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Mangrove Community Structure in Pematang Sei Baru Village, Tanjung Balai District, Asahan Regency

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Abstract

Coastal and marine areas are an integrated ecosystem and are interconnected with each other, so they have a mutual correlation. In a coastal ecosystem, there is an exchange of matter and energy that takes place in the system and with other external system components. Based on the importance of the role of mangrove ecosystems in a body of water and the lack of information about the structure of mangrove communities in Pematang Sei Baru Village, Tanjung Balai District, Asahan Regency, North Sumatra, this research is important to be carried out to determine the condition of mangrove ecosystems and can provide understanding to the community about the importance of ecosystems for coastal areas. The data analysis used in this study is both descriptive and quantitative. The data analysis used includes diversity and uniformity index, dominance, mangrove community structure, and canopy cover. The highest diversity in trees is found at station 3, with a value of 2.20, and the lowest, with a value of 2.12, at station 2. The highest uniformity in trees is found at station 2, with a value of 0.96, and the lowest at station 5, with a value of 0.93. The highest dominance value was in *Rhizophora mucronata* with a value of 15.75%, *Xylocarpus granatum* with a value of 11.51%, and *Bruguiera cylindrical* type with a value of 10.73%. 1 highest INP value is the type of *Rhizophora mucronata* with a value of 55.79% and canopy cover in the medium category. Based on the results of observations made at the location of this study, there are many remnants of logging carried out by the surrounding community, which, if left unchecked, will lead to reduced land, which will greatly affect the ecosystem in it. Therefore, the role of the government is expected in conducting supervision in this area.

Keywords: Mangrove, Diversity, Uniformity, Dominance, INP

1. Introduction

Coastal and marine areas are an integrated ecosystem and are interconnected with each other, so they have a mutual correlation. Within a coastal ecosystem, there is an exchange of matter and energy that takes place within the system as well as with other components of the external system. The mangrove forest ecosystem is one of the ecosystems that has high productivity compared to other ecosystems with high decomposition of organic matter, making it a very important ecological link for the life of living things in the surrounding waters. Organic matter makes mangrove forests a place of food sources and nurturing places for various biota such as fish, shrimp, and crabs. Fish and shrimp production in marine waters is highly dependent on litter production produced by mangrove forests. Various groups of economical mollusks are also often associated with the plants that make up mangrove forests. Imran (2016). Exploitation of mangrove areas has the potential to reduce the diversity of plant species that have the main role and function ecologically and have the potential to be utilized socioeconomically (Martuti, 2018).

The interaction between mangrove forest vegetation and the aquatic environment makes this ecosystem have important ecological and economic functions for coastal areas (Alongi *et al*., 2016). Mangrove forests become habitats, feeding grounds and nursery grounds for various types of fish, shrimp and crabs. In addition, with high organic matter content, mangrove forests play an important role in the food chain in aquatic and coastal

environments (Harefa *et al*., 2022). Through its root system. Strong and extensive, mangrove forests function to protect coastlines from abrasion and even able to withstand the threat of tsunami waves. Mangrove forests also play an important element in minimizing the impact of climate change and global warming. The ability of mangrove forests to absorb carbon dioxide (CO_2) and release oxygen (O_2) is better than other types of terrestrial forests (Shiau &; Chiu, 2020). Mangrove vegetation adapted to an an-aerobic environment results in the ability to store carbon for a long period of time. Furthermore, carbon stocks in mangrove forests are more distributed in plant biomass and only about 11% of carbon is stored in sediments (Li *et al.*, 2018).

Based on the importance of the role of mangrove ecosystems in a body of water and the lack of information about the structure of mangrove communities in Pematang Sei Baru Village, Tanjung Balai District, Asahan Regency, North Sumatra, this research is important to be carried out to determine the condition of mangrove ecosystems, and can provide understanding to the community about the importance of ecosystems for coastal areas.

2. Method

Based on the importance of the role of mangrove ecosystems in a body of water and the lack of information about the structure of mangrove communities in Pematang Sei Baru Village, this research district will be carried out in Pematang Sungai Baru Village, Tanjung Balai District, Asahan Regency, North Sumatra in September 2023. Where mangrove data collection is carried out at 5 different stations, with each station there are 3 sub-stations. Plots measuring 20m x 20m were carried out to observe trees or stands then plots measuring 10m x 10m were used for observing saplings/stakes, and plots of 2m x 2m were used to calculate the number of seedlings.

