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Analysis of Sediment Organic Matter Content and Macrozoobenthos Abundance in Padang and Pariaman Coastal Waters, West Sumatra

Analisis Kandungan Bahan Organik Sedimen dan Kelimpahan Makrozoobenthos di Perairan Pantai Padang dan Pariaman Sumatera Barat

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Abstract

The research was conducted in June - August 2022 in the coastal waters of Padang and Pariaman, West Sumatera. The method used in this research was a survey method. This research aims to determine the organic matter content of the sediment, the abundance of macrozoobenthos, and the relationship between sediment organic matter and the quantity of macrozoobenthos. Sampling was designed by purposive sampling by using 20x30 cm^2 Ekman grab. The organic matter content of sediments in the Padang and Pariaman Coastal Waters, West Sumatra, ranged from 4.09 to 7.53%. The average abundance of macrozoobenthos at the four stations ranged from 20.37 to 90.74 ind/m^2. Based on the identification results, the macrozoobenthos class found in the coastal waters of Padang and Pariaman consists of Bivalvia, Gastropods, and Malacostraca. The analysis of the sediment organic matter showed weak position relationships with macrozoobenthos abundance.

Keywords: Organic, Sediment, Macrozoobenthos, Abundance, West Sumatera

Abstrak

Penelitian dilakukan pada bulan Juni – Agustus 2022 di perairan Pantai Padang dan Pariaman, Sumatera Barat. Metode yang digunakan dalam penelitian ini adalah metode survei. Penelitian ini bertujuan untuk mengetahui kandungan bahan organik sedimen, kelimpahan makrozoobenthos, dan hubungan antara bahan organik sedimen dengan kelimpahan makrozoobenthos. Pengambilan sampel dilakukan secara purposive sampling dengan menggunakan 20x30 cm^2 Ekman grab. Kandungan bahan organik sedimen di perairan Pantai Padang dan Pantai Pariaman Sumatera Barat berkisar antara 4,09 sampai 7,53%. Kelimpahan rata-rata makrozoobenthos pada keempat stasiun berkisar antara 20,37 hingga 90,74 ind/m^2. Berdasarkan hasil identifikasi, jenis makrozoobenthos yang ditemukan di perairan Pantai Padang dan Pariaman terdiri dari Bivalvia, Gastropoda dan Malacostraca. Analisis kandungan bahan organik sedimen menunjukkan hubungan yang lemah terhadap makrozoobenthos.

Kata kunci: Bahan organik, Sedimen, Makrozoobenthos, Kelimpahan, Sumatera Barat

1. Introduction

The coastal waters of Padang and Pariaman are potential tourist areas consisting of beaches, seas, and other natural beauties. Padang and Pariaman beaches have long been known, such as Air Manis Beach, Muaro Lasak Beach, Gandoriah Beach, and Kata Beach. These beaches are always crowded with people from the area and abroad.

Various human activities occur along the waters, such as entrepreneurship, industry, exploration, ports of fishing boats, and passengers. These community activities are suspected to cause a buildup of organic and inorganic matter that can interfere with the life of organisms in the waters. If the amount of organic matter entering exceeds the seas' carrying capacity, the aquatic environment's condition becomes damaged. Further, it interferes with the life of the organisms living in it.

Organic matter is a food source for marine life, generally found in the base substrate, so its dependence on organic matter is huge (Hawari et al., 2014). Therefore, organic matter is essential for the life of aquatic organisms, including macrozoobenthos. Macrozoobenthos are marine organisms that live on the bottom of waters with relatively slow movements that are strongly influenced by the bottom substrate and the quality of the waters. Gholizadeh et al. (2012) added changes in macrozoobenthos communities as biota indicators of aquatic environmental conditions spatially depending on sediment particle size, organic matter, and water depth. The organic matter content of sediments is related to the abundance of macrozoobenthos in a body of water (Hawari et al., 2014). Macrozoobenthos are relatively passive, so they are used as a guide to environmental quality because they are always in contact with anthropogenic activities that enter their habitat and play an essential role in the content of organic matter in the substrate. The bottom substrate of the waters is one of the outstanding abiotic potentials. The substrate is helpful as a habitat, a place to forage, and spawn for most aquatic organisms. In addition, the bottom of the water has a very complex composition ranging from small-sized substrates to rocks (Ningsih et al., 2013).

