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Analysis of organic matters in sediment and mangrove density in mangrove conservation area of Mamburungan Village, Tarakan, Indonesia

Imra Imra[1,a,*], Minawati Minawati[1,b], Abdul Jabarsyah[1,b]

[1a]Fisheries Product Technology, Faculty of Marine Science and Fisheries, University of Borneo Tarakan, Indonesia.
[1b]Aquatics Resource Management, Faculty of Marine Science and Fisheries, University of Borneo Tarakan, Indonesia.
[a]imranmomo@gmail.com
[*]Corresponding author

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ABSTRACT

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The mangrove ecosystem in Mamburungan Village is known to have two dominant types of mangroves, namely *Avicennia sp*. and *Sonneratia sp*. The main factors that cause mangrove growth zoning are the type of substrate and the content of organic matter. This research was conducted through several stages, namely, determining the location, preparing tools and materials, taking sediment, and analyzing mangrove data. The highest organic matter content was found at station I of 2.53 % - 17.81 %, and the highest mangrove density ranged from 0.05 ind m^{-2} - 0.12 ind m^{-2} which was dominated by *Avicennia sp.* More organic matter content was found at a depth of 0 cm.

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1. Introduction

Tarakan City is an area in the province of North Kalimantan which is located at 30 14'23"-3 0 26'37" north latitude and 1170 30'50"-1170 40'12" east longitude. The area of Tarakan City reaches 657.33 km^2, consisting of a land area of 250.80 km^2 and an ocean area of 406.53 km^2 (BPS Tarakan, 2018). Tarakan City has various potentials, one of which is in the field of tourism, namely beaches, historic buildings, museums, and mangrove forests. Mangrove forest is a tourist attraction that is often visited by local and international communities. One of the mangrove forest areas that are used as tourist attractions is located in the Mamburungan Village, East Tarakan District. The mangrove ecosystem in Mamburungan Village is a conservation forest that has been established by the Tarakan City government since 2006. The area of the Mamburungan Mangrove is 203.00 Ha (BPS Tarakan, 2015). The mangrove ecosystem of Mamburungan Village is known to have three types of mangrove plants, but there are two dominant types of mangroves, namely *Avicennia sp*. and *Sonneratia sp*. (Wiharyanto et al., 2010). Various types of biota that live in this area include fish, shrimp, crabs, mollusks, and others.

Figure 1. Mamburungan mangrove conservation area, Tarakan City

Mangrove forest as an ecosystem typical of tropical coastal areas, has a strategic function as a connector and balancer for land and sea ecosystems. Plants, animals and various nutrients are transferred to land or sea through mangroves. Ecologically, mangroves act as a spawning ground, nursery ground and as a feeding ground for various types of fish, shellfish and other species. Another function of the mangrove ecosystem is to prevent coastal abrasion and as a catcher of organic matter found in waters and settles in sediments at certain depths. Mangrove plants generally grow in zoning from the coast to the mainland (Bengen, 2001).

The main factors that cause the zoning of mangrove growth are the type of substrate and the content of sediment organic matter in the mangrove species. Mangrove species that grow with high density from one place to another have different values of organic matter content (Simanjuntak et al. 2018). Sediment is a place where organic matter accumulates, both decomposed and not decomposed. Some of the most common organic materials found in mangrove forest areas include Nitrogen (N), Phosphorus (P), Potassium (K), Iron (Fe), and Magnesium (Mg). According to Nugroho et al. (2013) organic matter plays a very important role for microorganisms in the soil, namely as an increase in the development of metabolic microorganisms in the soil. Organic matter also greatly affects the productivity of mangrove plants, so it is necessary to do research on the content of organic matter in sediments in the mangrove forest conservation area, Mamburungan Village, Tarakan City. The purpose of this study was to determine the value of organic matter content in sediments in the Mangrove Conservation Area, Mamburungan Village, Tarakan City.