2.1 Data Analysis

The data analysis used in this study was descriptive and quantitative. The descriptive method is a method used to make a picture of the situation or event studied at a limited time and a certain place (Hadi, 1979). The variables that will be calculated in retrieving field data are as follows:

1. Diversity Index

The Shannon-Wiener diversity index is used to determine the level of diversity of jens in each growth (Odum, 1993) with the following formula:

$H' = -\sum_{i=1}^{s} \text{pi Ln pi}$, where pi=ni/N

Information:

H' = Diversity Index
N = Total number of individuals
Ni = Number of individuals of i-th type

2. Uniformity index

The uniformity index is used to determine the balance of the community, which is a measure of the similarity in the number of individuals between species in a community, The more similar the number of individuals between species (the more evenly distributed) the greater the degree of balance.

Uniformity is calculated using the Eveness Index formula (Magurran 1988), namely:

$$E = \frac{H'}{LnS}$$

Description:

E = Uniformity Index
H' = Diversity Index
LnS = 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 poppulation uniformity

E > 0.6 = large population uniformity rate

3. Density

The number of species per unit area is known as density (English *et al*., 1994).

$$Di = \frac{Ni}{A}$$

Information:

Di = Density of type i
Ni =Total number of i-th individuals
A =Total sampling area (m2)

4. Relative density

The comparison of the number of stands of all species to the number of stands of a species is called relative density (RDi) (English *et al*., 1994).

$$RDi = \frac{Ni}{\sum n} \times 100\%$$

Information:

RDi = Relative Density

N = Number of Individuals

∑n = Total stands of all types

5. Frequency

Frequency (Fi) is the probability that the i-th species will appear in all sample plots created (English *et al.,* 1994).

$$Fi = \frac{pi}{\sum p}$$

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.

6. Relative frequency

The ratio of the frequency of a species to the sum of the frequencies of all species is known as relative frequency (RFi) (English *et al.,* 1994).

$$RFi = \frac{Fi}{\sum F} \times 100\%$$

Information:

RFi = relative frequency
Fi = frequency of the i-th type
∑F = number of frequencies of all types

7. Dominance

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

8. Relative dominance (DR) (%).

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

9. Important Value Index (INP

The dominance of a vegetation type is assessed using the Important Value Index (INP). The following calculation yields the Importance Value Index: For seedling and stake levels, INP = RDi + RFi For the tree level, INP = RDi + RFi +DR.

The location of the data collection can be seen in (Figure 1).

