NOTES ON EXPANDING MANGROVE FORESTS IN SABAH

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ABSTRACT

Sabah hosts the largest mangrove ecosystem in Malaysia, covering approximately 390,526 hectares (or 60%) of the country's total mangroves, of which 90% are still intact. The biggest threats to mangroves in Sabah have been identified as land use conversion to oil palm plantations, aquaculture (shrimp farming), infrastructure development (such as the Pan Borneo Highway, urbanisation), illegal settlements, and illegal extraction of Tengar bark. Mangrove restoration started in 2006 under the RMK project (since 8th Malaysia Plan – Federal Government) and in 2011 through the SFD-ISME Mangrove Rehabilitation Project, mostly carried out within encroached and highly degraded mangrove areas within forest reserves. Mangrove forest expansion efforts commenced in 2016 and are currently ongoing in three distinct locations in Sabah, all situated adjacent to forest reserves.

Keywords: mangrove expansion, mangrove planting, forest reserve, Sabah

INTRODUCTION

Mangrove forests are dynamic ecosystems that thrive in the intertidal zone along coastlines in tropical and subtropical regions. Renowned for their unique adaptation to desalinate water (Wang *et al.*,2020), these forests flourish in brackish water and saline soil. Their remarkable ability to survive in harsh environments allows them to exist as the only forest type situated between land and sea.

Mangrove forests play a crucial role in mitigating climate change by sequestering carbon from the atmosphere. The remarkable ecosystem can store carbon belowground as soil carbon up to four times (Donato *et al*. 2021) more efficiently than other forest types. The mangrove ecosystem supports a diverse range of organisms by providing breeding grounds, habitats, and nurseries for various marine species.

The complex and unique root systems of mangroves serve as natural buffers against the impact of storm surges and wave action. For coastal communities, mangroves provide essential food sources and timber materials. Additionally, the aesthetic beauty of mangrove landscapes creates excellent opportunities for nature-based tourism, which can serve as a sustainable source of income for local communities and indirectly contribute to local government revenue.

According to FAO (2020), the total global mangrove area in 2020 was estimated at 14.80 million hectares, with nearly 44% (approximately 6.48 million hectares) located in South

and Southeast Asia. Malaysia's mangroves approximately 586,548 ha (the 6th largest in the world), and is one of the countries with the most extensive mangrove forests in Southeast Asia with almost 60% of the total mangrove area found in Sabah (with 90% are still intact), followed by Sarawak at 22% and Peninsular Malaysia at 18% (Omar & Misman, 2020; Tangah *et al*. 2022; Tangah, 2024).

In Sabah, mangroves primarily occur along the northeast, east, and southeast coasts, particularly along the coastlines of Beluran, Sandakan, Kinabatangan, Lahad Datu, Kunak and extending to the Tawau district. There are 58 forest reserves with mangrove vegetation under the jurisdiction of the Sabah Forestry Department, with the largest reserves being the Kuala Bonggaya and Kuala Labuk Forest Reserves, both located in the Beluran District (Tangah *et al*.2020).

Recent findings published in the IUCN Red List of Mangrove Ecosystems indicate that half of the mangroves in the Tropical Northwestern Atlantic are considered threatened (Troche-Souza et al., 2024). Additionally, 43% of mangrove losses between 2000 and 2020 were attributed to conversion for aquaculture, oil palm plantations, and rice cultivation (Leah & Spalding, 2024).

In Sabah, the primary threats and challenges facing mangroves include land use conversion for plantations, particularly oil palm and timber. Other significant threats include infrastructure development, extraction of the bark of *Ceriops tagal* (Tengar), mangrove clearance for aquaculture, human settlement, and the impacts of climate change.

Mangrove rehabilitation in Sabah started in 2006 and was supported by the federal government. Sibyte Forest Reserve, located in Sandakan, was the first area selected as a pilot project. In 2011, phase 1 of the SFD-ISME Collaborative Project was initiated with the understanding that the Sabah Forestry Department would carry out the rehabilitation project while ISME provided technical assistance. Mangrove rehabilitation works focus on the highly degraded areas of mangrove forest reserves all over the state.

The history of mangrove forest expansion in Sabah began in 2016 with the discovery of a newly formed mangrove mudflat adjacent to Class I Weston Forest Reserve in Weston, Beaufort. This area, named Pulau ISME (honouring the contribution from ISME in mangrove rehabilitation in Sabah), has since been the focus of ongoing mangrove planting efforts with another mangrove area.

