Structure community of mangrove in Tidung Kecil Island, Thousands Island National Park Jakarta

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Abstract. Mangroves, as intermediate vegetation in the tidal line of seawater, have benefits for the surrounding ecosystem. Tidung Kecil Island is an example of a conservation zone in northern Jakarta that has a mangrove cultivation area. The purpose of study is to determine the mangrove community structure on Tidung Kecil Island. The data was obtained by a descriptive method with purposive sampling technique and belt data collection techniques transect methods. The transect is drawn perpendicular to the shoreline along 50 meters and a 10m x 10m plot was made. Data were taken in the form of a number of stands and characteristics of the type of mangrove obtained. For the data technique analysis, Simpson's index formula was used to obtain density and dominance values and the Shannon-Wiener's index formula to obtain the value of diversity. The results showed that on Tidung Kecil Island 18 species from 15 families were found. The diversity of mangroves in this region is classified as low, with values 1.54 and 1.85. The high presence of species (*Rhizophora stylosa*) dominated the region, with dominance index values 1.21 and 1.32. *Rhizophora stylosa* is a species that is cultivated by the people and tourists of Tidung Kecil Island.

Keywords: Density, diversity, dominance, mangrove

1. Introduction

The Thousand Islands districts is administratively located in the northern part of Jakarta City, the capital of Indonesia. This area has a group of islands which are widely used as beach tourism or marine tourism, nature reserve tourism (conservation), and historical tourism. One of the biggest attractions of the Thousand Islands is beach tourism or marine tourism. Tidung Island ranks first with the number of tourist visits (2010-2013) reaching 373,887 people based on data from the Department of Tourism and Culture of the Thousand Islands Administrative District [1]. To the east of Tidung Island, there is Tidung Kecil Island. Tidung Island has a lot of potential natural resources that can be managed, one of which is the mangrove ecosystem. Tidung Kecil Island itself is a breeding and cultivation area for mangrove forests. Therefore, the potential of the mangrove ecosystem in Tidung Kecil Island will has a direct role in the coastal ecosystem and the community both physically and economically. Mangroves are forest vegetation that grows between tidal lines, so that mangrove forests are also called tidal forests. Mangrove ecosystems are ecosystems located in coastal areas that are affected by tides so that the floors are always flooded. Mangrove ecosystems are among the highest tide levels to levels around or above the average sea level in protected coastal areas [2] and are
supporting various ecosystem services along coastlines in the tropics [3]. The mangrove taxonomy divides into two main parts, namely 'true' mangroves or major mangroves and minor mangroves [4]. The difference between the two is the type of adaptation to freshwater. In true mangroves, mangrove species adapt to high salinity conditions that are controlled by tides. Whereas the following mangroves have been able to adapt to low salinity and/or freshwater, and have not even been able to adapt to high salinity (sea water). This minor mangrove lives in the coastal area of the land.

According of the book 'Introduction to Mangroves in Indonesia', Indonesia has at least 202 species of mangrove plants, including 89 species of trees, 5 types of palms, 19 types of climbers, 44 types of soil herbs, 44 types of epiphytes and 1 type of nails. Out of 202 species, 43 species (including 33 species of trees and several species of shrubs) are found as true mangroves, while other species are found around mangroves and are known as associated mangroves. Around the world, Indonesia [5] noted as many as 60 species of true mangrove plants. So, based on this data, it can be showed that Indonesia has a high diversity of mangrove vegetation types.

