ESTIMATING THE ABOVEGROUND MANGROVE BIOMASS AND POTENTIAL BIOMASS SEQUESTRATION FOLLOWING LAND USE, LAND USE CHANGE AND FORESTRY (LULUCF)

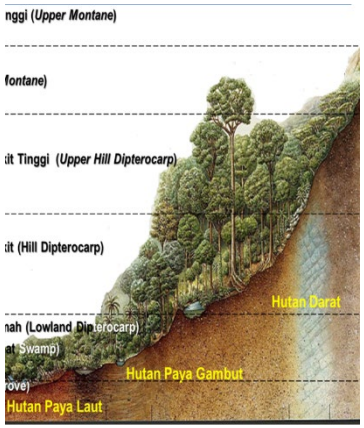
Zulfa Abdul Wahab

SILVA/IUFRO Div. 3 PhD conference

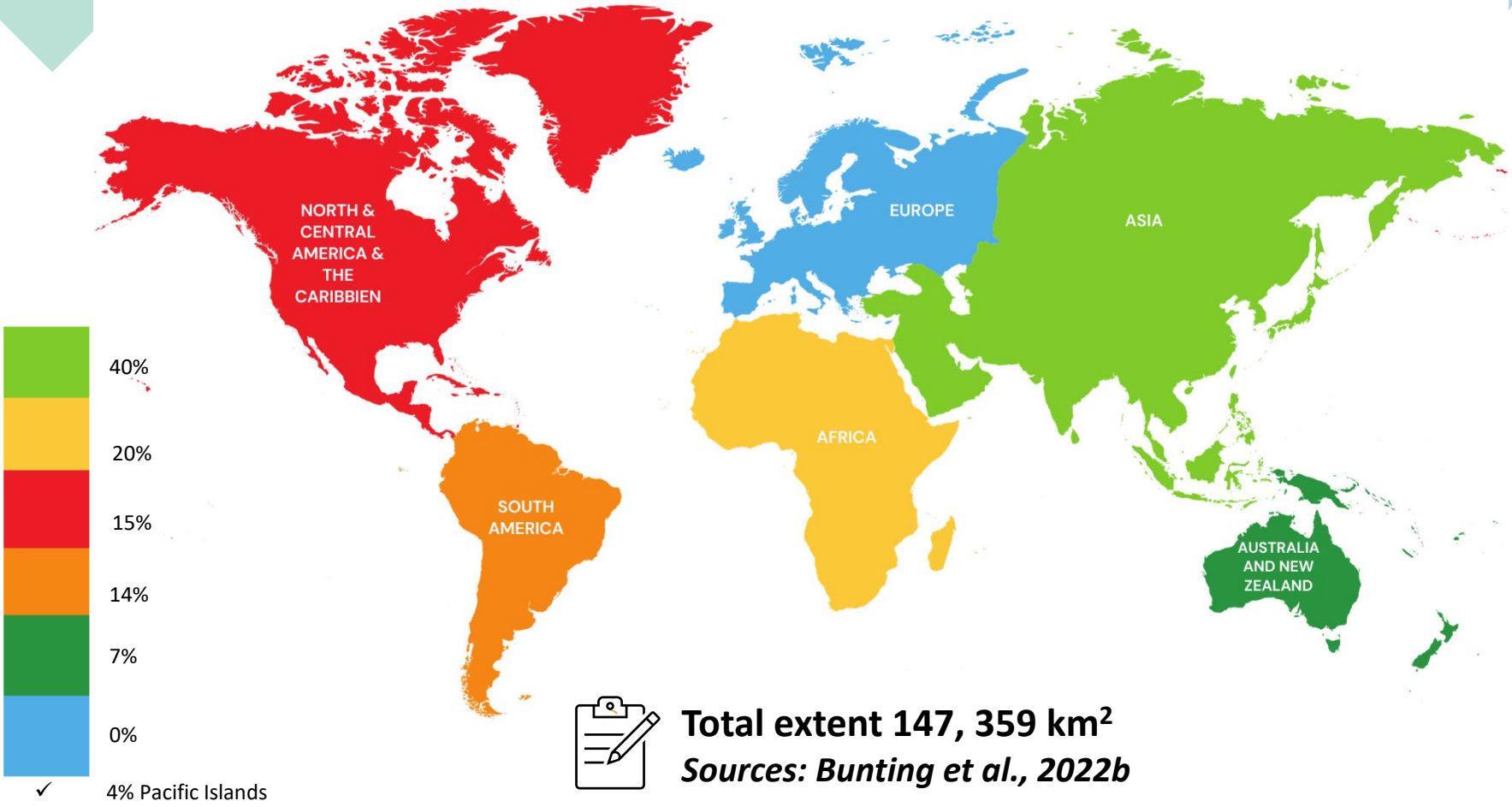
Sustainable forest management adaptation to climate change.

MANGROVE FOREST

- Mangrove is a coastal forest which composed of trees, shrubs, palms, and ferns communities found in sheltered estuaries, along riverbanks, as well lagoons of the tropics and subtropics (Thomas et al. 2017; Zhou et al. 2010; Naidoo, 2009; FAO, 2007; Hogarth P.J., 1999).



