

Mangrove Plant Community Structure, Sungai Apung Village, Tanjung Balai Sub-District, Asahan District, North Sumatra Province

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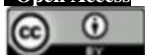
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Abstract

Mangroves are a type of vegetation found in tropical coastal areas. In general, mangrove vegetation thrives in sloping coastal areas or near river estuaries and beaches that are protected from waves. The physical function of mangrove forests is to keep the coastline stable, protect the coast from erosion, reduce storms and waves, and catch sediment, while the biological function of mangroves is as a spawning place or residence, shelter for shrimp, crabs, shellfish, and other animals. Research on Mangrove Plant Community Structure in the Kwala Indah Village Area was carried out in August–November 2023 with the aim of determining mangrove types, mangrove diversity and uniformity, dominance, the Important Value Index (INP), and mangrove canopy cover in Singai Apung Village. The method used to observe the community structure of mangrove plants is to use the quadrant transect method by analyzing species density, relative density, species frequency, relative frequency, species dominance, relative dominance, and important value index at the tree level. , saplings and seedlings, as well as canopy cover. Based on the research results, 10 species were found, namely *Avicennia alba*, *Avicennia lanata*, *Bruguiera cylindrica*, *Bruguiera sexangula*, *Excoecaria agallocha*, *Lumnitzera littorea*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba*, and *Xylocarpus granatum*. *Rhizophora mucronata*, which has INP, diversity in the medium category, and uniformity in the high category, has the highest dominance in *Rhizophora mucronata*. Canopy cover is in the dense category.

Keywords: Mangrove, Diversity, Uniformity, INP, Canopy

1. Introduction

1.1 Background

The area of mangroves on the east coast of North Sumatra is decreasing from year to year. According to Onrizal (2010), observations were made using remote sensing techniques in 4 different periods (1977, 1988/1989, 1997 and 2006). During 1977, 1988/1989, 1997 and 2006, mangroves continued to decline along the east coast of North Sumatra. Only 41,700 ha of mangroves remained in the area in 2006. The area of mangroves lost over 29 years was 59.68% of the initial area of 103,415 hectares in 1977. The main causes of change and damage to mangrove areas are excessive logging and conversion of mangroves into ponds and plantations. and agriculture.

The waters of Tanjung Balai Asahan are waters to the east of Sumatra Island. These waters are productive waters and receive fresh water input

from the Asahan River and other small rivers. Various forms of activity around the waters of Tanjung Balai Asahan have a direct impact on the water quality of Tanjung Balai Asahan.

Mangroves are a type of vegetation found in tropical coastal areas. In general, mangrove vegetation thrives in sloping coastal areas or near river estuaries and beaches that are protected from waves (Siahainenia *et al.*, 2014). The physical function of mangrove forests is to keep the coastline stable, protect the coast (abrasion), reduce storms and waves, catch sediment, while the biological function of mangroves is as a spawning place or residence, shelter for shrimp, crabs, shellfish and other animals.

Mangrove community structure is the quantitative arrangement or composition of mangrove vegetation such as number, type, density

and so on. The structure of the mangrove community can provide information about the condition of a coastal ecosystem and see how big a role mangroves play in maintaining coastal balance. In this regard, it can be seen that the mangrove ecosystem is very beneficial for coastal communities, especially the people of Sungai Apung Village. The study "Mangrove Plant Community Structure in Sungai Apung Village, Tanjung Balai District, Asahan Regency" is very important because the mangrove ecosystem is very important for coastal communities.

2. Research Methods

This research was conducted in Sungai Apung Village, Tanjung Balai District, Asahan Regency in September 2023. The method used was a quadrant transect where there are 5 stations and each station has 3 substations. The plot area used is 20 m x 20 m. The data taken for each plot is the type of mangrove and the circumference of the tree trunk.