The availability of organic matter will affect the abundance of macrozoobenthos (Suryani et al., 2014). Aquatic organic matter also indicates water quality because organic matter naturally comes from the waters themselves through decomposition, weathering, decomposition of plants, or the remains of dead organisms. Good waters can support the diversity of macrozoobenthos species living there. Conversely, waters that lack good macrozoobenthos diversity will decrease or decrease in number.

Based on this, the author is interested in researching sedimentary organic matter content and the abundance of macrozoobenthos in the coastal waters of Padang and Pariaman, West Sumatra.

2. Material and Method

2.1. Time and Place

This research was carried out in June - August 2022 in the coastal waters of Padang and Pariaman West Sumatra Province (Figure 1). Sample analysis was conducted at the Marine Chemistry and Biology Laboratory, Department of Marine Science, Universitas Riau.

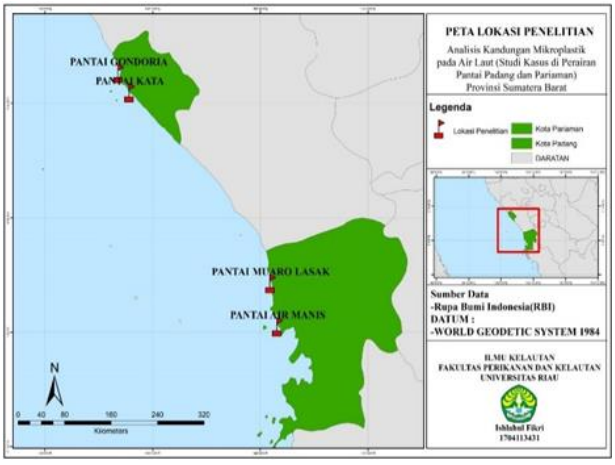

Figure 1. Research location

2.2. Methods

The location of the sampling point uses the purposive sampling method, Gandoriah Beach, as station 1 because there is an estuary of the river and a port. Kata Beach is station 2, which is a tourist location. Muaro Lasak Beach is station 3. This beach is the most visited location by tourists, and Air Manis beach is station 4 because of industrial activity from the palm oil collection mill (Crude Palm Oil).

2.3. Procedure

2.3.1. Sediment Sampling and Analysis

Sediment sampling was carried out using an Ekman grab measuring 20 cm×30 cm was carried out three times, sampling at each sampling point with a distance between selections of approximately 200 m. Sediment samples are taken as much as 500 g and put in a plastic bag labeled based on the station and sampling point. Then, the piece is put into an ice box for analysis in the laboratory. Sediment samples that have been taken as much as 500 g of wet weight, then 150 g are taken for sediment type analysis (Rifardi, 2008) and 50 g for sediment organic matter analysis (Pett, 1993).

Organic matter is analyzed in the laboratory with the stages of analysis by method (Pett, 1993) as follows:

1. All saucers are cleaned and then labeled according to the label on the sample.
2. The saucer is put in the oven at 105^{o} C for 15 minutes, then cooled using a desiccator for 15-20 minutes and weighed.
3. A sample of sediment that has been stirred evenly is put into a saucer of ± 50 g. Next put in the oven at a temperature of 105^{o}C for 24 hours to dry. After that, it is cooled for 15 minutes and then weighed.
4. The samples in a saucer were then burned in a furnace at 550^{o}C for 3 hours, then cooled for 30-60 minutes, and then weighed with analytical scales.