GLOBAL MANGROVE EXTENT



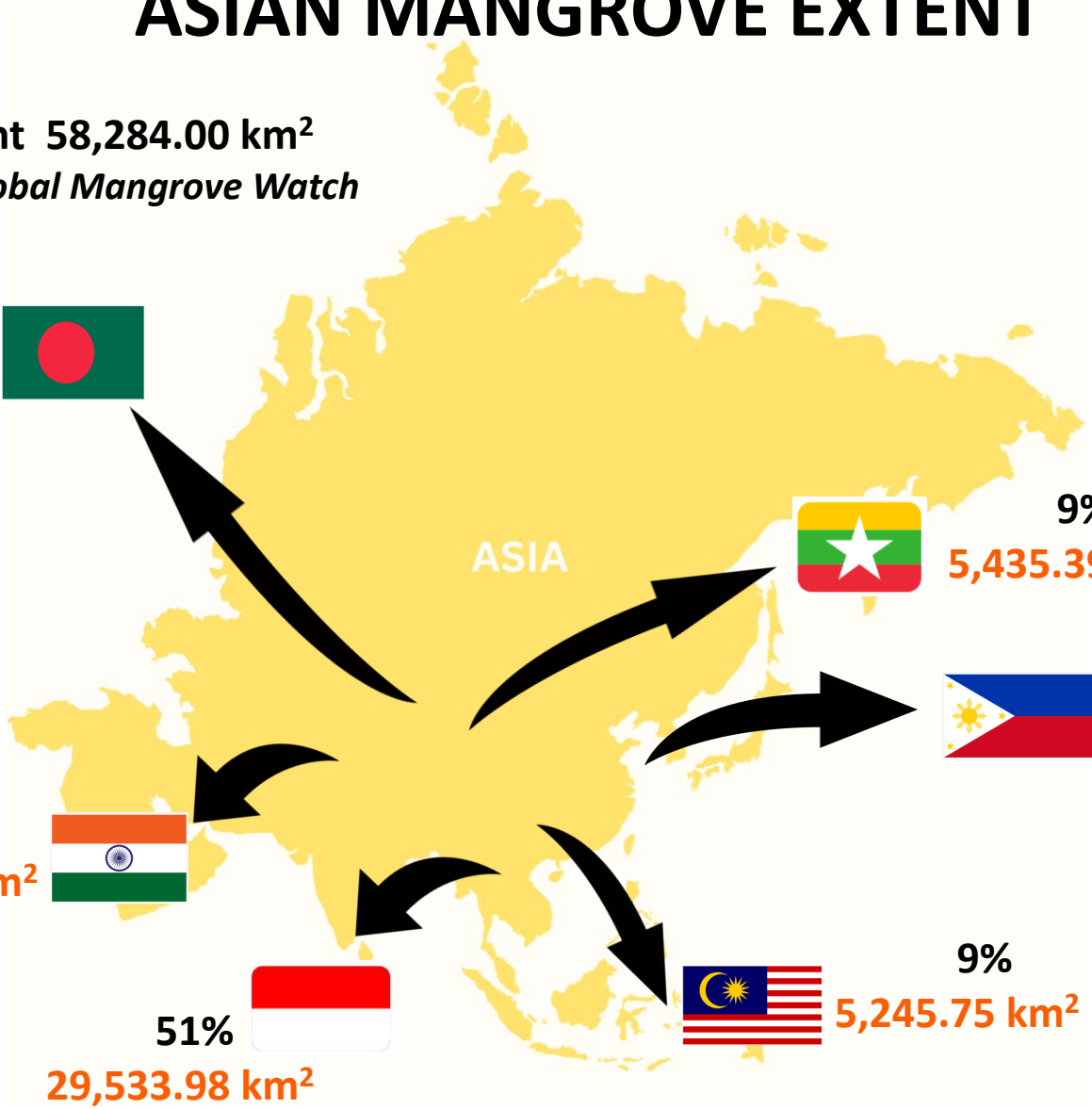
Total extent 147, 359 km²

Sources: Bunting et al., 2022b

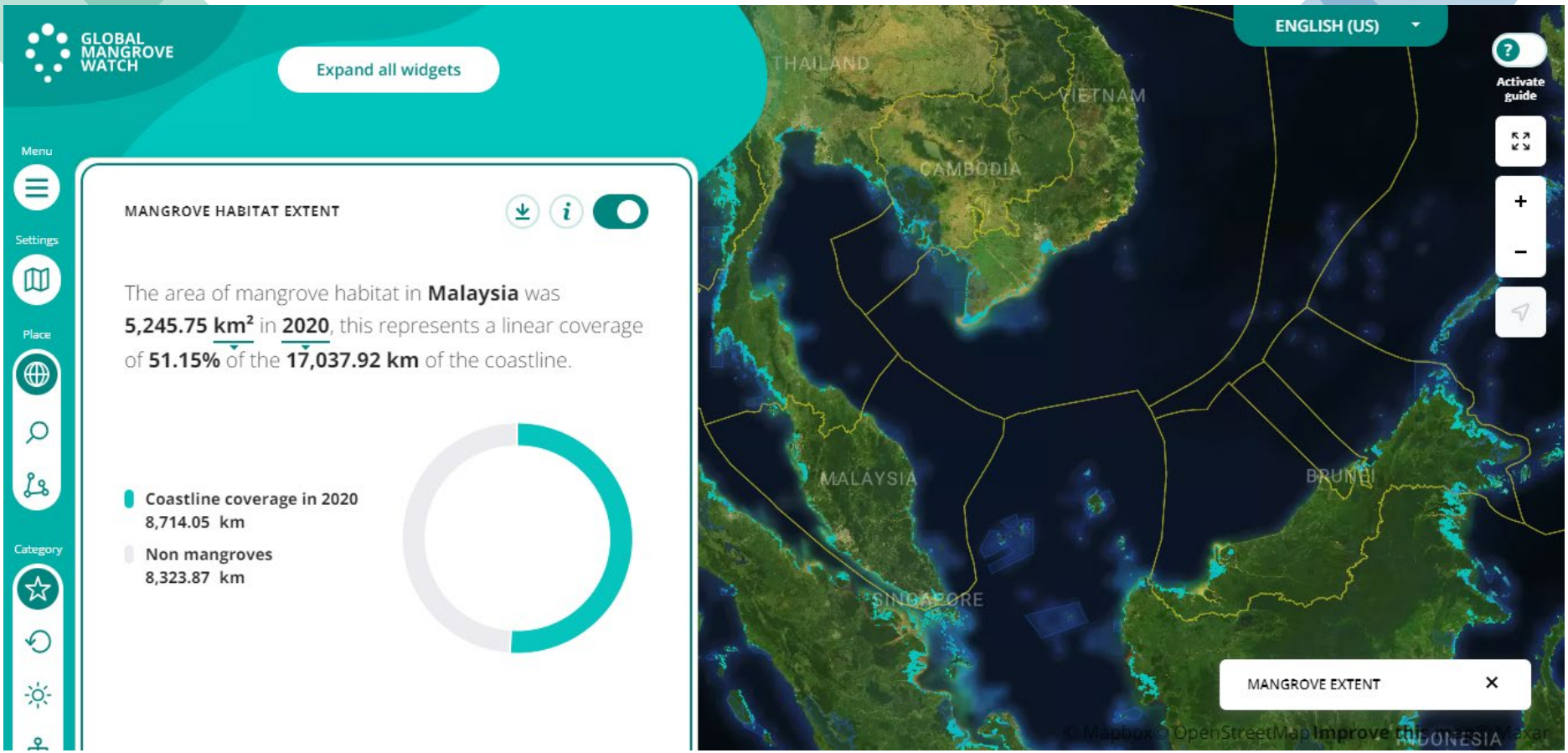
ASIAN MANGROVE EXTENT

Total extent 58,284.00 km²

Sources: Global Mangrove Watch



MALAYSIA MANGROVE EXTENT



Total extent 5,245.75 km²

Sources: Global Mangrove Watch

Region	Mangroves for 2017 (ha)
Perlis	49
Kedah	7,725
Penang	1,967
Perak	**44,990**
Selangor	20,853
Negeri Sembilan	1,557
Melaka	1,241
Johor	26,818
Pahang	3,759
Terengganu	1,571
Kelantan	422
Sub Total: Peninsular Malaysia	110,953
Sabah	378,195
Sarawak	139,890
Total	629,038

Mangroves in Malaysia (Hamdan et al., 2019)

HISTORY OF LAND USE CHANGE IN MANGROVE

01

- Asia was the region which undergo the largest loss of mangrove since 1980 around 1.9 million ha because of conversion activity to urban or to agriculture.