The diversity of species in mangrove vegetation depends on physical environmental factors, which are soil type, wave exposure, and flooding by tides [6]. Environmental factors that also influence growth include fresh water supply and salinity, substrate stability, and nutrient supply [7]. As one of the ecosystems located on the coast, mangrove forests are unique and vulnerable ecosystems because they are easily damage, if they are not wise in maintaining, preserving, and managing them. In general, The condition of mangrove forests has a heavy pressure. The current existence of mangrove forests is quite worrying because of human activities for the benefit of land conversion as ponds, settlements, hotels, or tourist attractions. Along the north coast of Java, mangrove forests are cut down legally or illegally. This activity can reduce the population of mangroves by more than 50% in a period of thirty years [8]. As a result, the function of the mangrove area has become disrupted. The loss of marine biota habitats, reduced protection of coastal areas, and the breaking of the food chain for the biota there can disrupt the stability of the ecosystem. In addition environmental changes and damage, the upstream region also contributes to worsen the condition of the coastal area. Various forms of solid sedimentary material (erosion), contamination sourced from industry and households, it is one of the factors that cause siltation of the coast and damage to mangrove ecosystems. From the results of several research it was reported that the condition of the Thousands Islands Coastal area, is currently in a state of disruption and is thought to be unable to support the balance of the environment and the welfare of the surrounding community [9]. DKI Jakarta Forestry Service (1998), reports that mangrove communities that function as buffer for coastal borders tend to be increasingly disrupted by their role. Though mangrove ecosystems have ecological functions that are associated with other marine biota and economic functions that can prosper the surrounding community. The ecological function of mangrove forests, among others, is as a protector of coastlines, prevention of sea water intrusion, habitat (dwelling) for marine biota, feeding grounds (feeding ground), nurseries and enlargements (nursery ground), spawning ground for various aquatic biota, and as a regulator of microclimate. While the economic function, among others, as a producer of household needs, producing industrial needs, and producing seeds [10]. Mangrove forests also greatly support the economy of coastal communities because they are a source of livelihood for people who work as fishermen.

In addition to functions, mangrove ecosystems also have several benefits related to physical functions including disaster mitigation such as wave dampers and hurricane winds for the area behind it; coastal protection from abrasion, tidal waves and tsunamis; mud cap and sediment traps carried by surface water flow; prevention of sea water intrusion to the mainland; as well as being able to neutralize water pollution to a certain extent [11]. Other benefits of this mangrove ecosystem are as objects of ecotourism [12] and sources of medicinal plants [13]. After knowing the functions and also the benefits of mangrove ecosystems and the lack of data on mangrove ecosystems in Tidung Kecil Island, it is necessary to conduct research on the structure of mangrove communities on Tidung Kecil Island. This study aims to determine the structure of the mangrove community in Tidung Kecil Island. This objective is one of the important aspects to determine the condition of a coastal ecosystem and
see how important the role of mangrove ecosystems is on the environment, especially on Tidung Kecil Island. The benefit of this research is that it can be used as a reference for other researchers related to the structure of the mangrove community in Tidung Kecil Island and also can be used as a basis for mangrove ecosystem conservation management.

2. Materials and methods
This research was carried out on February 9, 2019, located on the Tidung Kecil Island, the northern and southern parts of the Thousand Islands, namely the north being used as station I and the south being used as station II (figure 1).

2.1. Research tools and materials
The tools used in this study were salinometer, rope, peg, universal pH indicator paper, hand refractometer, thermometer, GPS (Global Positioning System), under water sheet, and road board. The materials used in this study are water samples, substrates, and all parts of the mangrove including fruit, flowers, leaves, stems, and roots.

2.2. Work procedure
This research was conducted using descriptive methods with purposive sampling techniques based on the specified area and data collection techniques Belt Transect Methods (belt transects). Transects are drawn perpendicularly from the coast along 50 meters to the sea and 50 meters to the mainland with sides along 10 meters to the left and right of the transect. Along the transect line a plot of 10 meters x 10 meters is made. Then every mangrove inside the plot is observed. Data on the number and characteristics of mangroves in the transect are recorded for identification. The data obtained are then grouped into types of true mangroves or associated mangroves.

In addition, abiotic factors were measured with physical and chemical parameters. The physical parameters we measure are temperature and salinity, while the chemical parameters we measure are pH.

2.3. Data analysis techniques
This study uses several measurement indices analyzed, namely species density (Di), relative density (DR), dominance index (D), and diversity index (H'). Species density is the number of species i stands in a unit area [14]. To determine the type and relative density index the formula is used:

$$Di = ni/A; \quad DR = Di/\text{Total Di} \times 100\%$$
The Shannon-Wiener diversity index (Shannon’s index) [15] is used to determine species diversity at each growth level using the following formula:

\[ H' = -\sum (pi \ln pi); \quad pi = (ni / n) \]

(2)

Dominance index (D) is used to determine the extent to which one group of biota dominates another group. Considerable dominance will lead to unstable and depressed communities. Dominance index is calculated based on Simpson's index of dominance formula [16], namely:

\[ D = 1 - \left( \frac{\sum n(n-1)}{N(N-1)} \right) \]

(3)

3. Results

Vegetation analysis results were carried out at 2 stations, each of which had 3 transects. There are 5 plots on each land transect. From all plots on each transect, 18 species from 15 families were identified. Furthermore, the results of the vegetation analysis are grouped into 2 criteria for mangrove types based on the book 'Introduction to Mangroves in Indonesia' (1999), namely true mangrove and associate mangroves. This grouping is done so that the data obtained more clearly illustrates the structure of the mangrove community in the study area. The vegetation analysis found in the study area is known as the first and second stations listed in table 1 along with their measurement indices.