2. Material and methods

2.1 Material

The object of the research is the organic matter in the sediment and the density of the mangrove species *Sonneratia sp.* and *Avicennia sp*.

2.2 Method

This research was conducted through several stages, namely, determining the location, preparing tools and materials, taking sediment, and analyzing mangrove data. The sediment that has been taken is then carried out sample preparation, analysis of organic matter content, and data analysis.

2.2.1. Location determination

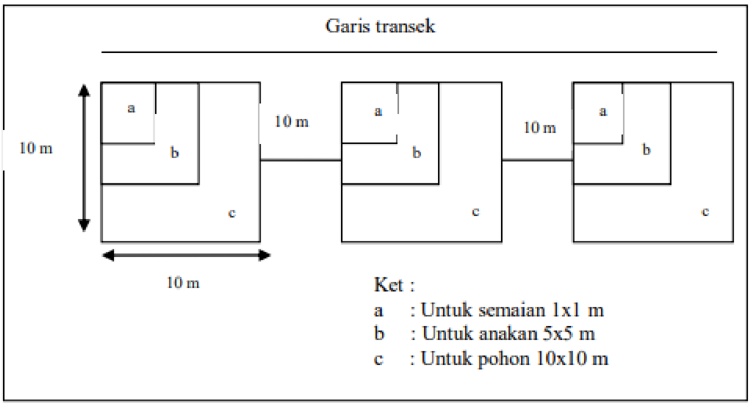
Determination of research stations is done using purposive sampling method. Notoatmodjo (2002) purposive sampling method, namely determining the location and respondents with certain considerations by researchers based on the characteristics or characteristics of the population that have been known previously. The sampling location was chosen based on the presence of mangrove species in the area. Two observation stations were chosen, namely: station 1 is located on the edge of the river mouth, where this location is dominated by the vegetation of *Avicennia marina* and station 2 is located next to the pier directly facing the sea, where this location is dominated by vegetation of *Sonneratia alba*.

2.2.2. Sampling

Sediment sampling was carried out at each plot measuring 10x10 m 3 times randomly at a depth of 0 cm, 10 cm, and 20 cm. Sediment sampling was carried out using a paralon pipe measuring 2 inches in diameter and 30 cm long. Sampling is done by inserting the pipe into the sediment until it sinks, then lifting the pipe again by closing the top of the pipe, this is done so that the pipe is airtight, so that the sediment in the pipe is lifted. Samples were removed and measured according to depth. Samples that have been measured and cut based on depth are then put into plastic bags according to the sample code for each plot that has been made. The samples were then taken to the laboratory for analysis. Sediment organic matter analysis was carried out using the Loss in Ignition method following the method used by Fairust and Graham (2003).

2.2.3. Mangrove data collecting

Mangrove data retrieval using the line transect method, namely the line transect drawing is carried out from the sea to the land (Bengen, 2000). Next, observation points were made by installing plots measuring 10×10 m each for tree-level vegetation, 5×5 m for sapling-level vegetation and 1×1 m for seedling-level vegetation.



Gambar 2. Determination of mangrove data plots

2.2.4. Analysis of organic matter content

Sediment samples that have been taken are put into aluminum foil and air-dried for 5 days, then in the oven for 1x24 hours at a temperature of 105oC. The dried samples were then mashed using a mortar and filtered. The sample that passes through the filter is weighed as much as 5 grams and put into a plastic sample. Porcelain dishes are oven-dried to remove moisture. Next, the porcelain dish is weighed as the weight of the dish (Wt). The sample was put into a porcelain dish as much as 5 g and the weight of the sediment sample was weighed using an analytical balance, then recorded as the initial weight (Wa). The sample weight of the porcelain cup was put into the furnace for 1.5 hours with an initial temperature of 300 °C and then the temperature was increased to 550-600 °C for 2.5 hours. After that the furnace is turned off and the sample is left to warm, then the sample is put into a desiccator and weighed as the final weight (Wt).