The calculation of organic matter content is as follows:

$$\text{Organic matter content (\%)} = \frac{a-c}{a-b} \times 100\%$$

Note:

a = Weight of saucer and sediment sample before combustion or after drying
b = Grail weight (g)
c = Weight of saucer and sample after combustion (g)

Analysis of sediment fractions using two methods, namely the sifting method and the pipette method. The sifting process uses a multilevel sieve to obtain Ø-1 - Ø 4, while for the pipette method, a volumetric pipette is used to obtain Ø 5- Ø7. An analysis of the type of sediment fraction is carried out concerning (Rifardi, 2008).

2.3.2. Macrozoobenthos Sampling and Analysis

Taking macrozoobenthos samples using Ekman grab 20 × 30 cm by performing three takes for each sampling point. Furthermore, the sample obtained is filtered using a sieve measuring 1 mm. The obtained macrozoobenthos are stored in plastic bags labeled by station and sampling point and then preserved using 10% formalin. The samples are put into an ice box and taken to the laboratory to analyze their type and abundance.

Macrozoobenthos samples taken to the laboratory are then washed with fresh water. Then, the macrozoobenthos are put into trays labeled according to the station point. Macrozoobenthos samples obtained were identified using the identification book Guide to Identification of Marine and Estuarine Invertebrates by Gosner (1971). Analysis of abundance Macrozoobenthos is calculated using the formula (Odum, 1993):

$$K = \frac{N}{A} \times 10.000$$

Description:

K = Individual abundance (ind/m^2)
N = individual of macrozoobenthos
A = Area of mouth opening Ekman grab (cm^2)
10,000 conventions from m^2 to cm^2

2.4. Data Analysis

Data analysis in this research used statistical methods. The relationship of organic matter content in sediments with macrozoobenthos abundance was analyzed by linear regression assays using Microsoft Excel. Differences in organic matter content in sediments and macrozoobenthos abundance between stations were tested using one-way ANOVA with the application Statistical Package for the Social Sciences (SPSS).

3. Result and Discussion

3.1. General State of the Research Location

The city of Padang is located on the west coast of Sumatra Island, is the largest city on the west coast of Sumatra Island as well as the capital of West Sumatra Province with an overall area of 694.96 km² or equivalent to 1.65% of the area of West Sumatra Province. The city of Padang is located between 0° 44' 00" and 1° 08' 35" South Latitude and between 100° 05' 05" and 100° 34' 09" East Longitude. Padang is one of Indonesia's coastal cities with tourist and recreational activities (Rahman et al., 2014).

Pariaman City is one of the cities located in the province of West Sumatra. Geographically, Pariaman City is located at 0° 33'00" and 0°40'43" South Latitude as well as between 100°10'33" and 100°10'55" East Longitude. Pariaman City is a stretch of lowland located on the west coast of West Sumatra Province with an

altitude of between 2 to 35 meters above sea level, with a land area of 73.54 km² and an ocean area of 282.69 km² (Aditama, 2010).

3.2. Water Quality Parameters

The water quality parameters measured in this research include chemical and physical parameters: temperature, salinity, pH, current speed, and brightness. This measurement of water quality parameters aims to describe the condition of the waters at the time the research was carried out. The average parameter oceanography obtained from the measurement results in this research can be seen in Table 1.

Table 1. Average parameter oceanography in the Coastal Waters of Padang and Pariaman

Water quality parameters	Station			
	1	2	3	4
Temperature (^oC)	29.33	30	28	29.67
Salinity (ppt)	27.67	27.67	29	27.67
pH	7.53	7.5	7.6	7.47
Current speed (m/s)	0.12	0.12	0.19	0.23
Brightness (m)	2.15	2.05	1.97	2.2

3.3. Organic Matter Content and Sediment Fraction

The results of the calculation of sedimentary organic matter at each station in Padang and Pariaman, West Sumatra, ranged from 4.09 – 7.53%, as seen in Table 2.