Based on the results in table 1 shows that the most number of species found is at station II and can be found as many as 815 individuals consisting of 11 species, while at station I can be found as many as 709 individuals consisting of 14 species. The species most commonly found at station I and station II are *Rhizophora stylosa* for sea-point transects and *Pandanus* sp. for land transects. Where, at station I found 527 *Rhizophora stylosa* and 94 were found, while at Station II *Rhizophora stylosa* found 698 individuals and *Pandanus* sp. 45 individuals were found.

3.1. Diversity Index, Dominance, and Density

Based on the results of research conducted on Tidung Kecil Island, Thousand Islands, the diversity and dominance index of mangroves found in both stations can be seen in table 2 and table 3.

Based on the research that has been done, it can be seen that the diversity index value (H’) in Tidung Kecil Island at Station II is higher by 1.85 compared to the diversity index value at Station I which is 1.54. Diversity at both stations is relatively low. Diversity is said to be low if 0 <H’<2.30, moderate diversity if 2.302 <H’ <6.907, and if diversity is said to be high if H’ > 6.907 [17]. So it can be said that the diversity on Tidung Kecil Island, which is included in the data collection station is relatively low.

The highest dominancy (D) index value is found at the II station (0.737) and the lowest at station I (0.527). Thus obtained the dominancy index in both research stations Tidung Kecil Island is around 1.309. If D = 1, the dominancy is said to be high and if D approaches 0 then the dominancy is declared low [18]. So the station I and II has a high dominancy value with the presence of the dominant species of *Rhizophora stylosa* species. High dominant concentrations (there are dominant individuals), conversely if low dominancy index expressed low concentration (no dominant) [18].

The highest species density index value (Di) is at station II which is around 1.823 ind/m2 compared to station I with its species density index value of around 1.418 ind/m2. The result is due to the large number of species in station II, with 815 of the 11 individuals, while at station I the number of individuals is 709 out of 14 species. It can be said that the density is relatively high for the criteria of quality standard of mangrove density, solid density ≥ 1.500 ind/ha, medium ≥ 1.000–1.500 ind/ha and rarely < 1.000 ind/ha [19]. The results of the relative density (DR) at the two stations obtained results that are high relative densities where in *Rhizophora stylosa* species become mangrove species that
have a large number of individuals, with a relative density value (DR) of 92% at Station I and 95% at station II, so that the relative density (DR) of mangroves on Tidung Kecil Island is relatively high.

Table 1. Species found in mangrove vegetation at station I and station II. Station I and station II both have a large number of individuals, namely *Rhizophora stylosa* species from the major mangrove group and *Pandanus* sp. from the associated mangrove group.

| No. | Name type         | Amount | No. | Name type         | Amount |
|-----|-------------------|--------|-----|-------------------|--------|
|     | Major Mangrove    |        |     | Major Mangrove    |        |
| 1   | *Rhizophora stylosa* | 527    | 1   | *Rhizophora stylosa* | 698    |
|     | Minor Mangrove    |        |     | Mangrove Associates |      |
| 2   | *Excoecaria agallocha* | 1      | 2   | *Pandanus* sp.    | 45     |
|     | Mangrove Associates |       |     | *Calophyllum inophyllum* | 24     |
| 3   | *Pandanus* sp.    | 94     | 4   | *Lantana camara*  | 9      |
| 4   | *Casuarina equisetifolia* | 29    | 5   | *Passiflora foetida* | 9      |
| 5   | *Lantana camara*  | 28     | 6   | *Scaevola taccada* | 8      |
| 6   | *Passiflora foetida* | 7      | 7   | *Pongamia pinnata* | 8      |
| 7   | *Hibiscus tiliaceus* | 6      | 8   | *Ipomoea pes-caprae (L.)* | 5     |
| 8   | *Terminalia catapa* | 5      | 9   | *Premna serratifolia* | 5     |
| 9   | *Premna serratifolia* | 4      | 10  | *Terminalia catapa* | 3      |
| 10  | *Sphagneticola trilobata* | 3  | 11  | *Stachytarpheta jamaicensis (L.) Vahl.* | 1      |
| 11  | *Clerodendrum inerme* | 2   |     |                    |        |
| 12  | *Acacia* sp.      | 1      |     |                    |        |
| 13  | *Pongamia pinnata* | 1      |     |                    |        |
| 14  | *Spinifex longifolius* | 1 |     |                    |        |