2.3 Data Analysis

2.3.1. Species Density

Specific density i (Di) is the number of species stands in a unit area. Species Relative Density (RDi) is the ratio between the number of stands of species i (ni) and the total number of stands of all species (Σn) (Bengen, 2002), with the formula:

$$\mathrm{Di} = \frac{\mathrm{ni}}{\mathrm{A}}$$

$$\mathrm{RDi} = \left(\frac{\mathrm{ni}}{\sum \mathrm{n}}\right) \times 100\%$$

Note: Di = Density of type i (Ind/m2)
ni = Total number of stands of type i
A = Total area of sampling area (m^2)
RDi = relative density of type i (%)
Σn = Total number of stands of all species

2.3.2. Analysis of the total organic matter content of the sediment

Analysis of the total organic matter content of the sediment was carried out using the Loss in Ignition method following the method used by Simanjuntak et al. (2018).

3. Results and Discussion

3. 1. Sediment Organic Material Content

The results of the analysis of organic matter found differences in values at each station, both between plots, points and depths. The difference in the value of organic matter in sediments can be influenced by several factors such as mangrove density, type of substrate, environmental conditions, and community activities. Citra et al. (2020) reported that the content of organic matter produced by mangrove trees varied greatly based on the type of organic matter, mangrove forest substrate and input from the mainland.

Based on the analysis of organic matter, the results obtained with the highest percentage at station 1 at a depth of 0 cm found in plot 3 point 2 which is 17.43%, while the lowest percentage at plot 1 point 2 is 15.23%. The highest percentage at a depth of 10 cm is found in the 1st 3 point plot of 17.81%, while the lowest percentage in the 2nd 2nd point plot is 12.53%. The highest percentage at a depth of 20 cm is found in plot 1 point 1, which is 14.78%, while the lowest percentage in plot 2 point 1 is 12.58% (Table 1).

Table 1. Organic matter content at station 1

Depth (cm)	Spot	Organic matter (%)		
		Plot 1	Plot 2	Plot 3
0	1	16,53	15,27	15,74
	2	15,23	17,36	17,43
	3	15,50	16,04	15,45
Average		15,75	16,22	16,20
10	1	14,55	13,14	17,81
	2	14,95	12,53	14,52
	3	14,04	15,66	14,74
Average		14,51	13,77	15,69
20	1	14,78	12,58	13,64
	2	14,14	12,80	14,54
	3	14,31	13,55	13,82
Average		14,41	12,97	14

The results of the analysis at station 2 of the organic matter content with the highest percentage at a depth of 0 cm were found in the 3rd 3 point plot of 13.25%, while the lowest percentage was 10.45% on the 3 3 point plot. The highest percentage at a depth of 10 cm is found in plot 1 point 2, which is 12.28%, while the lowest percentage in plot 3 point 1 is 9.70%. The organic matter content with the highest percentage at station 2 with a depth of 20 cm was found in plot 1 point 3, which was 12.99%, while the lowest percentage at plot 3 point 1 was 9.21% (Table 2).

Table 2. The results of the measurement of organic matter at station 2

Depth (cm)	Spot	Organic matter (%)		
		Plot 1	Plot 2	Plot 3
0	1	11,76	10,66	10,45
	2	11,44	11,92	11,21
	3	11,07	11,06	13,25
Average		11,42	11,21	11,63
10	1	11,04	10,06	12,04
	2	12,28	9,70	10,80
	3	11,44	11,30	11,41
Average		11,58	10,35	11,41
20	1	10,11	10,85	9,21
	2	9,85	10,90	12,26
	3	12,99	10,12	9,60
Average		10,98	10,62	10,35

The content of organic matter at stations 1 and 2 at a depth of 0 cm has a higher average value compared to a depth of 10 cm and 20 cm, this is presumably due to the large amount of mangrove litter that falls on the sediment surface and is then decomposed by decomposers into organic matter. The decomposition process only occurs at the surface layer and will continue to be decomposed by bacteria and utilized by mangrove plants and other organisms for the growth process, so that less organic matter enters at a depth of 10-20 cm. Paul and Ladd (1981) stated that the deeper (from the soil surface) the organic matter content decreased, the highest content was in the top layer or top soil (0-10 cm) followed by the bottom or subsoil (10-20 cm). Budiasih et al. (2015) also argues that the high organic matter in the surface layer (0 cm) is caused by high litter production, where the density of mangroves also affects the level of organic matter content.