2.1 Data Analysis

Diversity is determined using the diversity formula according to Shannon-Wiener (1984) in Bengen (2000) as follows:

$$H' = - \sum_{i=1}^n p_i \ln p_i$$

Information:

H' = Diversity Index

Pi = $\sum ni/N$

ni = number of individuals of Type i

N = total number of individuals

The diversity index (H') consists of some 3 Shannon-Wiener criteria (Martuti, 2013), namely:

H' > 3.0 = indicates high diversity, low ecological stress

1 ≤ H' ≤ 3 = indicates moderate diversity, low ecological stress

H' < 1 = indicates low security, low ecological stress

Uniformity index (E) type can use the formula. Evenness index of Shannon index of Diversity as follows:

$$E = \frac{H'}{\ln S}$$

Description:

E = Uniformity Index

H' = Diversity Index

S = number of species

Uniformity index values are grouped in three criteria, namely:

E < 0.4 = small population uniformity rate

0.4 < E < 0.6 = medium degree of population uniformity

E > 0.6 = large population uniformity rate

Type density (Di) is the number of i-type stands in a unit area (Bengen, 2000). Determination of density types through the formula:

$$D_i = \frac{N_i}{A}$$

Information:

Di = Density of type i

Ni = Total number of i-th individuals

A = Total sampling area (m²)

Relative density (RDi) is the number of comparisons between the number of stands of the 1st type with the total stands of all types (Bengen, 2000). Determination of relative density (RDi) using the formula:

$$RD_i = \frac{N_i}{\sum n} \times 100\%$$

Information:

RDi = Relative Density

N = Number of Individuals

∑n = Total stands of all types

Type frequency (Fi) is the chance of finding a type i in all sample plots compared to the total number of sample plots made (Bengen, 2000), to calculate the type frequency (Fi) used the formula:

$$F_i = \frac{p_i}{\sum p}$$

Information:

Fi = frequency of the i-th type

Pi = number of sample plots where Type I is found

∑p = total number of sample plots created.

Relative frequency (RFi) is a comparison between the frequency of the type i with the number of frequencies of all types (Bengen, 2000). To calculate the relative frequency using the formula:

$$RF_i = \frac{F_i}{\sum F} \times 100\%$$

Information:

RFi = relative frequency

Fi = frequency of the i-th type

∑F = number of frequencies of all types

The dominance of a Type (D) (m² /Ha) shows the amount of control of space in an ecosystem. D is only calculated for the category tree formula as follows:

$$D = \frac{\text{Area of Base Field of a type } (\frac{1}{4} \pi d^2)}{\text{Tile Area example}}$$

Relative dominance (DR) (%).

$$DR = \frac{\text{Dominance of a Breed}}{\text{Dominance of All Types}} \times 100\%$$

Important Value Index (INP) mangrove vegetation description was analyzed by calculating the influence value (K), relative influence (KR), frequency (F), relative frequency (FR), dominance (D), relative dominance (DR), and influence Value Index (INP) (Odum, 1993).

$$INP = RD_i + RFi + DR(\text{tree})$$

Canopy cover, data collection is done using the front mobile phone camera directed perpendicular to the sky. The number of photographs taken is determined based on the condition of the mangrove forest. The shooting point should be between the trees. Things to avoid are shooting next to tree trunks, taking multiple photos, and avoid photos from sunlight. Point and number of photos taken based on the condition of the Mangrove forest using the ImageJ application. The concept of this analysis is the separation of the pixel color of the sky (white) and the pixel color of mangrove vegetation (black).

The location map is found in (Figure 1) below :

According to The Minister Of Environment No. 201 of 2004 the value of the mangrove canopy cover is categorized into 3, namely; rare (< 50%), medium (50-75%), and dense ($\geq 75\%$). Canopy cover analysis is done by calculating the percentage of the number of pixels of mangrove vegetation cover in biner image analysis with the formula (Dharmawan and Pramudji, 2014):

$$\% \text{ Kanopi} = \frac{p255}{\Sigma P} \times 100\%$$

Information:

P255 = the number of pixels that are worth 255 as

interpretation of mangrove canopy cover

P = number of pixels

The location map is found in (Figure 1) below:

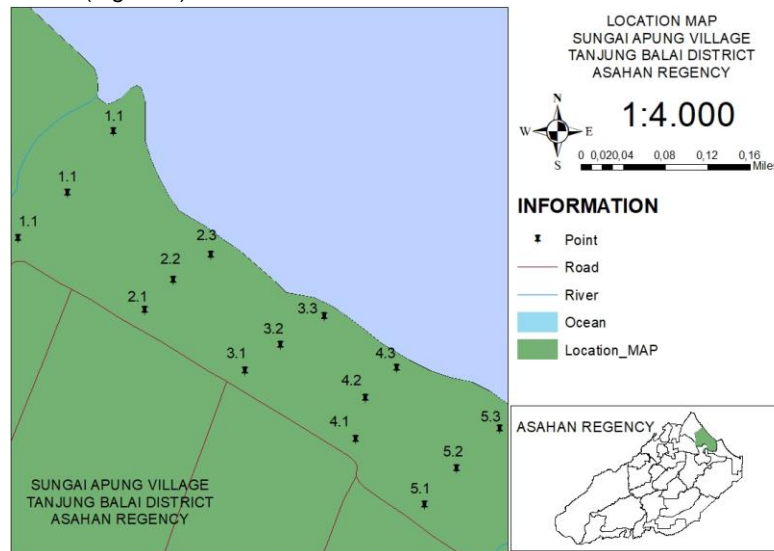


Figure. 1. Map of the study area

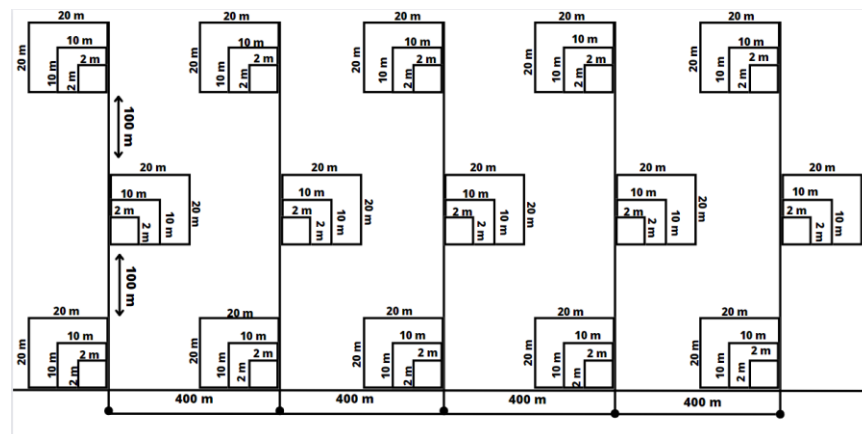


Figure 2. Mangrove Sampling Plot

In (Figure 2) above it is explained that each substation is 100 m away and the station is 400 m away. However, this can change if the terrain of the research location does not allow it.

3. Results and Discussion

3.1 Identification of Mangroves

Based on observations in Sungai Apung Village, Tanjung Balai District, Asahan District, North Sumatra Province. There are 10 types of mangroves in this village, namely *Avicennia alba*, *Avicennia lanata*, *Bruguiera cylindrica*, *Bruguiera sexangula*, *Excoecaria agallocha*, *Lumnitzera littorea*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba* and *Xylocarpus granatum*. The total number of individuals found was 186 trees. Based on the results of observations, the type most frequently found is *Rhizophora mucronata*, this is because the harder soil substrate which is rich in humus is the habitat of *Rhizophora mucronata* and the *Avecennia alba* type is a type that is rarely encountered because the condition of the substrate at the research location is muddy soil. a little hard, the substrate conditions are not the preferred habitat for *Avecennia alba*. The substrate that *Avecennia alba* prefers is sandy mud substrate. (Onrizal & Kusmana, 2004) stated that *Rhizophora mucronata* grows well on slightly hard muddy soil rich in humus, while *Avicennia* likes a mixed substrate of mud and sand.

3.2 Mangrove diversity and uniformity index

Based on the results of data processing on mangrove tree levels obtained in Sungai Apung Village based on Table 2, a diversity value (H') of 1.7636 was obtained, which indicates a medium level of diversity. Uniformity value (E) 0.7659 shows that at a large level of uniformity, the diversity value consists of the 10 types found.

Diversity in the medium category is influenced by the adaptability of mangroves, such as substrate conditions, ecosystem conditions, nutrient availability, selection of appropriate mangrove species, and community participation in the rehabilitation process which greatly influence the distribution of mangrove species. This agrees with Indriyanto (2006) that species diversity can also be used to measure community stability, namely the ability of a community to maintain itself stable. The diversity values obtained show that there are variations between stations, this is because the composition and number of species found at each location are different. Other factors influencing the diversity of mangrove species and growth are the supply of fresh water from rivers that empty into the sea, the suitability of the habitat for climate and geographical conditions. The diversity value of a community is influenced by the number of species and the number of individuals found in the community. This can illustrate that the mangrove area is quite stable with the support of vegetation growing in the area, so that the existence of this area will be more stable and can make the mangrove ecosystem play a good role.