02

- Aizpuru et al., (2000) and FAO, (1997) reported that in between 1975 to 2000, the extent of mangrove area in Malaysia especially has been recorded deceasing from 700,000 ha till 572,000 ha due to extensive harvesting and natural wave.

03

- Mangrove loss has been slow down around 187,000 ha in 1980s to 102,000 ha in between 2000 till 2005 due to increasing to awareness about important of mangrove and management system get improved.

04

- Roslan et al., (2014), in the last decade, approximately 580,000 ha of mangrove forest has been lost.

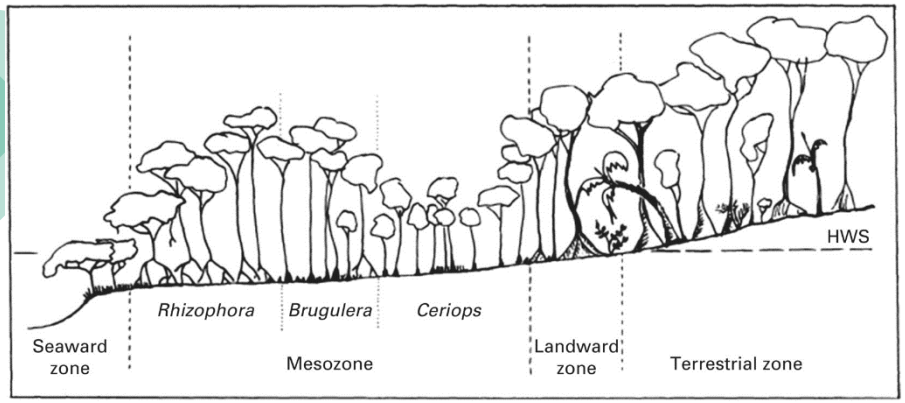
- Giri et al., (2015) human activities (aquaculture expansion, coastal movement and over harvesting) contribute to mangrove lost.

05

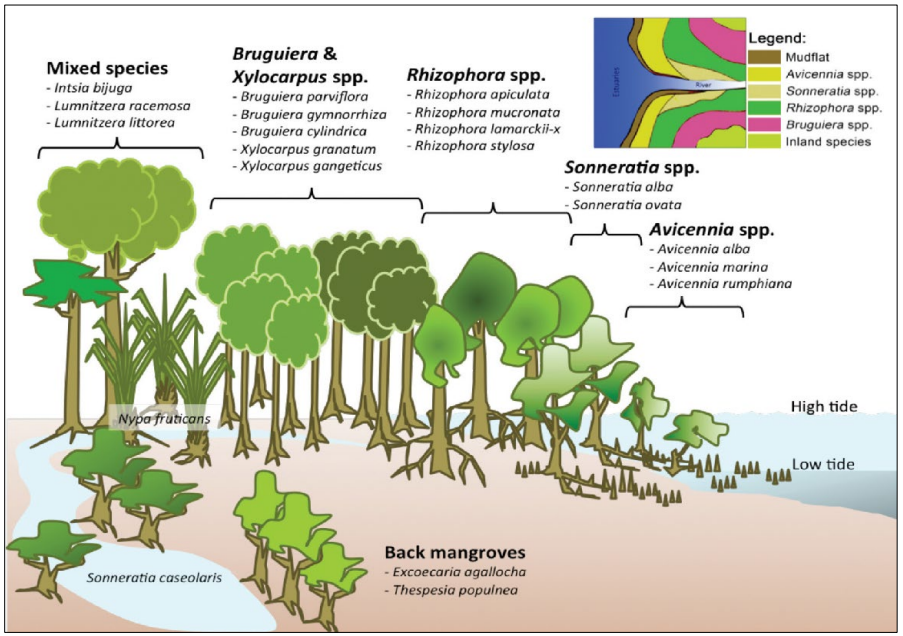
-Almost 580,000 ha of mangrove forest total area has decreased over the past 10 years (Hamdan et al., 2020)
- Kustiyanto (2019) mentions that approximately 2% of mangrove areas are converted yearly, contributing to 1.02 billion tons of carbon emission.

06

- The diminishment of mangrove areas is a consequence of deforestation for timber harvesting, expansion of urban areas, aquaculture, agriculture and other anthropogenic activities (Zulfa et al., 2021; Bindu et al., 2020; Kustiyanto, 2019; Hamdan et al., 2016; Wicaksono et al., 2015)

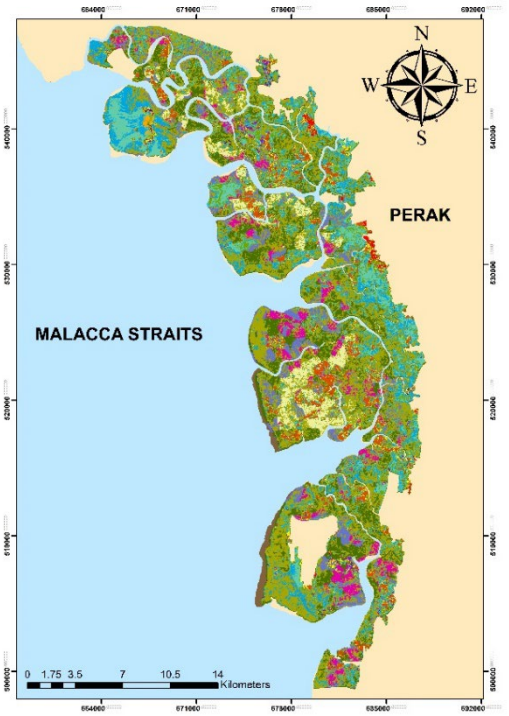


Classical mangrove profile (Source: Tomlinson, 1986)

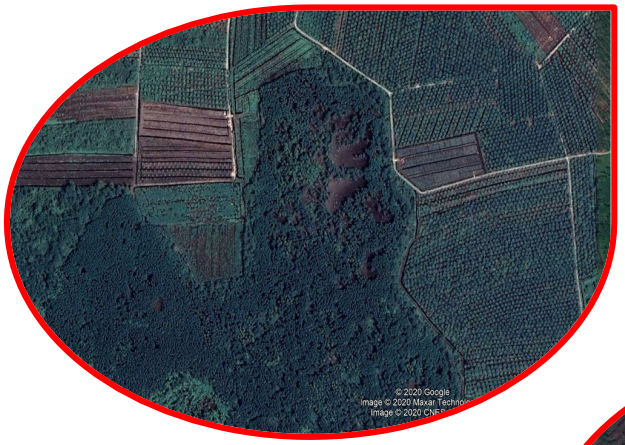


Typical zonation of mangrove in Malaysia (Source: Mubarak & Azian, 2012)

- Previous study shows that the anthropogenic activities were found to have high correlation with the species distribution in Matang Mangrove Forest Reserve (MMFR) (Zulfa et al., 2021)
- Due to anthropogenic activities, MMFR belong to typical zonation of mangrove instead of classical profile.