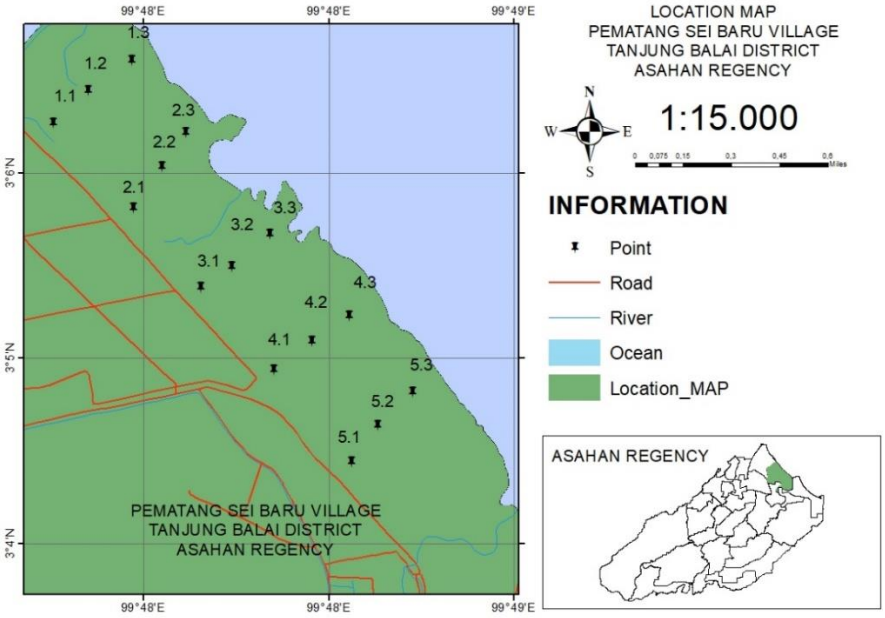

Figure 1. Research Location

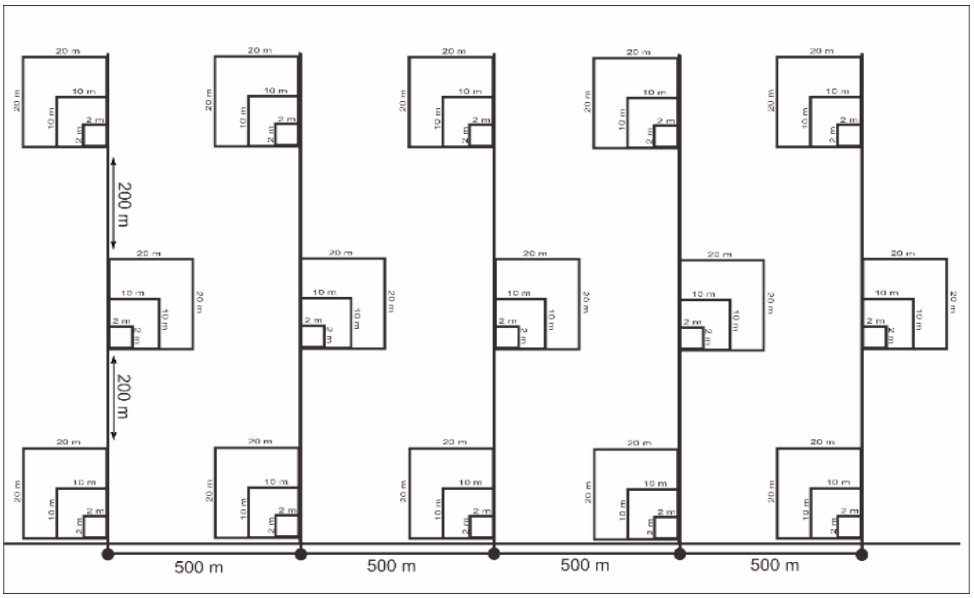

Figure 2. Mangrove Sampling Plot

Each observation station consists of three substations, with areas along the transect line stretching from the sea boundary of mangrove growth to the land boundary where mangroves are still growing. The distance between stations and substations is determined based on differences in vegetation structure. Plots measuring 20m x 20m were carried out to observe trees or stands, and then plots measuring 10m x 10m were used for observing. saplings and stakes, and plots measuring 2m x 2m were used to calculate the number of seedlings.

3. Results and Discussion

3.1. Mangrove Identification Results

Based on the results of observations made, there are 10 types of mangroves found, namely, *Avicennia lanata, Bruguiera cylindrical, Bruguiera sexangula, Ceriops tagal, Excoecaria agallocha, Lumnitzera littorea, Rhizophora apiculate, Rhizophora mucronata, Rhizophora stylosa, Xylocarpus granatum*. The total number of individuals found was 195 trees. Based on observations, the most commonly found species are, *Bruguiera cylindrical* with a percentage of 16.9% and the type of *Rhizophora mucronata* with a percentage of 16.4%.

The high percentage value is caused by several factors. The type of *Bruguiera cylindrical* is influenced by environmental conditions, where substrate conditions in more muddy and sandy locations make this type grow and adapt to the environment. This agrees with Rizki *et al .,* (2015), who said that *Bruguiera cylindrical* plants can be found in areas that have muddy and sandy substrates. In addition, the morphological characteristics that live in the middle layer of the ecosystem after the frontmost layer are overgrown by more resistant types with higher salinity. This agrees with Badu *et al.,* (2022), who stated that *Bruguiera cylindrical* species usually group and grow in the middle zone of mangrove vegetation towards the sea.

3.2. Diversity and Uniformity Index

Based on the results of mangrove observations in Pematang Sei Baru Village, the diversity index value at each station was obtained that is, at station 1 it was 2.15, at station 2 it was 2.12, at station 3 it was 2.20, at station 4 it was 2.17 and at station 5 it was 2.14. Based on the assessment criteria of the diversity index at each observation station, it can be concluded that all observation stations fall into the medium category (1<H'<3). This shows that the condition of the ecosystem is still stable. This is in accordance with the opinion of Suwardi *et al*., 2013, who stated that the value of the diversity index included in the medium category shows that the mangrove ecosystem has sufficient productivity, ecosystem conditions are still stable and ecological pressure is moderate.