|     | Total | 709   | Total | 815   |

Table 2. Average values of diversity index (H’) and dominance (D) of mangrove vegetation at station I and station II. Can be seen in the table, the inverse comparison between diversity index and dominance index.

| Index     | Station I | Station II |
|-----------|-----------|------------|
| Diversity (H’) | 1.54  | 1.85       |
| Dominancy (D)  | 0.572 | 0.737      |

3.2. Physical and chemical parameters
From the research that has been done, the results of measurement of physical and chemical parameters of the water in each transect at 2 stations can be seen in table 4.
Table 3. Average values of species density index (Di) and relative density (DR) of mangrove vegetation at station I and station II.

| No | Name type | Density (Di) (Ind/Ha) | Relative density (DR) (%) | No | Name type | Density (Di) (Ind/Ha) | Relative density (DR) (%) |
|----|-----------|-----------------------|---------------------------|----|-----------|-----------------------|---------------------------|
|    | Station I |                       |                           | Station II |                       |                       |
| 1  | Rhizophora stylosa | 1.3175 | 92.9 | 1  | Rhizophora stylosa | 1.745 | 95.721 |
| 2  | Excoecaria agallocha | 0.0006 | 0.042 | 2  | Ipomoea pes-caprae | 0.0033 | 0.181 |
| 3  | Casuarina equisetifolia | 0.0161 | 1.134 | 4  | Premna serratifolia | 0.0033 | 0.181 |
| 4  | Terminalia catapa | 0.0028 | 0.197 | 5  | Stachytarpheta jamaicensis | 0.0007 | 0.0383 |
| 5  | Premna serratifolia | 0.0022 | 0.155 | 6  | Lantana camara | 0.006 | 0.3291 |
| 6  | Clerodendrum inerme | 0.0011 | 0.077 | 7  | Pandanus sp. | 0.03 | 1.6456 |
| 7  | Pongamia pinnata | 0.006 | 0.042 | 8  | Calophyllum inophyllum | 0.016 | 0.8776 |
| 8  | Lantana camara | 0.0156 | 1.099 | 9  | Terminalia catapa | 0.002 | 0.1097 |
| 9  | Pandanus sp. | 0.0522 | 3.679 | 10 | Scaevola taccada | 0.0053 | 0.2907 |
| 10 | Hibiscus tiliaceus | 0.0033 | 0.232 | 11 | Pongamia pinnata | 0.0053 | 0.2907 |
| 11 | Spinifex longifolius | 0.0006 | 0.0422 | | | | |
| 12 | Passiflora foetida | 0.0039 | 0.2749 | | | | |
| 13 | Sphagneticola trilobata | 0.0017 | 0.1198 | | | | |
| 14 | Acacia sp. | 0.0006 | 0.0422 | | | | |
|    | Total | 1.4186 | 100 | | Total | 1.823 | 100 |

Table 4. Results of the measurement of physics-chemical water parameters at station I and station II. Temperature and pH values are ideal conditions for growing mangroves themselves followed by a salinity value that almost reaches maximum.

| Parameter | I  | II | Average |
|-----------|----|----|---------|
| Temperature(°C) | 29 | 29 | 29 |
| pH | 7 | 7 | 7 |
| Salinity (‰) | 28 | 28 | 28 |

Parameter measurements are carried out in mangrove-surrounding waters at the research site. The measurement results in both stations obtained a temperature of 29°C and have the same PH value of 7. The result of salinity measurement in the waters of Tidung Kecil Island on both stations has an average value of 28‰.