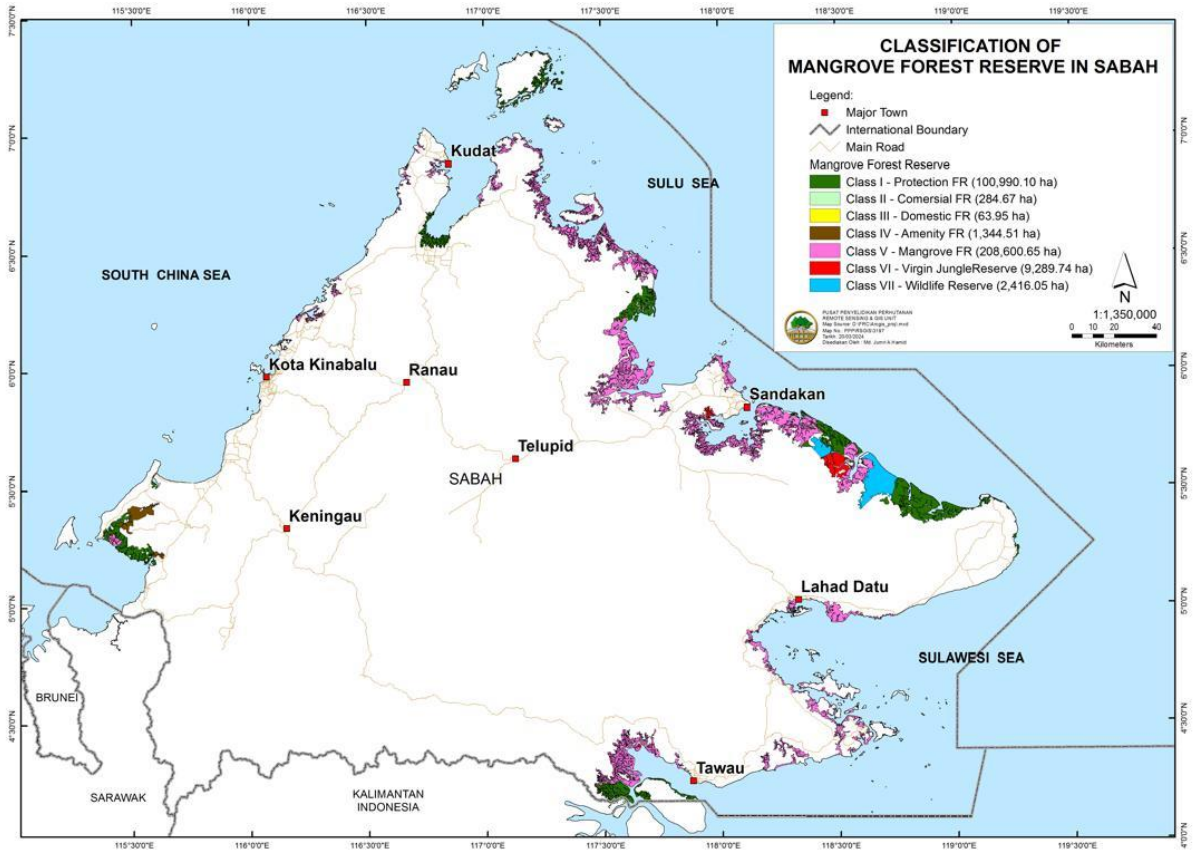

Figure 1: Distribution and classification of Mangrove Forest Reserve in Sabah.

MATERIALS & METHODS

Site Description

Pulau ISME, Weston Forest Reserve Extension (Class I)

Pulau ISME is situated adjacent to Class I Weston Forest Reserve (05.191305°E, 115.572378°E), at the river mouth of the Padas River in Weston Beaufort, Sabah. The island derives its name from the unique landform (an islet or shoal) and the ISME group based in Japan. It was formed through significant sediment accretion. The marine alluvium comprised of clay, silt and sand is deposited by tidal and wave action from Brunei Bay and Padas River upstream with a sedimentation rate of approximately 2 cm/ year. The water salinity of Pulau ISME ranges between 6 and 10 ppt.

Three mangrove forest reserves that grow in proximity to this area are Weston Forest Reserve, Nabahan Forest Reserve and Menumbok Forest Reserve. Notable mangrove species in these areas include *Nypa fruticans*, *Sonneratia caseolaris*, *Avicennia alba*, and *Acanthus ilicifolius,* along with associated species such as *Cerbera odollam*. There are reeds or grass-like plant belong to the family Poaceae that grows along the rivers and mix with the mangroves.

Mangrove ecosystems in these areas supports diverse wildlife, including the Proboscis Monkey (*Nasalis larvatus*), Saltwater Crocodile (*Crocodylus porosus*), the remarkable firefly species *Pteroptyx tener*, and various marine species.

The nearest community is located approximately 3 km from Pulau ISME, and the majority of the locals work as full-time fishermen. Tourism activities in the area primarily focus on observing Proboscis Monkeys, mangrove sightseeing via river cruises, and firefly watching.

Figure 2: An aerial view of Pulau ISME adjacent to Weston Forest Reserve in Weston, Beaufort, Sabah. Area was planted with *Sonneratia caseolaris* and *Kandelia candel*.

Teluk ISME, Marudu Bay Forest Reserve Extension (Class I)

Marudu Bay is the largest bay in Malaysia. The opening size of the bay is about 34km in width (Pereira *et al*, 2019). The bay experienced tides from South China Sea on the West and the Sulu Sea on the East. Marudu Bay is situated about 130 km from the capital city of Kota Kinabalu.