Urbanisation



Agriculture

Logging

Anthropogenic activities that may affect the mangrove forest

Aquaculture

Natural causes

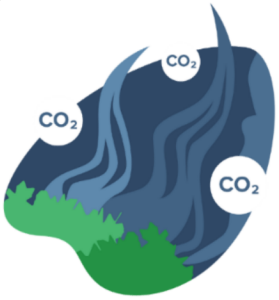
ROLES OF MANGROVE TREE

Home to thousand of species

A wide variety of species live or bread in the mangrove ecosystem, from fish, crab and birds.

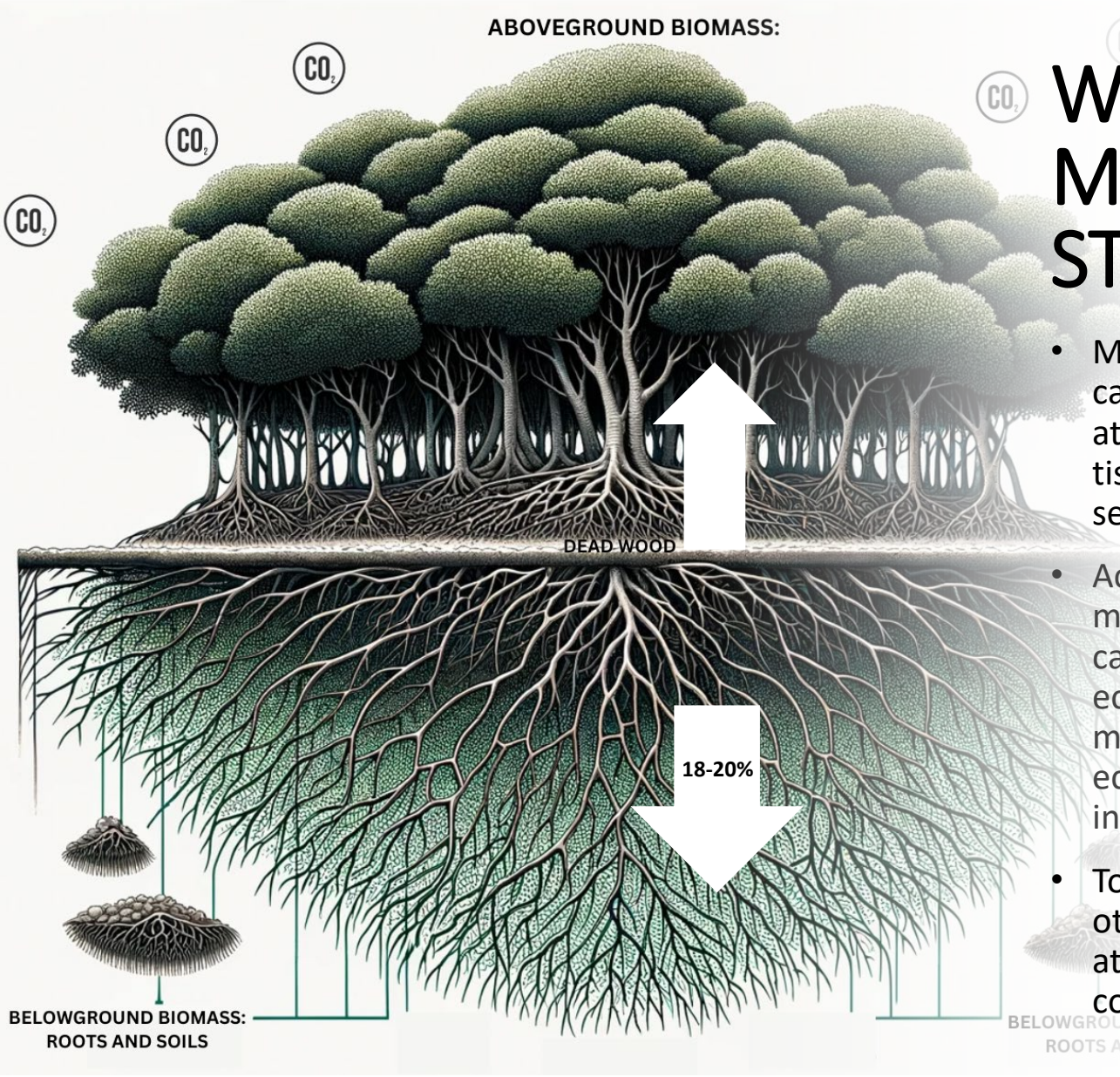
A natural coastal fortress

Mangrove act as a natural fortress against floods and storm surges.



Carbon sequester

Contribute to the fight against global warming by absorbing CO2 from the atmosphere



WHERE DO MANGROVE STORE CARBON?

- Mangroves are good at removing carbon dioxide from the atmosphere and storing it in their tissues, roots and in the soil and sediment below.
- According to Zoe (2022), mangroves are part of the term called blue carbon ecosystem (wetlands, salt marshes and other coastal ecosystems) and are very efficient in storing or sequestering carbon.
- Too much carbon dioxide and other “greenhouse gasses” in the atmosphere can trap heat and contribute to climate change.

MANGROVE AS CARBON SEQUESTER

- Mangrove forests play a crucial role in carbon sequestration, a process of carbon dioxide (CO_2) is removed from the atmosphere and stored.
- These unique coastal ecosystems are highly effective in capturing and storing large amounts of carbon, making them essential in the global fight against climate change.
- Mangrove forests are able to store three to four times more carbon than the forests which are found on land (Charles., 2020).
- For the whole world, mangroves can sequester more than 24 million metric tons of carbon per year (Twilley et al., 2019).
- Mangroves sequester important organic carbon stocks above (leaves, branches) and below (sediment, roots) the soil, at depths ranging from 30 cm to more than 3 m, providing long-term storage (Donato et al., 2011).

CARBON

ON THIS DAY

December 11 1997

IMAGE: Meeting Session during COP3 in Kyoto, Japan
Credit: UNFCCC

KYOTO PROTOCOL ADOPTED

A landmark agreement to reduce Greenhouse Gas Emissions

On this day in 1997, at the Conference of the Parties (COP3) in Kyoto, Japan, the Kyoto Protocol was formally adopted by more than 140 nations present in an effort to mandate industrialized countries to reduce their greenhouse gas emissions. However, it was only in 2005 that the protocol entered into force due to different ratification issues among parties.

