Asian Journal of Aquatic Sciences, August 2023. Vol 6, Issue (2) 243-251
e-issn: 2716-4608
p-issn: 2655-366X

ANALYSIS OF ORGANIC MATTER CONTENT IN WATER AND SEDIMENT IN THE EAST COAST WATERS OF BENGKALIS ISLAND, RIAU PROVINCE

Anggi Lestari[1]*, Bintal Amin[1], Nursyirwani[1]
[1]Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau
Kampus Bina Widya KM. 12,5, Simpang Baru, Bina Widya, Pekanbaru, Riau 28293
*anggi.lestari1148@student.unri.ac.id

ABSTRACT

Organic matter is one indicator of environmental fertility both on land and at sea. The content of organic matter in a certain amount can be useful for aquatic biota, but if the amount of organic matter exceeds the assimilation capacity of the waters, it can cause a disturbance. This study aims to determine the organic matter content of water and sediment at high and low tide conditions in the waters of the east coast of Bengkalis Island and to determine the relationship. The method used is a survey method that is carried out in the field directly to collect data and samples, which are then taken to the laboratory for analysis. The results showed that the organic matter content of water at high tide was 17.38-25.28 mg/L and at low tide, it was 29.63-35.55 mg/L. The organic matter content of sediments at high tide conditions ranged from 2.28-5.37% and at low tide, conditions ranged from 3.46-8.62%. These conditions indicate that the organic matter content of water and sediment has not passed the predetermined threshold. The results of the analysis of the relationship between the organic matter content of water and sediment at high tide conditions with a coefficient of determination (R2) of 0.533 with a correlation coefficient (r) of 0.730 and at low tide with a coefficient of determination (R2) of 0.713 with a correlation coefficient (r) of 0.844. The type of sediment that dominates the waters of the East Coast of Bengkalis Island is mud.

Keywords: Organic matter, Bengkalis island, Sediment, Water, Sediment

1. INTRODUCTION

Bengkalis Island is strategically located on the edge of one of the busiest international shipping lanes in the world, the Strait of Malacca[1]. The Bengkalis Sea consists of two parts, namely open sea waters in the east and north of Bengkalis Island which are part of the Malacca Strait, and estuarine waters in the west and south of Bengkalis Island.

The eastern waters of Bengkalis are directly connected to the waters of the Malacca Strait, where they are influenced by open sea water masses from the Malacca Strait. Several small rivers empty into the eastern waters of Bengkalis Island[2]. As a consequence, these waters receive a lot of organic matter input, mainly from human activities.

Organic matter is one indicator of environmental fertility both on land and at sea. The content of organic matter in a certain amount can be useful for aquatic biota, but if the amount of organic matter has exceeded the assimilation ability of waters, it can cause disturbances. The disturbance can be in the form of a decrease in water quality due to the decomposition process of organic matter. The process of aerobic decomposition of organic matter can cause the content of dissolved oxygen to be low or even depleted.

Organic matter in certain levels is a pollutant that pollutes waters. The input of

Received : 16 May 2023
Accepted : 14 July 2023

organic matter starts from upstream rivers that have dense residential activities, urban activities, and industries that are discharged into the river and carried by the current to the estuary. Organic matter in a body of water exists more in dissolved form than in suspended or colloidal form[3]. Organic matter will experience deposition and form sedimentation that causes siltation in the waters. Some dissolved organic matter that does not undergo precipitation will be carried by the current to the river mouth. The east coast waters of Bengkalis Island are an area that is quite dense with settlements, tourism, domestic household waste activities, and other activities that affect water quality. Tidal currents in river or coastal estuaries can also affect the distribution of organic material and nutrients[4].

This study aims to determine the organic matter content of water and sediment at high and low tide conditions in the east coast waters of Bengkalis Island and to determine the relationship between organic matter content in water and sediment at high and low tide conditions in the east coast waters of Bengkalis Island

2. RESEARCH METHOD

Time and Place

This research was conducted in March-April 2022. Sampling was carried out in the east Coast Waters of Bengkalis Island, Riau Province.

Methods

The method used is a survey method conducted in the field directly to collect data and samples, then brought to the laboratory for analysis. The research station was determined by purposive sampling, namely, the placement of stations carried out with certain considerations and specific criteria at each research station. The research station consists of three (3) stations with three (3) sampling points. The locations used for sampling were the coastal waters of Kembung Luar Village as Station I, the coastal waters of Teluk Lancar Village as Station II, and the coastal waters of Sekodi Village as Station III (Figure 1).