This uniformity value shows that the uniformity index value ≥ 0.6 is large. The cause of the large uniformity is because the number of individuals does not differ much or many are the same, meaning there is no dominant species. The high uniformity index value obtained indicates that the sustainability of the mangrove species in the research location has the opportunity to survive. According to Mawazin and Subiakto (2013), a species with a high level of balance has a greater chance of maintaining the sustainability of its species. This agrees with (Fitria *et al.*, 2019). The uniformity index value in these waters is close to 1, meaning that the distribution is even or the number of individuals is relatively the same for each species so that these waters are classified as having high uniformity. This opinion is also reinforced by the statement of Simatupang *et al.*, (2015) that high uniformity indicates that the mangrove plants are in good (stable) condition.

3.3 Tree Dominance and INP

From the results of observations and data processing obtained in the research area, it is known that the species that dominates the entire research location, from Table 4 it can be seen that the highest overall dominance value is *Rhizophora mucronata* with a value of 64.35%. The lowest value was *Avecenia lanata* at 1.10%. This is due to differences in the number and size of stem rings in the *Rhizophora mucronata* species, where dominance is influenced by the overall value of the stem rings that dominate the space of a plot or ecosystem area.

The high dominance of the *Rhizophora mucronata* species at each station is because in several plots this type of mangrove is always found in large diameters ranging from the smallest diameter with a value of 31 cm to the largest diameter with a diameter of 89 cm, and in this area it is a rehabilitation area for the *Rhizophora* sp type mangrove. Apart from that, the humus-rich soil substrate is the natural habitat of the *Rhizophora mucronata* species. This agrees with (Halidah, 2010) that in general this type grows in areas close to or on tidal river embankments with soil conditions that are rich in humus but has more tolerance for harder substrates and sand. This type is also often chosen as a rehabilitation plant in various regions because of its abundant seed availability, easy growth and high distribution rate. According to (Naohiro *et al.*, 2012) *Rhizophora mucronata* has high adaptability and function to protect against abrasion and sea waves. After several rehabilitation efforts, many saplings of this species began to stick to the ground and grow.

The Importance Value Index (INP) of Mangrove trees in the Apung River in all locations according to Table 3, the highest value is *Rhizophora mucronata* worth 113.24%. The lowest value was *Avecennia lanata*, namely 4.19%. This shows that the *Rhizophora mucronata* species has an important role in the coastal mangrove ecosystem of Sungai Apung Village. The important value index above can be seen as an illustration of how important the type of mangrove that dominates

an ecosystem location is. INP (Critical Value Index) is a quantitative parameter that can be used to state the level of dominance of a species in a mangrove community. Furthermore, the Important Value Index (INP) reflects the role (dominance) and structure of mangrove vegetation at a location.

The low dominance value of the *Sonneratia alba* species is because the research location has a soil substrate that is slightly muddy. The substrate conditions are not the preferred substrate for *Sonneratia alba*, which causes the low dominance value of the *Sonneratia alba* species, whereas in general *Sonneratia alba* lives in sand and sand substrate conditions. mud with rocks. This agrees Ontorael *et al.*, 2012). *Sonneratia alba* is a type of mangrove that can grow in areas of sand and mud, high salinity, but still in areas affected by tides. *Sonneratia alba* can usually be found in the areas closest to the sea.

3.4 Canopy Cover

The percentage of mangrove canopy cover in Sungai Apung Village ranges from 66.37% -

79.46%. The highest percentage of canopy cover was at station 3 and the lowest at station 2. According to the Minister of Environment No. 201 of 2004 the value of mangrove canopy cover was determined to be 3, namely; rare (< 50%), moderate (50 - 75%), and solid ($\geq 75\%$). The percentage of mangroves obtained at stations 1, 3, 4 and 5 were in the high category and at station 2 in the medium category. Most of the study area consists of stations that have dense mangrove canopy cover, which has a higher percentage because it is inhabited by *Rhizophora* sp. which is known as a broadleaf mangrove so it has a high chance of having higher cover with the same density (Noor, 2014; Syukri *et al.*, 2018). *Rhizophora* sp has a unique branching structure, namely tiered and short, this causes the distance between leaves to be narrower. As a result, canopy cover becomes of higher value (Purnama *et al.*, 2020). It has also been stated that the area of leaf overlap influences canopy cover, where the wider the leaf overlap, the denser the canopy cover, and vice versa (Pretzsch *et al.*, 2015; Syukri *et al.*, 2018; Purnama *et al.*, 2020).