REFERENCE: United Nations Climate Change (n.d.). What is the Kyoto Protocol?. UNCC. Retrieved from: https://unfccc.int/kyoto_protocol

PYDRRM Earth Shaker

ALL THE NEWS WITHOUT FEAR OR FAVOR

The Japan Times

Friday, December 12, 1997

5TH EDITION ¥160

TO EUROPE Daily Non-stops from Tokyo Tel. 0120-678-101 SAS SCANDINAVIAN AIRLINES

A Dynamic City; A Progressive Hotel

TODAY

▶ NATIONAL

Nago sets plebiscite
The Nago Municipal Government formally announced that a plebiscite will be held Dec. 21 on whether the Okinawa city should support construction of an offshore heliport for the U.S. military. Page 2

▶ ASIA-PACIFIC

Taiwan on the record
Winners and losers in Taiwan's local elections seek to reassure U.S. officials they expect no change in dealings with the U.S. or China. Page 6

▶ WORLD

What human rights?
Hillary Clinton highlights the lack of progress for many women in a speech at a U.N. ceremony marking the 50th anniversary of the Universal Declaration of Human Rights. Page 7

▶ BUSINESS

Japan T-bond seller
In a sharp reversal, Japan becomes a net seller of U.S.

160 nations adopt Kyoto Protocol

Developed countries to cut their gas emissions by 5.2%

By SUMIKO OSHIMA and ASAKO MURAKAMI Staff writers

KYOTO — Some 160 nations on Thursday adopted a historic agreement to fight global warming that calls on industrialized nations to cut the total volume of their greenhouse gas emissions by 5.2 percent between 2008 and 2012.

After an all-night negotiating session, the Third Conference of Parties to the United Nations Framework Convention on Climate Change produced the Kyoto Protocol, which for the first time ever sets legally binding targets for greenhouse gases, is required to reduce emissions by 7 percent, the European Union by 8 percent and Japan by 6 percent.

The enforcement issue was pushed aside, but parties to the convention will meet in the future to determine how to penalize countries that fail to meet their targets.

An article on developing nations' "voluntary" participation in the fight against global warming — strongly demanded by the U.S. at the Kyoto conference — was deleted. Developing nations opposed the clause, fearing an eventual mandate that they be required to curb emissions.

The six types of gases singled out for reductions are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

Whether to include all six was a main point of contention; initially, only the U.S. wanted all listed in the protocol.

It was also agreed that a "clean development mechanism" will be established, under which "credits" will be given to developed countries that provide financial assistance to developing countries in their efforts to reduce gas emissions.

In addition, a country will be allowed to subtract the amount of greenhouse gases absorbed by forests within its borders from its emissions.

The protocol allows the European Union to keep its "bubble" scheme, under which its 15 members will have different targets but will work together toward a common emissions-reduction goal.

Rill Bjerregaard, head of the EU negotiating team, said that although an 8 percent reduction for the EU was agreed to, how the target will be achieved remains to be worked out.

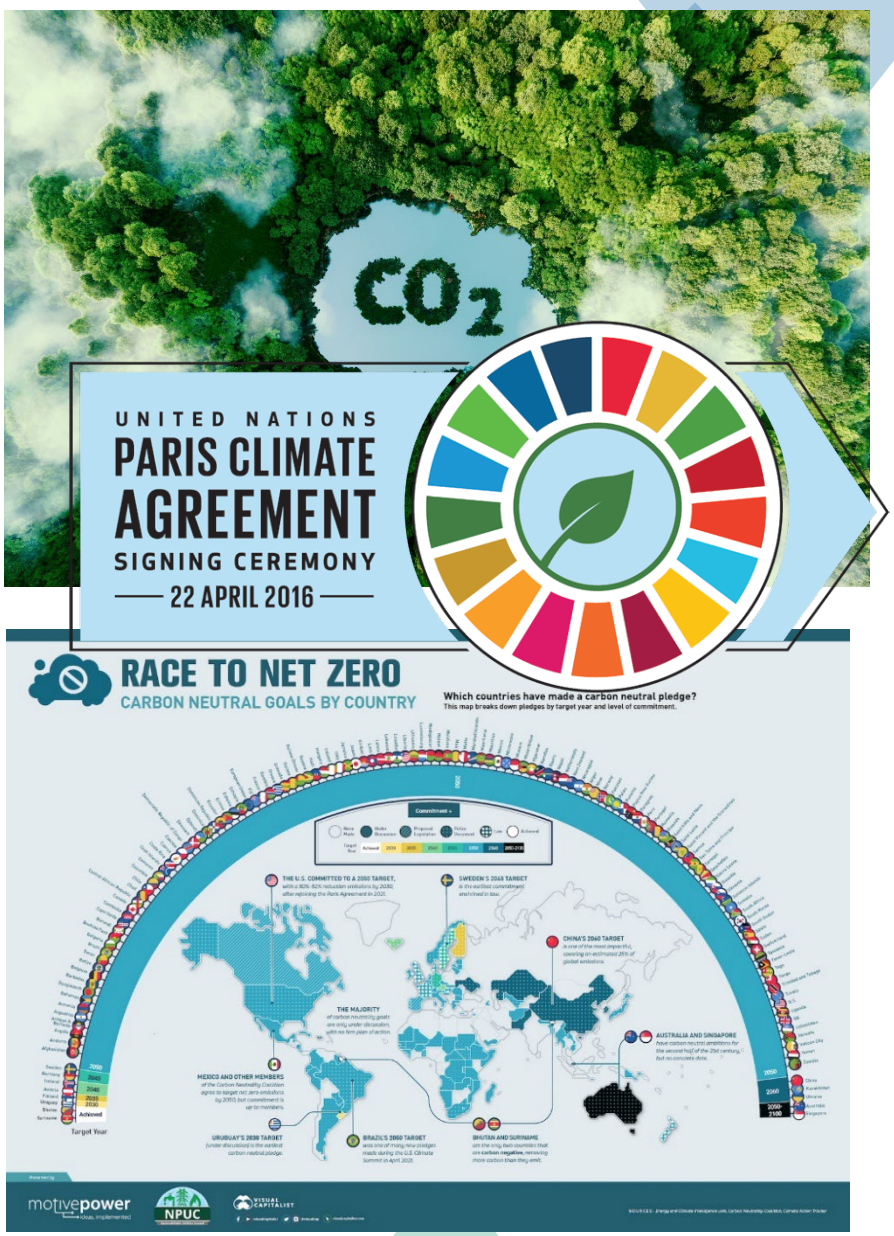
"It's clear that we will have to go back and analyze the results of the conference," she

KYOTO COP3

RAUL ESTRADA-OYUELA (center), chairman of the Committee of the Whole at the global warming conference that ended Thursday in Kyoto, is congratulated after the committee approved a draft protocol for gas emissions cuts. KYODO PHOTO