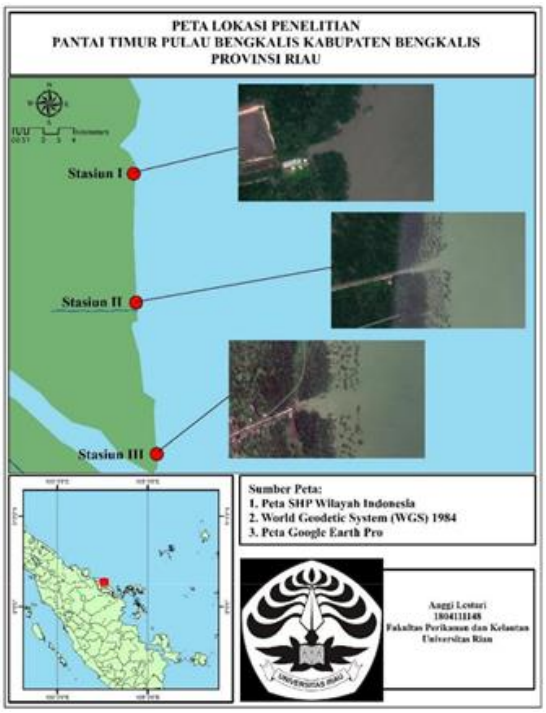


Figure 1. Map of research locations

Procedure

Sampling for organic matter content analysis consists of two samples, namely water samples and sediment samples. Water sampling was carried out at high and low tide conditions by entering water directly into the sample bottle and immediately put into an ice box. Sediment sampling was carried out at high and low tide conditions using Ekman grab tools and 4-inch pipes. Supporting data in the form of oceanographic parameters obtained directly (in situ) from the field consist of salinity, temperature, brightness, current speed, acidity (pH), and depth. Water and sediment samples obtained were then analyzed at the Chemical Oceanography Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Sciences, Universitas Riau.

Data Analysis

Water Organic Matter Content Analysis

The content of organic matter in water was analyzed using the Titrimetric

method of SNI 06-6989.22-2004[5]. The first step is to heat 100 mL of distilled water at a temperature of 70^o C and then add 5 mL of sulfuric acid. Added 10 mL (V1) 0.01N oxalic acid solution (N1) then titrated with potassium permanganate 0.01N until pink and records the volume of use (V2) and calculated the actual normality of potassium permanganate (b).

$$b = \frac{V1\ x\ n1}{V2}$$

The next step included 100 mL (d) sample water and added 3 boiling stones and added potassium permanganate until pink. Add 5 mL of 8N sulfuric acid (c) and heat on a hot plate at 105±2^{o}C until boiling added 10 mL of 0.01N potassium permanganate and heated again to boiling for 10 minutes. Titrate with 0.01N potassium permanganate until pink and record the volume of use (a) (if the volume of use is more than 7 mL, dilute (f) and repeat the test). Calculate using the formula:

TOM = [(10+a)b-(10xc)]1x31.6x 1000xfd]

Sediment Organic Matter Content Analysis

Analysis of organic matter content in sediments using the Loss on Ignition method[6]. The first step is the cup is put in the oven at 105^{o}C for 15 minutes then cooled in a desiccator for 15-20 minutes and weigh as the weight of the cup (b). Sediment samples were put in a cup ±50g and put in the oven at 105^{o}C for 24 hours after which it was cooled in a desiccator for 15 minutes and then weighed (a). The dried sample was then burned in a furnace at 550^{o}C for 3 hours, then cooled in a desiccator for 30-60 minutes, and then weighed (c). Calculate using the formula:

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

Sediment Fraction Analysis

Sediments taken from the research site were used for sediment type analysis. The stages of sediment analysis followed the instructions of Rifardi[7], using the multistage sieving method to obtain ø1- ø4 and the pipette method to obtain ø5-ø7. The classification of sediment fractions is based on the proportion of gravel, sand, and mud particles.

Analysis of the Relationship between Water, Sediment, and Organic Matter Content

Simple linear regression analysis was used to analyze the relationship of water organic matter content with sediment organic matter content, using SPSS software. Simple linear regression analysis is an analysis to see the relationship between one influencing or independent variable (X) with the affected or dependent variable (Y).