Factors that affect the value of diversity at this research location are human activities where, illegal logging carried out by the community can be one of the factors that influence the level of diversity. This is in line with the opinion of Wanaputra, *et al*., 2019, the high and low diversity of a species in an area is vulnerable to disruption of composition changes either due to environmental factors or factors that arise due to human activities. Over time this mangrove vegetation will lead to homogeneous conditions. According to the uterus. Rahim *et al*., 2019 Moderate species diversity in an ecosystem is influenced by the presence of species components found and changes in vegetation caused by humans. Meanwhile, in the opinion of Soerianegara (1972), stated that species diversity is caused by continuous changes in vegetation supported by the presence of nutrients, light and water obtained by vegetation.

The value of the uniformity index in the tree category at each observation station is obtained that is, at station 1 it is 0.94, at station 2 it is 0.96, at station 3 it is 0.95, at station 4 it is 0.94, and at station 5 it is 0.93. Based on the assessment criteria, the uniformity index at each station has a high diversity value, in accordance with the uniformity index value of ≥ 0.6 is included in the high category. This shows that the number of individuals at the study site is evenly distributed. This shows that the species present at each research station tend to have uniformity, meaning that no particular species dominates a station. This is in line with Rahadyan's (2005) opinion in (Rosalina. D., *et al*. 2021), which states that uniformity in a high community reflects that the total wealth between individuals is relatively even, and vice versa if uniformity in low communities reflects that the amount of wealth between individuals is very different. According to Insafitri (2010), mangrove uniformity is very dependent on the number of species in the community, the more the number of the same species will cause higher uniformity.

3.3. Mangrove Dominance

Observation and calculation of mangrove dominance is only carried out at the tree level. Based on the calculation of the dominance level of mangroves in Pematang Sei Baru Village, it was found that the most dominating species were the type of *Rhizophora mucronata* with a value of 15.75%, *Xylocarpus granatum* with a value of 11.51%, and the type of *Bruguiera cylindrical* with a value of 10.73%. The high value of type dominance of the three types, because the type has a larger average diameter compared to other types, this is in agreement with the statement of Gufran and Kordi (2012) who said that the value of type dominance is closely related to the circumference of the stem.

The high dominance of *Xylocarpus granatum* because this type has an average diameter that is larger than other types in accordance with the opinion of Gufran and Kordi (2012) who said that the value of type dominance is closely related to the circumference of the trunk. Hotden *et al.,* (2014) added that the larger size of the tree will make its dominance wider and will be able to compete well for nutrients in the ecosystem.

3.4. Mangrove Community Structure

It can be seen that the highest overall INP value is found in the type of *Bruguiera cylindrical* with a value of 49.45% and the type of *Rhizophora mucronata* with a value of 47.87%, this shows that this type has the most important role in the mangrove ecosystem in Pematang Sei Baru Village, this is in line with Paruntu *et al*., 2017 stated that the important value index shows the degree of importance or absence of a species in high density, high presence and high cover of a species in a study area. The higher

the importance index, indicating that the species is more successful in occupying the area than other species.

The high INP value of *Rhizophora mucronata* is supported by environmental conditions in the front zone of the research site, where the softer and muddy substrate conditions cause this type to grow well, this is in line with the opinion of Supardjo (2008) in (Rahayu *et al.,* 2018) explained that Rhizophora sp is a pioneer vegetation type and can grow on soft mud. This condition is caused by the spread of *Rhizophora sp* which is influenced by the tides that help the spread of floating seeds to various places and seeds rooted at the ends and can tether themselves to mud at low tide, then grow upright.