Hashimoto vows efforts

Gist of Kyoto Protocol



Source: National Public Utilities Council

The Washington Post

Democracy Dies in Darkness

Countries' climate pledges b flawed dat investigati

A large plantation of palm trees, v
borders an undrained peat forest
Sarawak region of Malaysia. Whe
drained and converted to farmlar
pulse of carbon dioxide and other

The Washington Post

Democracy Dies in Darkness

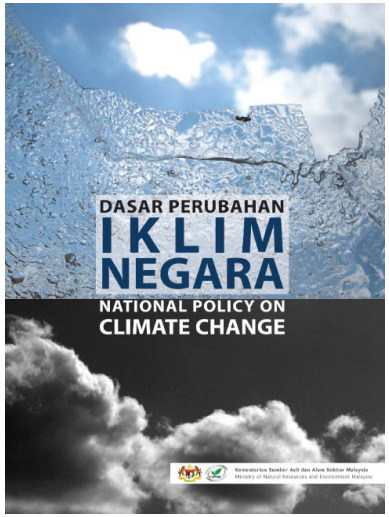
By Chris Mooney, Juliet Eilperin, Desmond Butler, John Muyskens, Anu Narayanswamy and Naema Ahmed

Nov. 7, 2021

Malaysia's latest catalogue of its greenhouse gas emissions to the United Nations reads like a report from a parallel universe. The 285-page document suggests that Malaysia's trees are absorbing carbon four times faster than similar forests in neighboring Indonesia.

The surprising claim has allowed the country to subtract over 243 million tons of carbon dioxide from its 2016 inventory — slashing 73 percent of

RELEVANCE OF GOVERNMENT POLICY



AIM AND OBJECTIVES

➢The aim of this study is to estimate the aboveground mangrove biomass and potential biomass sequestration following land use, land use change and forestry (LULUCF) at Matang Mangrove Forest Reserve (MMFR), Perak.

1. To estimate aboveground mangrove species biomass.

2. To examine the effect of mangrove forest change on biomass.

3. 1.To model aboveground biomass estimation over time.

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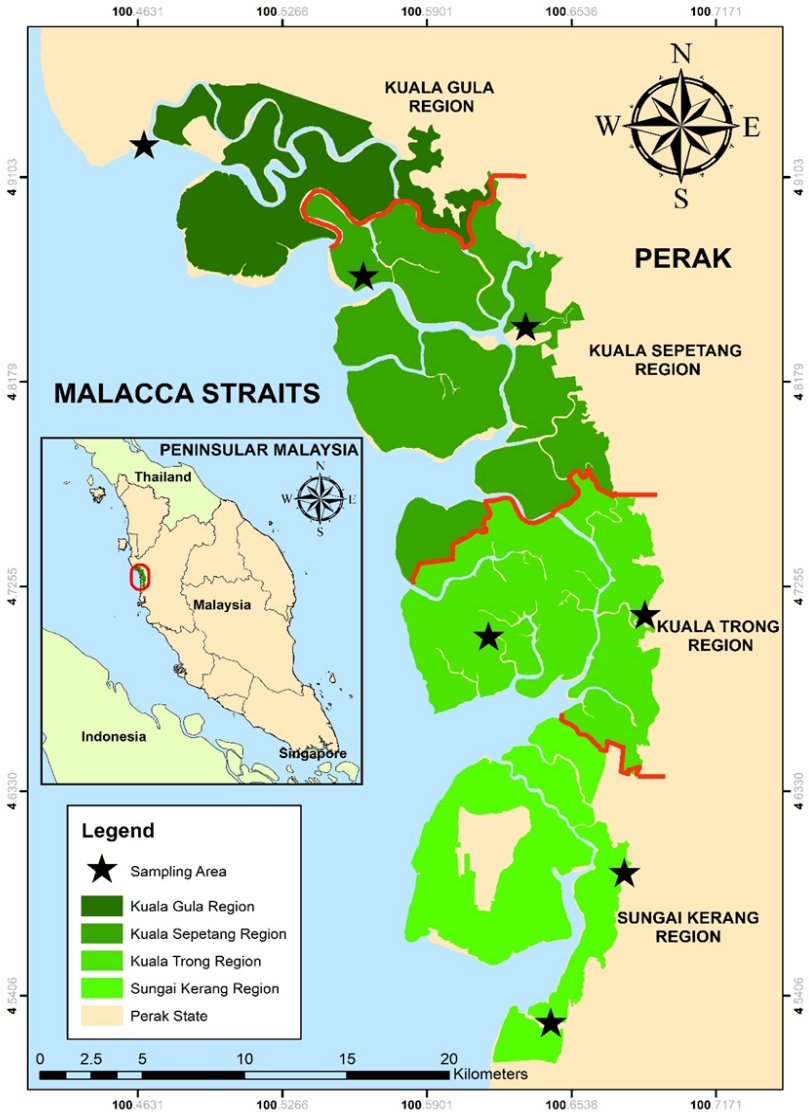
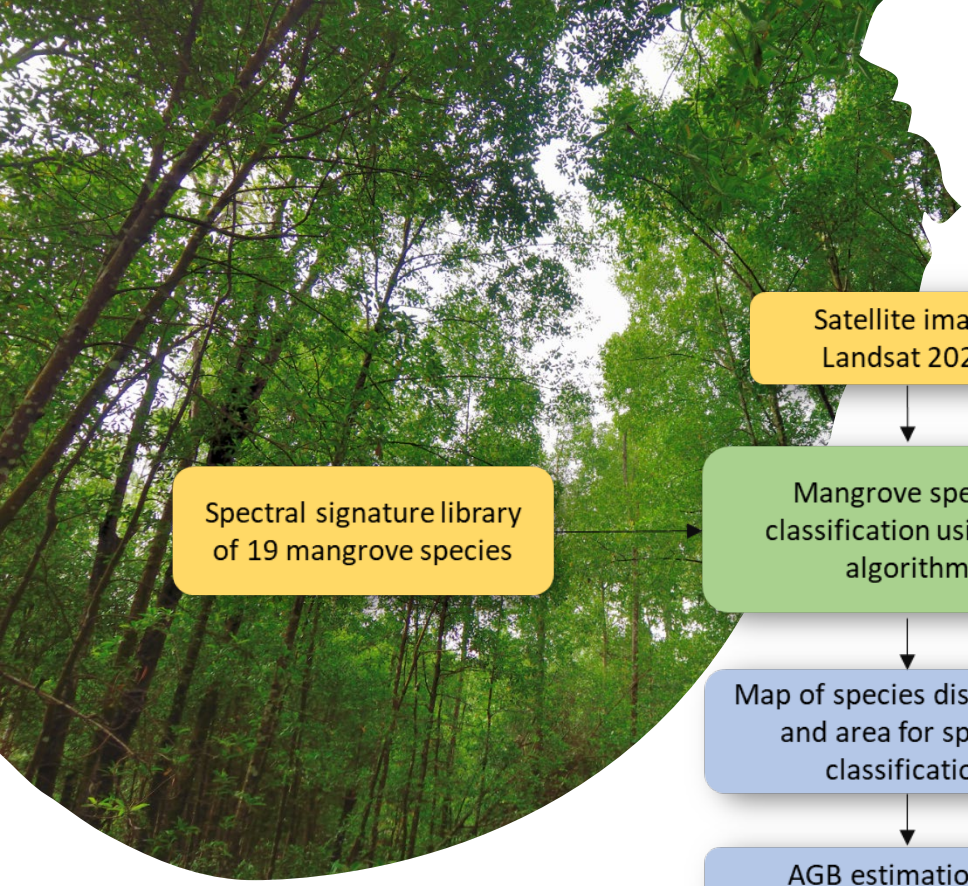
STUDY AREA



