Spatial distribution of mangroves in tidal lake ecosystem

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Abstract. Siombak Lake is a tidal lake whose waters are affected by Belawan tidal in the Malacca Strait. The characteristics of the waters are dynamic, especially its salinity. The existence of salinity causes the lake and the surrounding area growth by mangrove. This study aims to map the distribution and condition of mangrove forests in Siombak Lake. This research was carried out in Siombak Lake, Medan City, North Sumatra Province in August 2019. The data were collected of mangrove vegetation and density at the study site. The results of research on Siombak Lake found 14 species of mangrove. There are 2 species of mangrove that is rarely found before, that is found at the research location, namely the powder-puff tree and looking glass tree. Nipa palm and mangrove apple are mangrove species that have the highest distribution and density in the Siombak Lake ecosystem. The condition of mangroves at the Siombak Lakeside is in damage to good condition, while in the Siombak Lake ecosystem can be said in good condition.

1. Introduction
Mangrove ecosystem is a buffer ecosystem of life on the coast and has multiple functions. Physically, mangrove plays an important role in protecting the coast from waves, winds and storms. Ecologically, mangrove ecosystems serve as life support systems for a variety of aquatic organisms and terrestrial organisms [1,2], both as feeding ground, nursery ground and spawning ground [2]. Socio-economically, mangrove ecosystems are a source of livelihood for coastal communities. Mangroves have long been used as firewood and building materials [1,2], intercropping with silvofishery [2,3] including mangrove ecotourism [2]. In addition, mangrove ecosystems contribute to global climate control through carbon sequestration [4].

The existence of mangroves is very important to maintain the survival of both aquatic and terrestrial fauna resources. The destruction of mangrove ecosystems will have an impact on habitat loss in coastal areas. This will have a direct impact on the loss of various species of flora and fauna associated with the mangrove ecosystem. Land conversion activities for cultivation (ponds) and plantations (especially palm oil) become the main problem causing damage to mangrove ecosystem [5]. In addition, logging activities for firewood, building materials and other uses are still a major problem causing destruction of mangrove ecosystems [1,2].
Mangroves grow and flourish in ecotone whose existence is strongly influenced by land and sea factors [1,2]. In general, mangroves grow and develop along beaches or river mouths that are affected by tides. It is very rare for mangroves to grow and develop deep in the lakeside. Siombak Lake is one of the unique lake ecosystems found in Indonesia, because in some parts of the lake there are mangroves of various types and thicknesses [6]. This lake is a tidal lake whose waters are affected by tides [7]. Thus the study of the distribution of mangroves in the Siombak Lake ecosystem needs to be carried out in the framework of an inventory of flora and fauna for the purposes of sustainable lake ecosystem management.

2. Material and methods

2.1. Research locations and data collection
The location of study was carried out at Siombak Lake, Medan - Indonesia. Data collection was carried out in August 2019. The main tool in this study is book guide mangrove from Giessen et al. [1]. Another tool is the GPS Garmin Oregon 65 for determining the point of location as well as stationery for documentation.

![Figure 1. Sampling location](image)

2.2. Data processing procedures and data analyse
Mangrove spatial information is analysed by ArGis which is then presented in the form a map. While information is presented descriptive.
3. Results and discussions

3.1. Mangrove richness

The results of the identification of mangroves in the lake area of the tidal lake was found of 14 mangrove species consisting of 9 types of primary mangrove and 5 secondary mangroves as well as from 11 families (Table 1 and Figure 2). All mangrove species were found in these study location, namely R. apiculata, R. mucronata, and R. stylosa. In addition, there are 2 species of mangrove are rarely found in other places to grow and develop in this location, namely dungun (H. littoralis) and Putat (B. racemose). Although Giessen et al. [1] state that both types have distribution in Indonesia, but several scientific reports related to mangrove ecology have not found these two types. At least some of the results of research on the East Coast of North Sumatra did not find both types [5,8,9,10]. Including several other regions in Indonesia [11,12,13,14].

Table 1. Species mangroves that were found in Siombak Lake ecosystem

| No | Family          | Species                  | Indonesia name           | Local name | Type of mangrove |
|----|-----------------|--------------------------|--------------------------|------------|------------------|
| 1  | Acanthaceae     | Acanthus ilicifolius     | Jeruju                   | Jeruju     | Primary Mangrove |
| 2  | Arecaeeae       | Nypa fruticans           | Nypah                    | Nipah      | Primary Mangrove |
| 3  | Astereaceae     | Wedelia biflora          |                          | Beluntas   | Secondary Mangrove |
| 4  | Combretaceae    | Terminalia catappa       |                          | ketapang   | Secondary Mangrove |
| 5  | Euphorbiaceae   | Excoecaria agallocha     | Mata buta/ Garu          | Buta-buta  | Primary Mangrove |
| 6  | Lecythidaceae   | Barringtonia racemosa    |                          | Putat      | Primary Mangrove |
| 7  | Malvaceae       | Thespesia populnea       | Waru laut                | Baru       | Secondary Mangrove |
| 8  | Pteridaceae     | Acrostichum aureum       | Paku laut                | Piayi      | Secondary Mangrove |
| 9  | Rhizophoraceae  | Rhizophora apiculata     | Bakau                    | Bako       | Primary Mangrove |
| 10 | Rhizophoraceae  | Rhizophora mucronata     | Bakau besar              | Bako       | Primary Mangrove |
| 11 | Rhizophoraceae  | Rhizophora stylosa       | Bakau merah              | Bako kurap | Primary Mangrove |
| 12 | Rubiaceae       | Morinda citrifolia       |                          |            | Secondary Mangrove |
| 13 | Sonneratiaceae  | Sonneratia caseolaris    | Pedada                   | Berembang  | Primary Mangrove |
| 14 | Sterculiaceae   | Heritieralittoralis      |                          | Dungun     | Primary Mangrove |