3. RESULT AND DISCUSSION

Bengkalis Regency is one of the districts in Riau Province. Astronomically, Bengkalis Regency is located between 2^o 7'37.2" - 0^o 55'33.6" North latitude and 100^o 57'57.6" - 102^o 30'25.2" East longitude. Its geographical position has the following boundaries: North - Malacca Strait; South - Siak and Meranti Islands; West - Rokan Hilir, Rokan Hulu, and Dumai City; East - Malacca Strait and Meranti Island. Bengkalis Regency as a whole has an area of 7,773.93 km^2. The Bengkalis region consists of the mainland of the eastern part of Sumatra and the archipelago, the island consists of two large islands, namely Bengkalis Island with an area of 938.40 km^{2,} and Rupat Island with an area of 1,525 km^2[8].

Research station I located in Kembung Luar Village and research station II located in Teluk Lancar Village are villages that are part of the Bantan District, Bengkalis Regency. Kembung Luar Village has an area of 40.64 km^2 or 9.11% of the total area of Bantan District and Teluk Lancar Village with an area of 38.30 km^2 or 8.58% of the total area of Bantan District [8].

Oceanographic Parameter Conditions

Measurement of oceanographic parameters to describe the condition of the

waters under study. Oceanographic parameter measurement values can be seen in Table 1.

Table 1. Oceanographic parameter measurement values

Oceanographic Parameters	Station (Tide)			Station (Low tide)		
	I	II	III	I	II	III
Brightness (cm)	18	16	16,5	17,5	15	15
Degree of Acidity (pH)	6	7	7	6	7	7
Temperature (^{o} C)	33	30	33	33	30	34
Salinity (‰)	25	28	28	25	28	28
Current Velocity (m/s)	0,186	0,252	0,299	0,016	0,021	0,023

The results of measurements of water quality parameters at high tide conditions are brightness ranging from 16.5-18 cm, acidity (pH) ranging from 6-7, temperature ranging from 30-33^{o}C, salinity ranging from 25-28‰, and current velocity of 0.186-1.299 m/s. Water quality at low tide conditions is brightness ranging from 15-17.5 cm, acidity (pH) ranging from 6-7, temperature ranging from 30-34^{o}C, salinity ranging from 25-28‰, and current velocity 0.016 - 1.023 m/s.

The current is the movement of water that causes the displacement of the water mass. The current speed on the East Coast of Bengkalis Island is in the range of 0.016 - 0.252 m/s; these conditions are in the slow and very slow category[9]. Current velocity conditions that are in that range are still fairly common and normal for measuring the speed of surface water currents, this is supported by research by Yogaswara et al.[10] which states that the surface current speed has an average speed ranging from 0.0341-0.277 m/s.

The salinity of the waters of the East Coast of Bengkalis Island is in the range of 25-28‰. Each station is adjacent to several rivers, so the waters are categorized as brackish waters. Temperature is one of the water quality parameters that affect various marine chemical, physical and biological activities. The temperature of the waters of the east coast of Bengkalis Island is in the range of 30-34^{o}C. Water brightness is a parameter that shows the ability of sunlight to penetrate the water to a certain depth. Water brightness can affect the activity of the formation of organic matter contained in the waters through photosynthesis activities. The brightness of the waters of the east coast of Bengkalis Island is in the range of 16.5-18 cm. This condition can be categorized as low as a result of the murky waters of Eastern Sumatra due to various factors such as the high input of sediment particles and organic matter through flow from the mainland. Amri et al.[11] stated that in waters that are classified as turbid, the brightness of the waters tends to be relatively low.

The pH of the waters of the east coast of Bengkalis Island is in the range of 6 - 7, these conditions are in a good range for various activities in the waters. Winanda[12] states that the pH of Bengkalis Island waters is in the range of 7. The pH value of water greatly affects the biochemical processes of water, for example, the nitrification process will be inhibited if the pH is low as a result of the inhibition of the activity of microorganisms that can carry out the decomposition process.

Sediment Type

The results of sediment type analysis at each sampling point in the southern waters of Bengkalis Island can be seen in Table 2.

Water organic matter content at high tide ranges from 17.38 - 25.28 mg/L and at low tide ranges from 29.63 - 35.55 mg/L. At high tide, the highest water organic matter content is found at station II sampling point 3, namely 25.28 mg/L, and the lowest at station III sampling point 2,

namely 17.38 mg/L. At low tide, the highest water organic matter content is found at station II sampling points 1 and 2, namely 35.55 mg/L, and the lowest at station III sampling point 1, namely 29.63 mg/L. In general, the water organic matter content at low tide is higher than the water organic matter content at high tide.