- Coordinate : **4.9340^{0}N** and **4.5363^{0}N** and from **100.4759^{0}E** until **100.6279^{0}E**
- Area: 40 288 ha - largest mangrove forest in Peninsular Malaysia
- Three management zone; (Kuala Sepetang North, Kuala Sepetang South), Kuala Trong and Sungai Kerang.
- Best-managed mangrove in Southeast Asia with its ability to balance the timber resource production and ecosystem conservation.



FLOW CHART OF METHODOLOGY

Satellite image Landsat 2023

Spectral signature library of 19 mangrove species

Mangrove species classification using SID algorithm

Map of species distribution and area for species classification

Allometric equation for AGB estimation by species based on existing allometric equation found in literature review;

AGB per ha for each species

AGB estimation for mangrove species for 2023

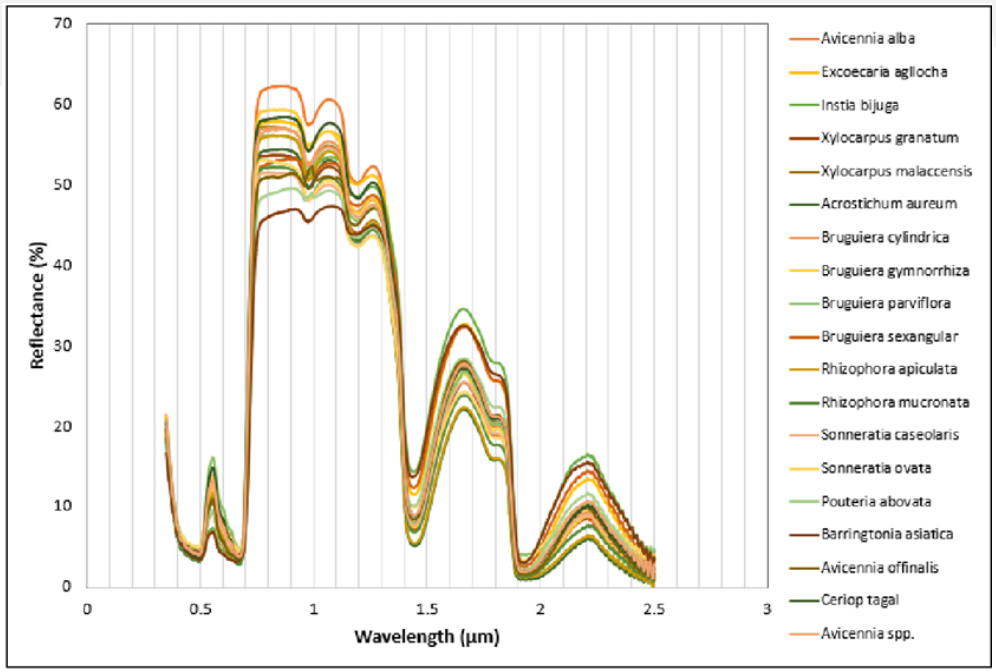
Data

Process

Output / result

MATERIALS

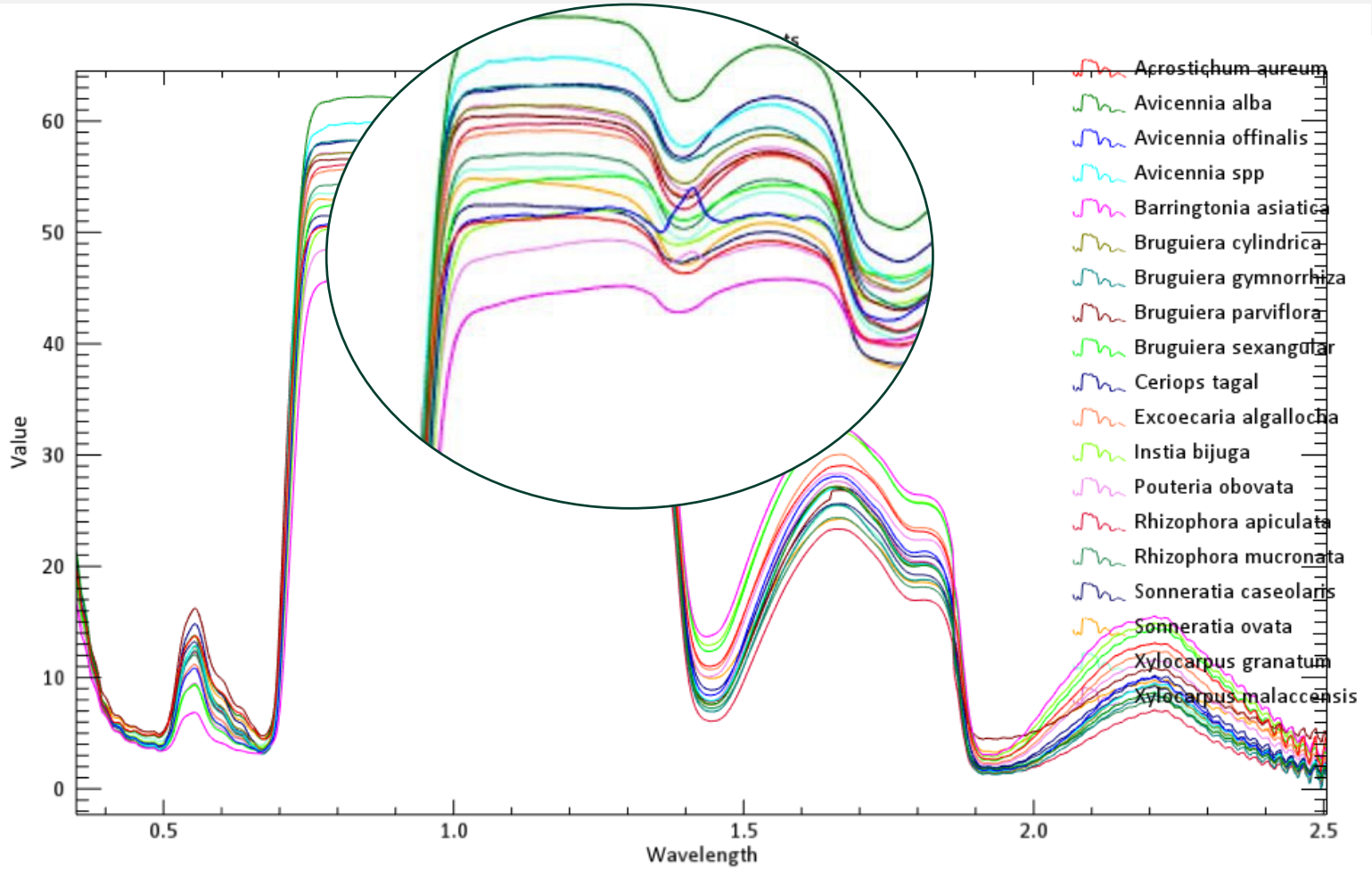
Satellite imagery **2023**



Spectral library data for **19 species**

Sources: Zulfa et al., (2021)

SPECTRAL LIBRARY FOR MANGROVE SPECIES



ALLOMETRIC EQUATION

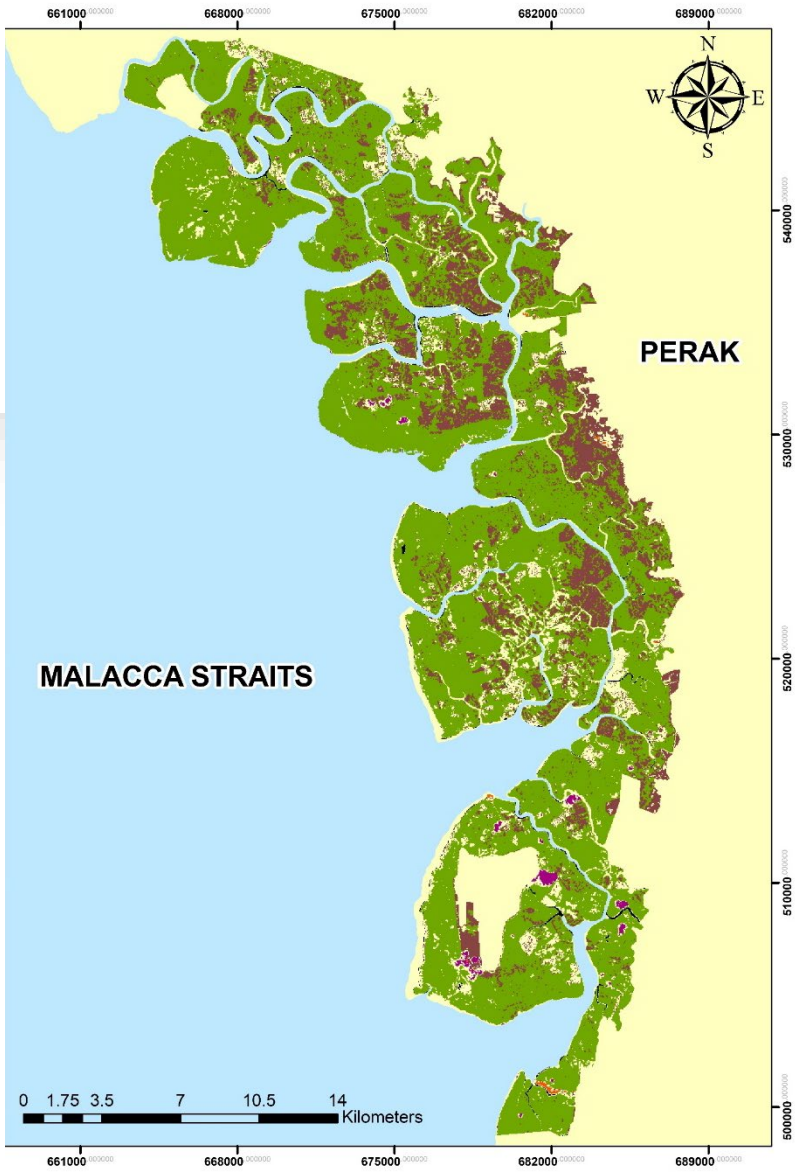
Species	Allometric Equation	Reference
Rhizophora apiculata	$W_{top}= 0.235 \times DBH^{2.42}$	Ong et al. (2004)
Rhizophora mucronata	$W_{top}= 0.128 \times DBH^{2.60}$	Fromand et al. (1998)
Bruguiera gymnorhiza	$W_{top}= 0.186 \times DBH^{2.31}$	Clough and Scott (1989)
Ceriops tagal	$W_{top}= 0.529 \times DBH^{2.04}$	Kangkuso et al. (2018)

GROUND MEASUREMENT