The type of *Bruguiera cylindrical* is found at almost all stations, this is due to the flow of water that will be flooded at high tide where the fruit of *Bruguiera cylindrical* is very light and easily covered so that it is likely to spread through the water flow, this is in accordance with the opinion of Onrizal (2012) who said that the type of *Bruguiera cylindrical* has a hypocotyledonous that is very light and floats so that its distribution can be assisted by water. In addition, the supporting factor of the high INP value in this type is influenced by environmental conditions where, substrate conditions in more muddy and sandy locations make this type able to grow and adapt to the environment, this is in agreement with Rizki *et al* ., 2015 who said that *Bruguiera cylindrical* plants can be found in areas that have muddy and sandy substrates. Darmadi *et al*., 2012 added, the high value of INP Bruguiera cylindrical because this type lives in accordance with the zoning of substrate characters that support the growth of *Bruguiera cylindrical* species, besides that the type of *Bruguiera cylindrical* has the ability to grow on newly formed substrate types.

Table 1. Mangrove Identification Results

No	Species
1	*Avicennia lanata*
2	*Bruguiera cylindrica*
3	*Bruguiera sexangula*
4	*Ceriops tagal*
5	*Excoecaria agallocha*
6	*Lumnitzera littorea*
7	*Rhizophora apiculata*
8	*Rhizophora mucronata*
9	*Rhizophora stylosa*
10	*Xylocarpus granatum*

Table 2. Mangrove Dominance

No	Types of Mangroves	Dominance
1	*Avicennia lanata*	3.69
2	*Bruguiera cylindrical*	10.73
3	*Bruguiera sexangula*	7.31
4	*Ceriops tagal*	2.83
5	*Excoecaria agallocha*	2.86
6	*Lumnitzera littorea*	2.89
7	*Rhizophora apiculate*	9.25
8	*Rhizophora mucronata*	15.75
9	*Rhizophora stylosa*	7.94
10	*Xylocarpus granatum*	11.51

Table 3. Diversity and Uniformity Index

Station	Diversity (H')	Uniformity (E)
1	2.15	0.94
2	2.12	0.96
3	2.2	0.95
4	2.17	0.94
5	2.14	0.93

Table 4. Overall tree mangrove community structure

Types of Mangroves	Number of Species	Number of Plots	Di (ind/m²)	RDi (%)	Di (Ind/ha)	Fi	RFi (%)	D	DR (%)	INP (%)
Avicennia lanata	13	5	0.002	6.67		0.33	6.49	3.69	4.94	18.10
Bruguiera cylindrica	33	14	0.006	16.92		0.93	18.18	10.73	14.35	49.45
Bruguiera sexangula	27	9	0.005	13.85		0.60	11.69	7.31	9.77	35.31
Ceriops tagal	9	4	0.002	4.62		0.27	5.19	2.83	3.79	13.60
Excoecaria agallocha	13	8	0.002	6.67		0.53	10.39	2.86	3.83	20.89
Lumnitzera littorea	11	6	0.002	5.64	117	0.40	7.79	2.89	3.86	17.29
Rhizophora apiculata	21	7	0.004	10.77		0.47	9.09	9.25	12.37	32.23
Rhizophora mucronata	32	8	0.005	16.41		0.53	10.39	15.75	21.07	47.87
Rhizophora stylosa	16	5	0.003	8.21		0.33	6.49	7.94	10.62	25.32
Xylocarpus granatum	20	11	0.003	10.26		0.73	14.29	11.51	15.39	39.94
TOTAL	**195**	**15**	**0.0325**	**100**		**5.13**	**100**	**74.7678284**	**100**	**300**

4. Conclusion

Based on the results of observations made, there are 10 types of mangroves found, namely, *Avicennia lanata, Bruguiera cylindrical, Bruguiera sexangula, Ceriops tagal, Excoecaria agallocha, Lumnitzera littorea, Rhizophora apiculate, Rhizophora mucronata, Rhizophora stylosa, Xylocarpus granatum.*

Pematang Sei Baru Village obtained a diversity index value ranging from 2.12 – 2.20 included in the medium category. The uniformity index value in the tree category ranges from 0.93 – 0.96 included in the high category. Based on the calculation of the dominance level of mangroves in Pematang Sei Baru Village, it was found that the most dominating species were the type of *Rhizophora mucronata* with a value of 15.75%, *Xylocarpus granatum* with a value of 11.51%, and the type of *Bruguiera cylindrical* with a value of 10.73%. The structure of the mangrove community in Pematang Sei Baru Village shows that the *Bruguiera cylindrical* species with an INP value of 49.45% and the *Rhizophora mucronata* type with a value of 47.87% have the most important role, this is because this type has the highest INP value of other types.

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