4. Discussion
Based on the results obtained in table 1 for true mangrove groups (mangrove major) there are only species of *Rhizophora stylosa* that have a significant number of individuals and exceed half of all species found. While other species are included in the group of associated mangroves (mangrove
associations). The abundance of *Rhizophora stylosa* species are caused by the local community that planted the mangrove species, so that in addition to the large numbers, only true mangrove species of *Rhizophora stylosa* are found in sea-point transects. Indonesia, *Rhizophora stylosa* grows on sandy beaches, or even on rocky beaches [20]. Rhizophora generally grow in areas with soft substrates and have wide spread [6]. This causes Rhizophora to have a good form of adaptation to environmental conditions on Tidung Kecil Island. Bengen [14] added that the typical life cycle of Rhizophora with seeds that can germinate while still in the parent plant is very supportive of the extensive distribution process of this species in the mangrove ecosystem. In addition, in the associated mangrove groups, many species of *Pandanus* sp. both at station I and at station II. Pandan laut (*Pandanus* sp.) Adapts well in coastal areas with full sunlight [21]. Then one of these factors causes many species of *Pandanus* sp. around Tidung Kecil Island.

4.1 Diversity, dominancy and density indices

Diversity in both stations is low because of the dominant species in Tidung Kecil island such as *Rhizophora stylosa* and *Pandanus* sp. The value of diversity of a community relies heavily on the number of types and amounts Individuals found in the community. The diversity of a community will be high if the community is compiled by many types and no species is dominating. In contrast, a community has a low diversity type value, if the community is compiled by a few types and there are dominant species [22].

In addition, the Mangrove dominance index value in Tidung Kecil Island is said to be high, where there is a dominant species, *Rhizophora stylosa*, which has a dominance value of 1 at both stations. The many species of *Rhizophora stylosa* in Tidung Kecil Island can be caused by supporting environmental conditions, namely the condition of the substrate dominated by mud. That substrate can determine the life of a mangrove forest [23], the type of soft mud substrate is very suitable for the growth of mangrove forests that contain silt clay and also soft-textured organic material. Dahuri [7] said that mangroves can be found in coastal areas that are protected from the onslaught of waves with gently sloping areas. Smaller wave conditions and calmer currents cause the mangrove seeds to grow perfectly to drop their roots so that it also makes the *Rhizophora stylosa* species can dominate the area other than because of mangrove planting by visitors and surrounding communities.

The density of mangrove vegetation at stations I and II can be said to be high due to the number of trees in the region. *Rhizophora stylosa* species have the highest mangrove density in all categories. This condition can be caused because the species *Rhizophora stylosa* is a type of mangrove that growth is tolerant of environmental conditions. In addition, *Rhizophora stylosa* is in the condition of substrates containing organic material so it is suitable for the growth of its type. *Rhizophora stylosa* is also a pioneer plant or pioneer of it as it is with Parawansa [24], which states carrying the type of land relies heavily on pioneer plants demonstrated by the genus Rhizophora which is common characteristic for muddy soil mixed with organic material.

The physical and chemical parameters become one of the factors that can determine a growth of mangrove vegetation. The average gained in this study is a salinity value approaching the maximum salinity value to grow for mangroves on seawater salinity, as said by Smith [25] the maximum salinity value to grow can reach 35 o/oo, i.e. salinity value of sea water. Indeed the magnitude of the value of mangrove salinity in the sea water is higher than swamp water. Therefore, mangrove has several methods to obtain freshwater from seawater, by absorbing the salty water from the root and removing excess salt in the leaves by using salt excretion glands [26].

5. Conclusion

Based on the results of research on the structure of mangrove communities in Tidung Kecil Island, it can be concluded that there are 18 types of mangroves in Tidung Kecil Island, the study site area, which consists of one true mangrove type in the form of *Rhizophora stylosa* and 17 associated mangrove species as have been found. Diversity index values obtained at 1.54 at station I and 1.86 at station II, this value is included in the low category which can be said that the mangrove community
on Tidung Kecil Island is of little species and there are dominant species. This is evidenced by the results obtained in the dominance index, namely the presence of species that have a dominance value of 1 at stations I and II which state a high dominant concentration. The dominant species is *Rhizophora stylosa*. Both species density and relative density index obtained the highest value in *Rhizophora stylosa* mangrove species, with species density 1.418 ind / m² at station I and 1.823 ind / m² at station II, and relative density value (DR) of 92% at Station I and 95% at station II.

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