Table 2. Sedimentary organic matter content in the Coastal Waters of Padang and Pariaman

Station	Sampling Point	Organic Matter Content (%)	Average organic matter (%)	Criterion (Reynold, 1971)
1	1	8.37	7.53	Medium
	2	7.08		
	3	7.16		
2	1	5.12	5.16	Low
	2	5.89		
	3	4.48		
3	1	3.45	4.09	Low
	2	5.16		
	3	3.67		
4	1	7.04	6.58	Low
	2	6.85		
	3	5.86		

The content of organic matter in the waters can come from various activities and sources, including tourism, shipping lanes, river flows that emptied into sea waters, industrial activities, and community activities that continue without good management (Rahmawati et al., 2014). The highest organic matter content is at the Pariaman (Gandoriah Beach), 7.53%. This research is located in an area close to the river estuary. The high organic matter content is due to this area receiving organic matter input from the Batang Pariaman River flow.

Various wastes such as household waste, factory waste, agricultural waste, and waste from other activities will enter the river and flow into the sea. The lowest organic matter content in the Padang (Muaro Lasak Beach) is 4.09%. This location has a low range of organic matter because it is a tourist area that needs more organic matter input from land. Along the periphery of the beach, there are only wave-bearing rocks. The low content of organic matter in this location is also influenced by the type of substrate, namely sand. This sand substrate is complex to accumulate organic matter input. Puspasari et al. (2012) said that the kinds of substrates are essential in developing benthic organism communities. Sand tends to make it easier to shift and move elsewhere. Substrates in the form of sludge usually contain little oxygen, and therefore, the organisms living in it must be able to adapt to this situation.

The difference in organic matter content at each station was analyzed with an ANOVA test. In the Test of Homogeneity of Variances, it can be seen that the test results show that $p = 0.771$ (> 0.05), so the data is said to be homogeneous, then continued with the ANOVA test. The ANOVA test results obtained a significant value of 0.002, meaning that the p-value < 0.05 shows a substantial difference in sedimentary organic matter content between stations.

Sediment fraction is a way of determining the sediment type at the research site. The results of the analysis of sediment fractions obtained in the coastal waters of Padang and Pariaman can be seen in Table 3. The analysis results show that at station 1, there is a sandy mud sediment type, and at station 2, there is a sandy mud sediment type, while at stations 3 and 4, there are muddy sand sediment types and sandy mud

Table 3. Percentage of weight of sediment fractions and types in the Coastal Waters of Padang and Pariaman

Station	Sampling Point	Sedimentary Fraction			Sediment Type
		Gravel %	Sand %	Lumpur %	
1	1	0.06	39.96	59.98	Sandy Mud
	2	0.10	17.10	82.81	Mud
	3	0.73	27.96	7137	Sandy Mud
2	1	0.05	33.15	66.80	Sandy Mud
	2	0.08	30.07	69.85	Sandy Mud
	3	0.11	37.56	62.33	Sandy Mud
3	1	0.44	70.12	29.43	Muddy Sand
	2	3.48	38.59	57.93	Sandy Mud
	3	2.79	64.35	32.86	Muddy Sand
4	1	0.29	69.46	30.25	Muddy Sand
	2	4.06	37.23	58.71	Sandy Mud
	3	5.37	64.31	30.33	Muddy Sand

The results of measuring sediment fractions in the coastal waters of Padang and Pariaman are three types: mud, sandy mud, and muddy sand. The gravel fraction at station I ranges from 0.06–0.73%, station II 0.05–0.11%, station III 0.44–3.48%, and station IV 0.29–5.37%. The sand fraction at station I ranges from 17.10–39.96%, station II 30.07–70.12%, station III 38.59–70.12%, and station IV 37.23–69.46%. The sludge fraction at station I ranged from 59.98 – 82.81%, station II 62.33 - 69.85%, station III 29.43 - 57.93%, and station IV 30.25-58.71%. The texture of the mud sediment has the most significant content, followed by sand and gravel.

The results of sediment texture measurements show that the Pariaman location is more dominated by sandy mud, while the Padang location is more dominated by muddy sand. For gravel proposers, the value is lower than that of sand and mud. This difference is likely due to its different sedimentation processes. The results of this research are the same as the research that has been carried out by Kinasih et al. (2015) in the Betahwalang Demak River, which shows that the texture of sediments is always dynamic and undergoes changes, which is caused by physical processes, namely the existence of stirring and settling processes that are strongly influenced by environmental conditions such as currents.

