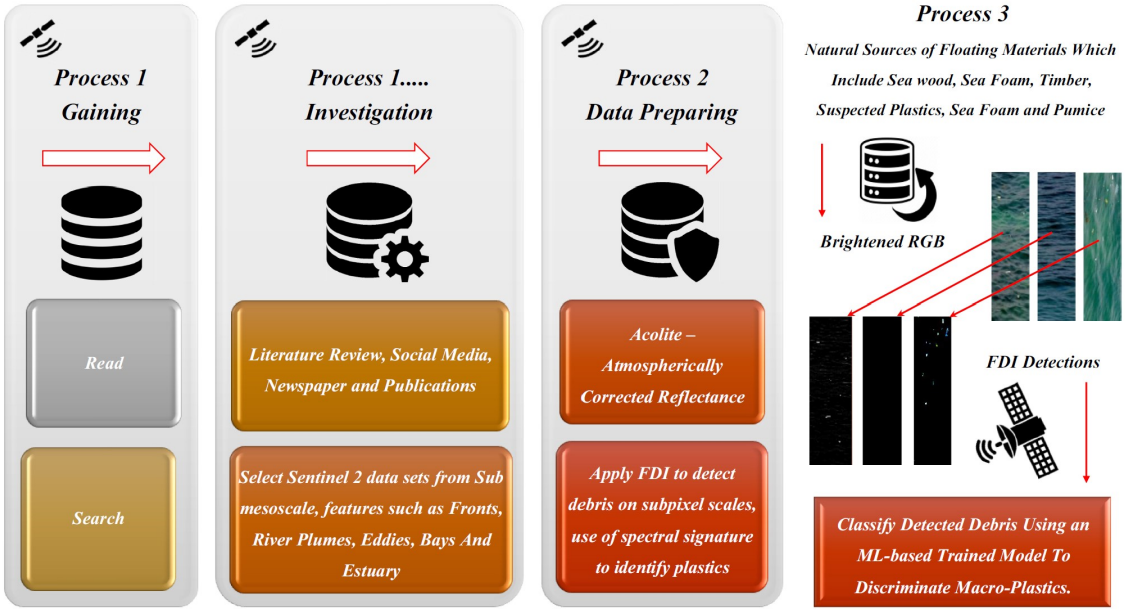


Figure 2.3: source :

3 Xaringan and Quarto Book

Lecture this week reminded me of one of powerful figure in Uchiha Clan, the one who can manipulate reality once he activates this-so-called Xaringan. Well, but this Xaringan is not related to figures in Konoha's world but related to a certain library in R Studio that enable us to create neat HTML slides in R.

3.1 Summary

```
xaringanExtra::embed_xaringan(url = "https://nooriza16.github.io/Xaringan/Xaringan.html",
```

3.2 Reflections

For someone who is not familiar with html, learning Xaringan is definitely challenging compared to powerpoint, as we just usually click tabs on power point. Honestly, I still consider power point provides more themes and more visualization effects that is easily to access compared to Xaringan. However, as I delved further I realize that using Xaringan is providing us with flexibility even such as positioned our picture.

So far, I feel like Xaringan is best at incorporating snippet code on presentation or interactive features that usually too heavy to load in power point. Besides, it helps me to give a sense of what html look like.