Five villages, Kampung Tambun, Kampung Tanjung Batu, Kampung Tigaman, Kampung Tanah Merah, and Kampung Taritipan, are located near the reserve. Three districts, Kota Marudu, Kudat, and Pitas, share the bay.

Teluk ISME or ISME Bay (06.584198°N, 116.769176°E) is located at the river mouth of Marudu Bay Forest Reserve. Connected with Sungai Simpangan upstream, this mudflat

receives daily broad and heavy tidal interaction. The brackish water salinity is below 20 ppt but may drop when heavy rainfall occurs, especially in the wet season (November – March).

Other mangrove species observed growing nearby include *Rhizophora apiculata*, *Rhizophora mucronata*, *Bruguiera parviflora*, *Avicennia alba*, *Nypa fruticans*, and *Excoecaria agallocha*. Additionally, associated mangrove species such *as Xylocarpus granatum*, *Merope angulata*, and *Heritiera littoralis* can also be found in the vicinity.

Figure 3: An aerial view of Teluk ISME facing the Marudu Bay, Kota Marudu, Sabah.

Pulau Loboh, Sg. Gum-Gum & Sg. Loboh Forest Reserve Extension (Class IV)

Pulau Loboh (06.036832°N, 118°.016479°E) is located adjacent to Sg. Gum-Gum & Sg. Loboh Forest Reserve in Sandakan district. This delta encompasses the largest area, measuring approximately 500 ha.

The mudflat adjacent to the forest reserve consists of a mixture of mud and sandy substrates, while coarser sand is observed closer to the sea. The coarser sand area near the sea, influenced by wave action, is unsuitable for mangrove planting. Therefore, only the muddy regions have been selected for this purpose. Water salinity in the area ranges from 15 to 20 ppt.

The primary pioneer mangrove species identified within the project area is *Avicennia alba*. The tidal flat is also characterised by a vibrant carpet of bright and colourful fiddler crabs and various shell types that can be seen during low tide.

The nearest coastal community is situated about 2 km from the area. The majority of residents engage in fishing or work in oil palm plantations.

Figure 4: An aerial view of Pulau Loboh in Sandakan District.

RESULT AND DISCUSSION

Mangrove planting is the most widely used method for restoring degraded mangrove areas and expanding existing mangrove forests. Alternatively, natural regeneration can occur, although this process may take a considerable amount of time, depending on the specific environmental stressors present. Successful natural regeneration relies on the availability of water-borne seeds or propagules from nearby mother trees (Kamali & Hashim, 2011). Environmental stressors such as strong waves and vigorous water currents can significantly hinder the natural recruitment of new mangrove seedlings.

Table 1: Project area and total area of mangrove expansion

No	Project Area	Year Started	Area Expansion (ha)	Status
1	Pulau ISME, Beaufort	2016	~75	Ongoing
2	Teluk ISME, Kota Marudu	2023	~50	Ongoing
3	Pulau Loboh, Sandakan	2024	~125	Ongoing

	Total	**~250**	

Table 1 presents the project area and the expanded mangrove area. Afforestation efforts on Pulau ISME commenced in 2016. Two successful mangrove species flourishing in the area are *Sonneratia caseolaris* and *Kandelia candel*. These species are classified as riverine and back mangrove types, both which prefer low salinity and calm water conditions. While other mangrove species had also been trialled in this area, they have not exhibited growth rates comparable to these two species. Planting material utilised consisted exclusively of nursery raised seedlings for *Sonneratia caseolaris*, while both propagules and seedlings were used for *Kandelia candel*.

Teluk ISME and Pulau Loboh project areas demonstrate similarities in their selection of mangrove species. While the pioneer mangrove species in these areas are *Avicennia alba* and *Sonneratia alba*, a variety of other mangrove species also thrive well. To create and enhance mangrove diversity, other species such as *Rhizophora apiculata*, *Rhizophora mucronata*, *Rhizophora stylosa* and other members of the *Rhizophoraceae* family were introduced through the planting of propagules and seedlings. Furthermore, nursery-raised seedlings of *Avicennia alba* and *Sonneratia alba* were also incorporated into the planting efforts.

CONCLUSION

Successful mangrove expansion through suitable planting methods is highly dependent on the proper site selection. It is essential to understand and address environmental stressors prior to planting. Additionally, having a sufficient supply of planting materials and knowledge about the appropriate mangrove species is crucial to ensure a lower mortality rate of planted mangrove seedlings. Furthermore, the expansion of mangrove forest is not a one-time effort, it requires an ongoing commitment and continuous work.

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Figure 5; (a) Nursery-raising seedling for *Sonneratia caseolaris* at ISME Nursery (b) propagules of *Kandelia candel* for direct planting method

Figure 6: (c) Mangrove planting using propagules at Pulau Loboh Project Area (d) Mangrove planting using seedlings at Pulau ISME Project Area