3.4. Abundance of Macrozoobenthos

The results of the identification of macrozoobenthos in the Coastal Waters of Padang and Pariaman found as many as 25 species which can be seen in Table 4.

Table 4. Types of macrozoobenthos found in the Coastal Waters of Padang and Pariaman

Phylum	Class	Family	Genus	Species
Mollusca	Bivalvia	Mesodesmatidae	Atactodea	*Atactodea striata*
		Tellinidae	Fabulina	*Fabulina fabula*
		Glycymerididae	Glycymeris	*Glycymeris violacescens*
		Limidae	File	*Lima marioni*
		Plicatulidae	Plicatula	*Plicatula gibbosa*
		Arcidae	Anadara	*Anadara granosa*
	Gastropoda	Buccinidae	Busycon	*Busycon contrarium*
		Cerithiidae	Cerithium	*Cerithium scrabidum*
		Conoidea	Conus	*Conus striatus*
		Fasciolariidae	Fusinus	*Fusinus longissimus*
		Melongenidae	Hemifusus	*Hemifusus colosseus*
		Trochidae	Monodonta	*Monodonta lip*
		Nassariidae	Nassarius	*Nassarius reticulatus*
		Naticidae	Buttock	*Tigrinya buttock*
		Terebridae	Oxymeris	*Oxymeris maculata*
			Terebra	*Terebra chirping*
		Potamididae	Pirenella	*Conical Pyrenel*
		Planaxidae	Planaxis	*Planaxis nucleus*
		Fissurellidae	Fissurella	*Fissurella nubecula*
		Mitridae	Strigatella	*Strigatella litterata*
		Triviidae	Trivia	*Trivia arctica*
		Architectonicidae	Philippia	*Philippia radiata*
		Clavatulidae	Turricula	*Turricula javana*
		Costellariidae	Vexillum	*Vexillum echinatum*
Arthropoda	Malacostraca	Varunidae	Cyclograpsus	*Cyclograpsus punctatus*

As a result of the identification of macrozoobenthos, three classes of macrozoobenthos were found, namely Gastropods with the most types, 18 species, Bivalvia 6 species, and Malacostraca 1 species. The number of Gastropod classes in this research is because this class is a macrozoobenthos that can live in various types of

substrates, ranging from sand substrates, stones, mud, and so on. The result from the calculation of Macrozoobenthos found at the research site obtained as many as 121 individuals. The average abundance and standard deviation of macrozoobenthos are presented in Table 5.

Table 5. Average abundance of macrozoobenthos in the Coastal Waters of Padang and Pariaman

Station	Sampling Point			Average abundance
	1	2	3	
1	72.22	83.33	61.11	72.22
2	105.56	88.89	77.78	90.74
3	27.78	33.33	0.00	20.37
4	55.56	27.78	38.89	40.74

The result calculation of the average value of macrozoobenthos abundance has varying values at its four stations, which range from 20.37 to 90.74 ind/m^2. The highest average abundance value is found at station 2, which is 90.74 ind/m^2, and the lowest abundance is at station 3, which is 20.37 ind/m^2.

The abundance at the Pariaman is because this area has a substrate in the form of mud and a high content of organic matter, a food source for macrozoobenthos. Amin & Nurrachmi (2007) say that benthos is generally found in base substrates that contain a lot of sludge because these substrates have a lot of organic matter. Organic matter that settles at the bottom of the waters is a source of food for macrozoobenthos organisms.

The gastropod class predominates because it reasonably adapts to its environment. Gastropods also have a high body resistance and a hard-shell adaptation, allowing them to have a greater survival rate than other classes. The low abundance of macrozoobenthos found in Padang sites with muddy sand substrate types, caused by the substrate type that dominates sand, makes it challenging to accumulate organic matter and causes a low organic matter content at this station. So, the source of foodstuffs for macrozoobenthos is also tiny. Statement of Rizal et al. (2017) that the type of sludge sediment is generally richer in nutrients than sand sediment. Sand tends to make it easier to shift and move elsewhere and does not provide a fixed substrate to cling to the organism.