Table 1. Percentage of mangrove species

No	Species	Sum	Percentage (%)
1	<i>Avicennia alba</i>	2	1,08
2	<i>Avicennia lanata</i>	3	1,61
3	<i>Bruguiera cylindrical</i>	8	4,30
4	<i>Bruguiera sexangula</i>	26	13,98
5	<i>Excoearia agallocha</i>	6	3,23
6	<i>Lumnitzera littorea</i>	17	9,14
7	<i>Rhizophora apiculata</i>	24	12,90
8	<i>Rhizophora mucronata</i>	82	44,09
9	<i>Sonneratia alba</i>	5	2,69
10	<i>Xylocarpus granatum</i>	13	6,99
	Sum	186	100

Table 2. The results of data processing H' , and E overall tree

Species	Sum	Pi	Ln Pi	H'	E
<i>Avicennia alba</i>	2	0,01075	-4,5326	0,04874	
<i>Avicennia lanata</i>	3	0,01613	-4,1271	0,06657	
<i>Bruguiera cylindrical</i>	8	0,04301	-3,1463	0,13532	
<i>Bruguiera sexangula</i>	26	0,13978	-1,9677	0,27505	0,76592
<i>Excoearia agallocha</i>	6	0,03226	-3,434	0,11077	
<i>Lumnitzera littorea</i>	17	0,0914	-2,3925	0,21867	
<i>Rhizophora apiculata</i>	24	0,12903	-2,0477	0,26422	

<i>Rhizophora mucronata</i>	82	0,44086	-0,819	0,36108
<i>Sonneratia alba</i>	5	0,02688	-3,6163	0,09721
<i>Xylocarpus granatum</i>	13	0,06989	-2,6608	0,18597
Sum	186	1	-28,744	1,7636

Table 3. Dominance Value and INP

Mangrove Species	JuNumber Of Species	Number Of Plots	Di (ind/m ²)	RDi (%)	Di (Ind/ha)	Fi	Rfi (%)	D	DR (%)	INP (%)
<i>Avicennia alba</i>	2	2	0,0003	1,08	310	0,133	3,57	1,12	0,80	5,45
<i>Avicennia lanata</i>	3	1	0,0005	1,61		0,067	1,79	1,10	0,79	4,19
<i>Bruguiera cylindrica</i>	8	5	0,0013	4,30		0,333	8,93	5,13	3,66	16,89
<i>Bruguiera sexangula</i>	26	10	0,0043	13,98		0,667	17,86	11,21	8,00	39,84
<i>Excoecaria agallocha</i>	6	2	0,001	3,23		0,133	3,57	4,44	3,17	9,97
<i>Lumnitzera littorea</i>	17	5	0,003	9,14		0,333	8,93	10,98	7,84	25,91
<i>Rhizophora apiculata</i>	24	8	0,004	12,90		0,533	14,29	26,47	18,90	46,09
<i>Rhizophora mucronata</i>	82	13	0,0137	44,09		0,867	23,21	64,35	45,94	113,24
<i>Sonneratia alba</i>	5	3	0,0008	2,69		0,2	5,36	2,99	2,13	10,18
<i>Xylocarpus granatum</i>	13	7	0,0022	6,99		0,467	12,5	12,28	8,77	28,26
Sum	186	15	0,031	100		3,733	100	140	100	300

Table 4. Overall Canopy Cover Data Processing Results

No	Station	Canopy Cover %	Average
1	1	73,70	75,22
2	2	69,37	
3	3	79,46	
4	4	75,79	
5	5	77,78	

4. Conclusion

Based on the results of research in the Sungai Apung Village area, Tanjung Balai District, Asahan Regency, it can be concluded that:

10 types of mangroves were found, namely *Avicennia alba*, *Avicennia lanata*, *Bruguiera cylindrica*, *Bruguiera sexangula*, *Excoecaria agallocha*, *Lumnitzera littorea*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba* and *Xylocarpus granatum*

Diversity and uniformity index of mangroves in Sungai Apung village on trees with H' 1.76 and E 0.76

The most dominant type of mangrove in Sungai Apung Village is the *Rhizophora mucronata* type with a value of 64.35.

Community structure of mangrove plants in Sungai Apung Village with the highest INP value of 113.23 for the *Rhizophora mucronata* type.

Canopy cover in Sungai Apung Village is in the dense category with an average value of 75.22%

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