- Measurement has been taken at field to apply with the allometric equation from literature review:
  i. Diameter at breast height (DBH)
  ii. Height
  iii. Species identification
  iv. Location of tree species
- Plot 10m x 10m has been select randomly covered the whole area of MMFR.

MANGROVE SPECIES DISTRIBUTION

- SID algorithm has been found to map the mangrove species with overall accuracy 84.5%
- Area for 4 selected species:
  i. *Rhizophora apiculata* **(14725.35 ha)**
  ii. Rhizophora mucronata **(81.36 ha)**
  iii. Bruguiera gymnorhiza **(5458.68 ha)**
  iv. Ceriops tagal **(2436.74 ha)**



CARBON STOCK AGC TONNE/HA

- Total estimation of above-ground carbon per ha is 49.58 ton/ha
- Area for 4 selected species:
  - i. *Rhizophora apiculata* **(7.5010 ton/ha)**
  - *ii. Rhizophora mucronata* **(41.1659 ton/ ha)**
  - *iii. Bruguiera gymnorhiza* **(0.4491 ton/ha)**
  - *iv. Ceriops tagal* **(0.4651 ton/ha)**

ESTIMATION ABOVEGROUND BIOMASS

- Total estimation of above-ground carbon per ha for 4 selected species is 117,388.92 ton/ha
- Area for 4 selected species:
  i. *Rhizophora apiculata* **(110,454.85 ton/ha)**
  ii. Rhizophora mucronata **(3,349.26 ton/ ha)**
  iii. Bruguiera gymnorhiza **(2,451.49 ton/ha)**
  iv. Ceriops tagal **(1,133.32 ton/ha)**

LIMITATION OF STUDY

- Resolution of satellite imagery
- Allometric equation of mangrove species is limited especially for mangrove species
- Spectral reflectance is hard to distinguish if the reflectance of each species almost hit at the same range

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Thank You