Differences in the abundance of macrozoobenthos at each station were analyzed using ANOVA. The Homogeneity of Variances test obtained a result of p = 0.739 (>0.05), so the data was said to be homogeneous, then continued with the ANOVA test. The ANOVA test results obtained a significant value of 0.001, meaning that the p-value < 0.05 illustrates a substantial difference in the abundance of macrozoobenthos between stations

3.5. Relationship of Sedimentary Organic Matter Content with Macrozoobenthos Abundance

The substrate's large amount of organic matter content will significantly affect its distribution and abundance of macrozoobenthos. The results of the analysis of the relationship between sedimentary organic matter and macrozoobenthos abundance in the coastal waters of Padang and Pariaman can be seen in Figure 2.

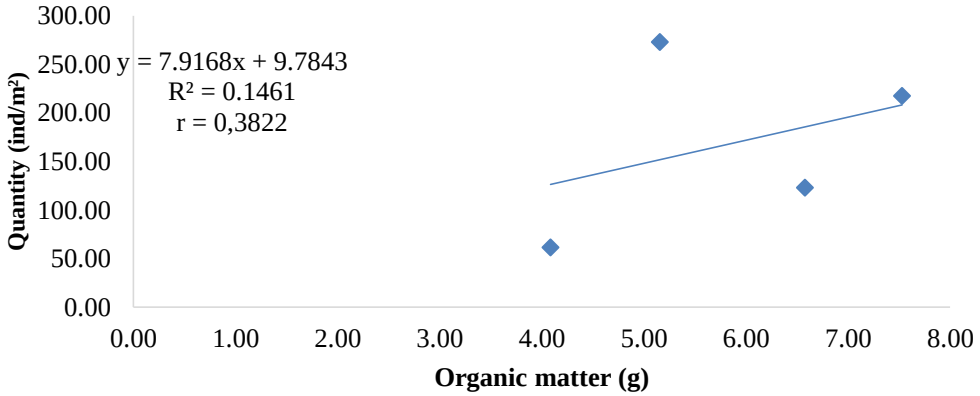

Figure 2. Relationship of sedimentary organic matter with macrozoobenthos abundance

Equation y = 7. 9168x + 9.7843 with the coefficient of determination (R 2) obtained is 0.1461, and the correlation coefficient (r) is 0.3822, which indicates a weak correlation relationship, the content of organic sedimentary material does not have much influence on the abundance of macrozoobenthos at the site of this research.

The effect of sedimentary organic matter content on the abundance of macrozoobenthos is 14.61%, while other factors influence 85.39%. Other factors that affect are the type of substrate, the availability of foodstuffs, and human activities. According to Choirudin et al. (2014), sedimentary texture or base substrate is one of the main ecological factors influencing the abundance and dispersal of macrozoobenthos.

4. Conclusions

The sedimentary organic matter content in the coastal waters of Padang and Pariaman ranges from 4.09 – 7.53%. The highest is found at Station 1 (Gandoriah Beach, Pariaman), while the lowest is at Station 3 (Muaro Lasak Beach, Padang). Macrozoobenthos overflow ranges from 20.37–90.74 ind/m^2, the highest at station 2 (Kata Beach) and the lowest at station 3 (Muaro Lasak Beach). Based on the results of the ANOVA test, there is a significant difference between the content of sedimentary organic matter and the abundance of macrozoobenthos. The relationship between the content of organic matter sediment and the abundance of macrozoobenthos showed a weak correlation. The higher the organic matter content, the greater the macrozoobenthos in these waters.

5. Suggestion

There is a need for further research on other parameters. These physic-chemical factors affect sedimentary organic matter's content and macrozoobenthos' abundance in the coastal waters of Padang and Pariaman. The government and local communities should continue to protect the aquatic environment from various forms of pollution that can reduce the quality of marine waters.

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