4 Image Correction

4.1 Summary

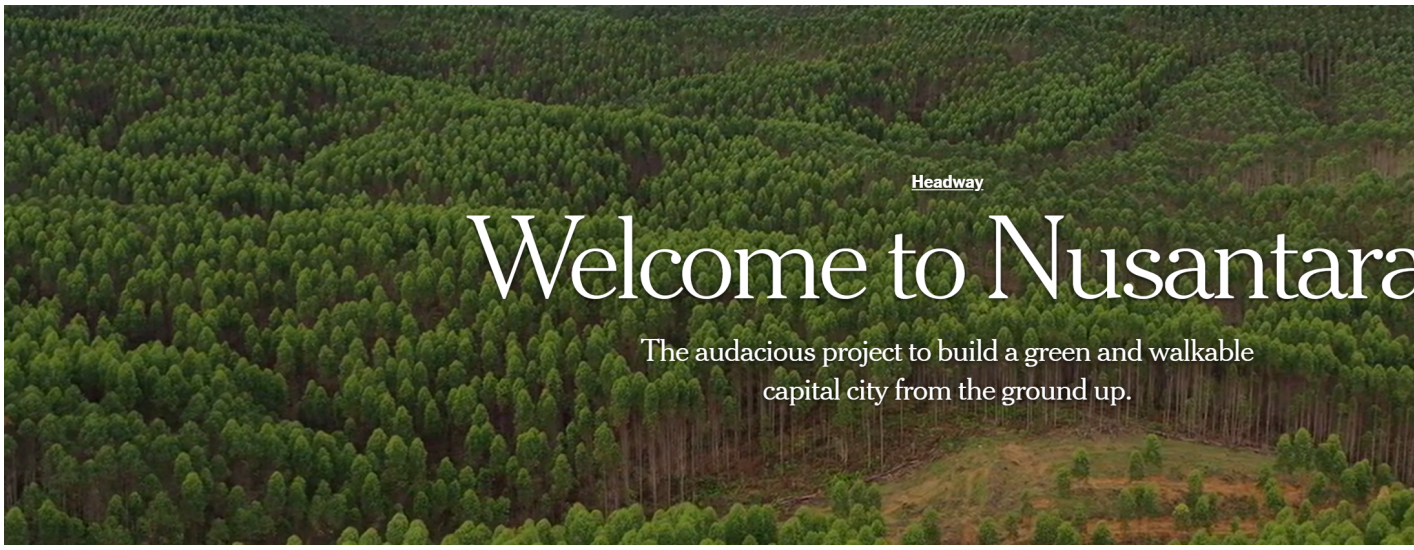
4.2 Application

4.3 Reflections

I think performing Remote Sensing correction on R Studio is quite challenging, as I become more used to using 'button' in Remote Sensing application such as ENVI or SNAP. Besides, after this week's lecture, I genuinely think that Remote Sensing is quite complex as it is not only an image but behind the imagery each pixel is composed by digital number collection and it could be linked with regression too !

5 Policy

Project Case : A New Relocated Capital City of Indonesia ; From Jakarta to Nusantara



Source : www.nytimes.com

5.1 Summary

Recently Indonesia planned to move its capital city from Jakarta (in Java islands) into Penajam Paser Utara City (Borneo Islands), as the current capital city, Jakarta, faced an issue of sinking, land subsidence, overcrowding, low air and water quality (Bappenas 2021). The term Nusantara is used to name this new capital city, symbolizing the varied geographic settings and cultural diversities of Indonesia.

As for the time this published, Nusantara Development is on the phase 2 (2025-2029) that involved strengthening core area (housing, office, commercial zone). Thus, in the time being, Jakarta will still remain the capital of Indonesia until the Presidential Decree on the transfer of the capital to Nusantara is issued. The issuance of this decree will depend on the readiness of the new capital city, including the preparation of all supporting systems such as infrastructure, human resources, and governance systems.

Figure 1: The Relocation Settings and Vision. source: (Capital Authority 2024)

As the development is still in the initial stage, the detailed planning documents haven't been launched yet. Thus, I use available published documents regarding the detail of Nusantara's Development which all of them are publicly available, such as:

1. Nusantara Sustainable Development Goals (SDGs) Voluntary Local Review Baseline [2024]
2. Nusantara Biodiversity Management Master Plan [2024]

Policy

The new capital city, Nusantara, is designed as a **forest city**, with 75% of its designated area being green space. This design aims to create a harmonious blend of urban development and biodiversity hotspots (Borneo Island, where Nusantara is located, is famous for its tropical rainforests). However, the design of being a forest city, its proximity to the rainforest, and its drive on landscape change would present significant **challenges**. One of the major concerns is the increasing likelihood of mosquito-borne diseases (such as **malaria**) spreading in the new capital, which are prevalent in tropical regions Surendra et al. (2024).

Addressing this risk is essential, as Nusantara aims to become a sustainable city aligned with the Sustainable Development Goals (SDGs). However, there is currently no official framework from the government for mitigating malaria risk in Nusantara, as the primary focus remains on infrastructure development. Since malaria is both a global and local challenge, certain goals should be considered to support Nusantara's sustainability, such as:

A. Global Goals : Sustainable Development Goals (SDGs) 3.3 : Fight Communicable Diseases

The SDGs propose achievable global in combating malaria with target that in include reducing incident, mortality rates, eliminate malaria in 35 countries by 2030 and prevent resurgence of the disease in a malaria-free country. Meanwhile, Indonesia's estimated malaria incidence per 1000 population at risk is still on range between 1-50 incidents per 1000 population in 2023. To achieve target of Global Goals, (WHO 2021) have launched global technical strategy for malaria with framework such as:

Figure 2 : SDGs Goal and WHO Technical Strategy

B. Local Goals (National Level): Eliminate malaria case by 2030 and maintain malaria free status

Translating the global goals on malaria elimination, Indonesia's Ministry of Health (Ministry of Health and Control 2023) had proposed recommendations, including the new capital city such as:

- Malaria elimination policies and implementation need basic research, operational support, and efficient technology development.
- Provide input to the IKN special authority regarding malaria risk to ensure the design of the IKN area drainage system is free from malaria mosquito larvae habitat
- Mapping legal and illegal forest encroachers to develop an activity plan and budget

5.2 Application

Remote Sensing as Baseline for detecting malaria hotspot

In malaria elimination, remote sensing could be beneficial as a baseline data for mapping malaria hotspot by incorporating climatic factors and landuse factors to detect mosquito habitat as what (Wimberly et al. 2021) aggregated in framework on Figure 1. Dataset for the Nusantara analysis could use imagery product which is able to highlight water bodies and wetland (proxy for breeding sites), vegetation and land cover (proxy for mosquito habitat), surface temperature (proxy for mosquito activity), and topography (potential inundation area). We could use rainfall season for in our dataset, however If we have yearly rainfall data perhaps we could identify the pattern of rainfall session to get more informed when picking the time series.