Mangrove biodiversity in Siombak Lake is much lower than mangrove vegetation in the tidal lake of Belukar Bay (Nias-Indonesia), which is as many as 20 species of mangroves and 17 types of coastal vegetation [15]. The high diversity of mangroves in the Belukar Bay due to the distance of the lake which is closer to the sea. This can be seen from the salinity value that ranges between 29 - 34.5 ppt [15] so that the mangroves can grow well around the Lake of the Belukar Bay. While mangrove biodiversity in other tidal lakes was found of 8 species of mangrove in lagoons lagoon (Nigeria) [16], while in Chilika Lake (India) only of 5 species in mangrove [17] as well as only 2 primary mangrove species and 12 secondary mangroves in coastal Lagoon Nallavadu village, Puducherry, India [18]. This shows that mangroves in Indonesia are higher than in Africa and other Asia.

Mangrove biodiversity in Siombak Lake is still higher than other tidal lakes (Including coastal lake), except in the Laguna of the Teluk Bleukar (Nias-Indonesia). Mangrove in the Teluk Belukar as many as 20 species of true mangrove and 17 species of secondary mangrove [15]. Mangrove biodiversity in other coastal lake is only 2 primary mangrove species and 12 secondary mangrove in the coastal lagoon Nillavadu Village, Puducherry (India) [16], 5 species mangrove in Chilika Lake (India) [17], and 8 species of mangrove in the Lagoons lagoon (Nigeria) [18].

The diversity of mangrove is high in the Teluk Belukar is caused by the location of the lake wich is near to the sea. This can be seen from salinity that ranges between 29-34.5 ppt, so that mangroves can be grow well around Teluk belukar [2], while in Siombak Lake the highest is only 15 ppt [19,20]. Based on the above mangrove biodiversity shows that mangrove in coastal lake in Indonesia have a high biodiversity compared to Africa and other Asia.
3.2. Spatial distribution of mangrove
Apple mangrove is the most numerous mangrove and spread almost evenly on the Siombak Lakeside (stations 1-28) and Nipa palm covers the "forest" vegetation on Siombak Lake (stations 29-40). The distribution of different mangroves between the lake and the "forest" is thought to be caused by differences in salinity measured in the two regions. In lakes, the salinity measured values vary greatly from 2 ppt to 15 ppt, while outside the lake (rivers and creek where Nipah forests grow and develop), the salinity measured is 2 ppt - 10 ppt. However, broadly speaking, of course Nipa palm dominates mangrove vegetation in the Siombak Lake ecosystem. The area of "forest" Nipa palm (very dominant)
in the Siombak Lake reaches more than 40 ha. This is quite reasonable because the salinity range is quite low in the waters of Lake Siombak that is <15 ppt [6,19,20]. Even in the wet season, it can reach 3-5 ppt [6,19,20]. While mangrove on the Siombak Lakeside (mixed: dominated by Mangrove apple) no more than 6 ha.

The density of mangroves on the edge of Lake Siombak varies from sparse to dense. Nevertheless, in general, mangroves on the Siombak Lakeside are rare (Figure 3.), the location of mangrove that is still in good condition is in the southeast (stations 1-4), while in the north part (point 23-24) categorized moderate. The rest of the mangroves on the Siombak Lakeside grow "in one row" on the lakeside. In the forest "Nipa palm in the Siombak Lake ecosystem can be said still in good condition with a very high density (more than 2000 trees/ha) (see Figure 3).

The difference in the condition of mangroves on the lakeside and outside cannot be separated from the pressure of human activity. Based on google earth image data in 2001, shows the condition of mangroves along the lakeside are still commonly found in the north, south, and southeast part of the like. At present (2019) mangroves are seen only remaining in the southeast and slightly north (see Fig. 4). The main pressure of human activity on mangroves on the lakeside is the cutting down of mangrove trees for the expansion (opening) of ponds. Unlike the Nipa palm forest in the Siombak Lake ecosystem which looks still the same between 2001 and 2019 with relatively stable cover and area conditions. This is further learned that the palm forest is only trimmed of its leaves to be used as a roof and not cutting down the entire nipa trees. Mangroves logging for expansion of ponds and for oil palm plantations is a serious threat to the mangrove ecosystem in northern Sumatra [2,5].

![Figure 3. Map of mangrove distribution in Siombak Lake](image-url)
March 2001

June 2019

Figure 4. Picture of mangrove vegetation condition in 2001 and 2019 (source: Google Earth 2001; 2019)

4. Conclusions

Nipa palm and mangrove apple are mangrove species that have the highest distribution and density in the Siombak Lake. The condition of mangroves in the Siombak Lake side is in a damaged to good condition, while in the Siombak Lake ecosystem can be said in the good condition.

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