In general, station 1 has higher organic matter content than station 2, ie the average value of station 1 ranges from 12.53% - 17.81%, while station 2 ranges from 9.21% - 13.25%. This is presumably because the location of station 1 is in the estuary area where organic matter from the river will settle in the sediment during low tide. Amella et al. (2014) stated that the high content of organic matter at stations located at the mouth of the river, cannot be separated from the input of organic matter carried by river flows and community activities around these waters. Then the low organic matter content at station 2 is suspected because the location is directly opposite the sea so that inorganic waste carried by waves will be left on the surface of the sediment or settle in the sediment. Manengkey (2010) states that areas directly adjacent to the sea will experience a decrease in the content of organic matter in sediments as a result of waves that unload sedimentary material and are carried directly into the sea by tidal currents.

In general, the organic matter content at station 1 and station 2 is in the medium to high category, in the range of 9.21% - 17.81%. Simanjuntak et al. (2018) stated that the percentage of organic matter content in sediments is classified into 5 (five) groups, namely very high with a value of >35%, high with a value of 17-35%, medium with a value of 7-17%, low with a value of 3, 5-7%, and very low with a value of <3.5%.

3.2. 1 Mangrove Density

Mangrove density consists of species density and relative density, species density is the number of stands of species i in one unit area and relative density of species is the ratio between the number of stands of species i and the total number of stands of all species. Mangrove density at each station depends on the number of stands of mangrove trees. The more stands of mangrove trees, the higher the density of mangroves at the station. The results of the analysis of mangrove density data can be seen in Table 3.

Table 3. Mangrove Desity

Station	Species	Plot	Species Density (ind/m^2)
1	*Avicennia* sp.	1	0.05
		2	0.12
		3	0.10
Total			0.27
2	*Sonneratia* sp.	1	0.07
		2	0.05
		3	0.09
Total			0.21

Station 1 which is dominated by Avicennia sp. has a higher density value of 0.27 ind/m2 compared to station 2 which is dominated by the mangrove species Sonneratia sp. of 0.21 ind/m2. The high density value at station 1 is thought to be because it is able to adapt to high and low salinity, is protected from strong waves and currents and is influenced by the ebb and flow of river estuaries, so that mangroves get sufficient fresh water input. Nontji (2002) states that strong waves do not allow the deposition of sediment which is needed as a substrate for the growth of mangroves. Parmadi et al. (2016) also argues that the high value of the density level of mangrove species is due to the location where mangroves grow, they have an adequate supply of fresh water.

The range of density values for Avicennia sp. and Sonneratia sp. in each plot between 0.05 ind/m2 – 0.12 ind/m2 and included in the criteria of rare to moderate. Based on the Decree of the State Minister of the Environment Number 201 of 2004 in Appendix 1, the standard criteria for mangrove damage are set which can be seen in Table 4.

Table 4. Standard criteria for mangrove damage

Condition		Density (Ind/ha)
good	dense	≥ 1500
	moderate	≥ 1000 - < 1500
damaged	rarely	< 1000

4. Conclusion

The highest organic matter content in sediments in the mangrove conservation area, Mamburungan sub-district, Tarakan city was at station 1, and the highest mangrove density ranged from 0.05 ind/m^2 - 0.12 ind/m^2 which was dominated by Avicennia sp. More organic matter content was found at a depth of 0 cm.

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