Earth observation data commonly used in malaria research included Sentinel-2 and Landsat 8, although Sentinel-2 is preferred because its finer resolution and its frequent visit. However, (Wimberly et al. 2021) mentioned that those resolution is still too coarse to detect individual larva habitat and breeding thus suggest Very High Resolution imagery (such as Pleaides, WorldView) or SAR imagery (such as C-band SAR Sentinel-1 data) that able to penetrate cloud cover during the wet season.

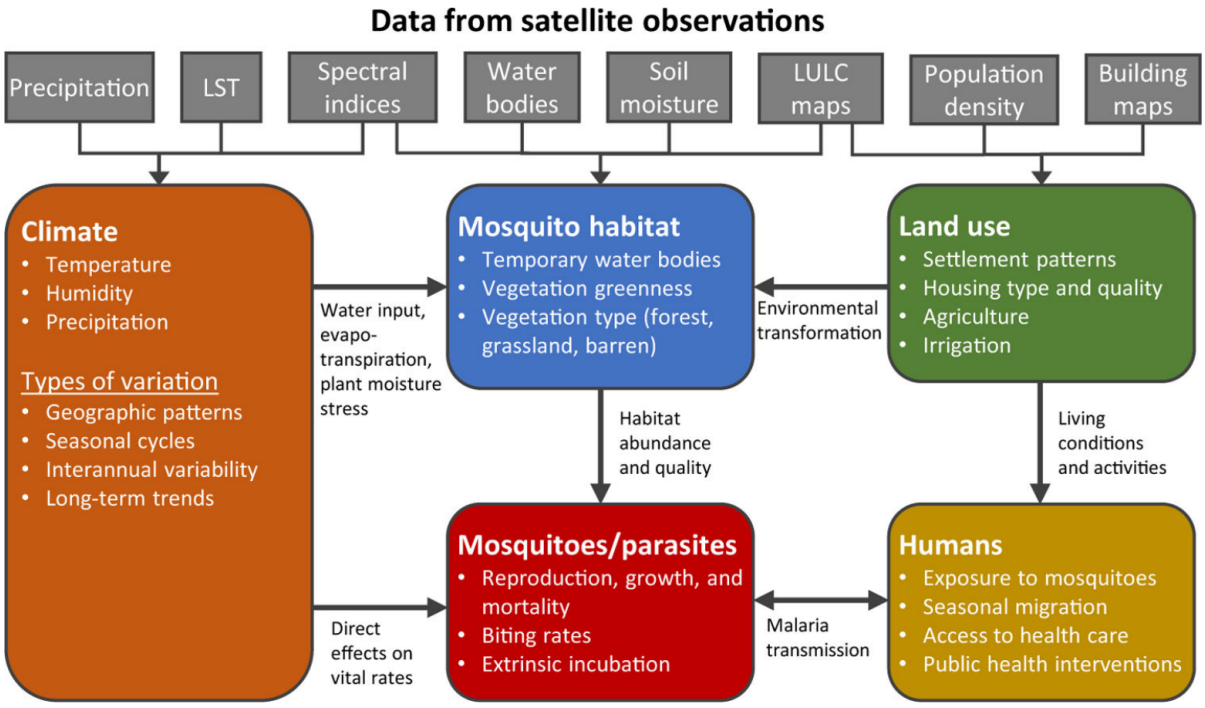


Figure 2: Framework in which Remote Sensing used in Malaria studies. source : Wimberly et al. (2021).

5.3 Reflections

During this week, I got a lot of reflections as I finally found lecture that explicitly bridging the gap of 'academics' to real-world policy. My reflections would be:

1. Combining remote sensing with GIS

Since Nusantara is still uninhabited, we could model nearby settlements to investigate the remote sensing framework. By combining the results with malaria incident data, we can validate our classification—analyzing what percentage of high-risk areas have recorded incidents and which have not. While global and local malaria elimination frameworks mention aggregating incident data and risk levels, they do not explicitly emphasize mapping. Using maps, we can overlay malaria hotspots with incident data, land use, and socio-economic factors. As [@naserrudin2023] notes, people are exposed to malaria due to professions that require them to venture deeper into the forest.

2. Remote Sensing and GIS is good, but enriching the analysis with affected communities make it better

Beyond remote sensing data, incorporating local knowledge can improve the analysis. Understanding how communities respond to malaria provides insight into the effectiveness of mitigation efforts. These communities have lived near rainforests for generations and are directly affected, making their experiences valuable for practical prevention strategies..

3. Implementation challenges, the need for collaboration

One the most important key-takeaway from the lecture is that "some academics papers are too technical, without clearly addressed policy; some policy don't include academic findings they could benefit for." This condition lead to a gap between academics and urban governance. However, in my observation during my work with the government the potential cause is human resources (make the adoption of academics finding hard to implement), annual budget cycles (governments prioritize immediate results and may be reluctant to invest in the long-term experimental processes typical of academia). Bridging the gap on malaria prevention requires collaboration and commitment not only between epidemiologists, healthcare, and geospatial analysts but with the governments to ensure research translates into actionable policies.

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