Table 2. Sediment type in the east coast waters of Bengkalis Island

Station	Point Sampling	Sediment Fraction (%)			Sediment Type
		Gravel	*Sand*	*Mud*	
I	1	1,19	4,87	93,94	Mud
	2	0,68	16,79	82,52	Mud
	3	0,64	34,96	64,40	Sandy Mud
II	1	0,09	44,73	55,19	Sandy Mud
	2	0,07	22,63	77,30	Mud
	3	0,06	8,05	91,88	Mud
III	1	1,06	35,92	63,01	Sandy Mud
	2	0,66	45,71	53,62	Sandy Mud
	3	0,70	20,03	79,26	Mud

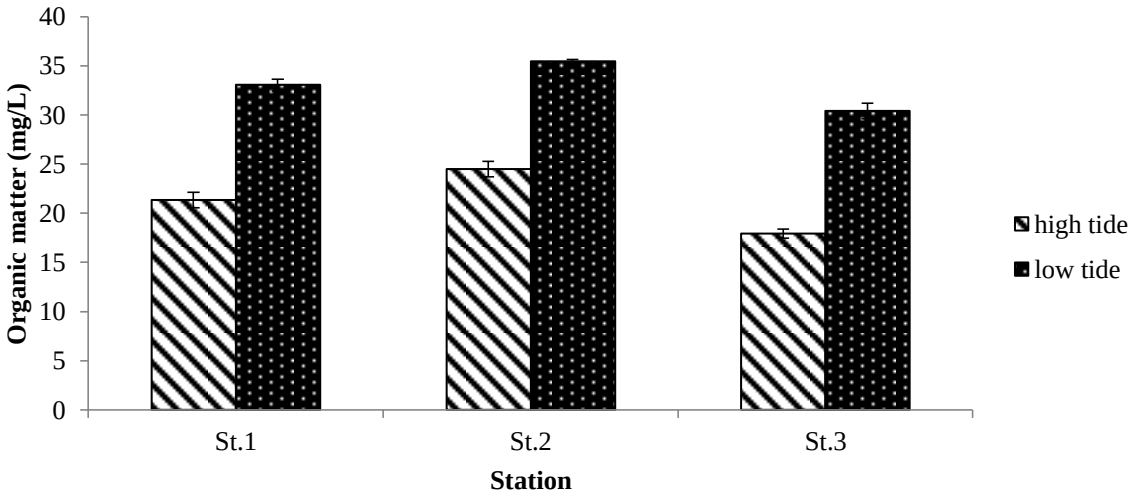


Figure 2. Organic matter content of water

The average organic matter content of water in high and low tide conditions is 17.91 - 24.49 mg/L and 30.42 - 35.42 mg/L, respectively. This condition is categorized as not exceeding the quality standard threshold set by the Decree of the State Minister of Population and Environment Number 2 of 1988 concerning Wastewater Quality Standards, which is 80 mg/L[13]. This indicates that the waters are still feasible and good for various activities and processes in these waters in terms of water organic matter content parameters.

The results showed that the organic matter content of water at low tide was higher than the organic matter content of water at high tide. This is thought to be a result of the stirring process that causes organic matter from the substrate to be lifted to the water body as a result of the smaller and closer water medium to the substrate when compared to tidal conditions.

The content of water organic matter at high and low tide conditions is highest in the waters of Teluk Lancar Village at station II. The high content of water organic matter in this area when compared to other areas is thought to be due to this area being the largest river estuary and with a more densely populated area. Population density can provide input of organic matter into

waters as a result of various activities such as plantations, development, and others. Merian et al.[14] stated that development in riverbank areas, increased settlement, and construction of facilities and infrastructure can increase organic matter.

The lowest water organic matter content in the Sekodi Village water area at station III with an average at high and low tide conditions was 17.91 mg/L and 30.42 mg/L, respectively. The low water organic matter content is thought to be a result of the Sekodi Village area, which has a lower number of settlements compared to other areas, and relatively less mangrove vegetation in this area. The lack of mangrove vegetation in this area results in low mangrove litter entering the water, where mangrove litter is one of the highest contributors of organic matter input to coastal waters or beaches. Mangroves are one of the main sources of organic matter for water, followed by human and industrial activities[12,13].

Organic Matter Content of Sediments in Tidal Conditions

Analysis of organic matter content in sediments to show the content of organic matter contained in sediments in the southern waters of Bengkalis Island. The results of the analysis of sediment organic matter content at each research station can be seen in Figure 3.

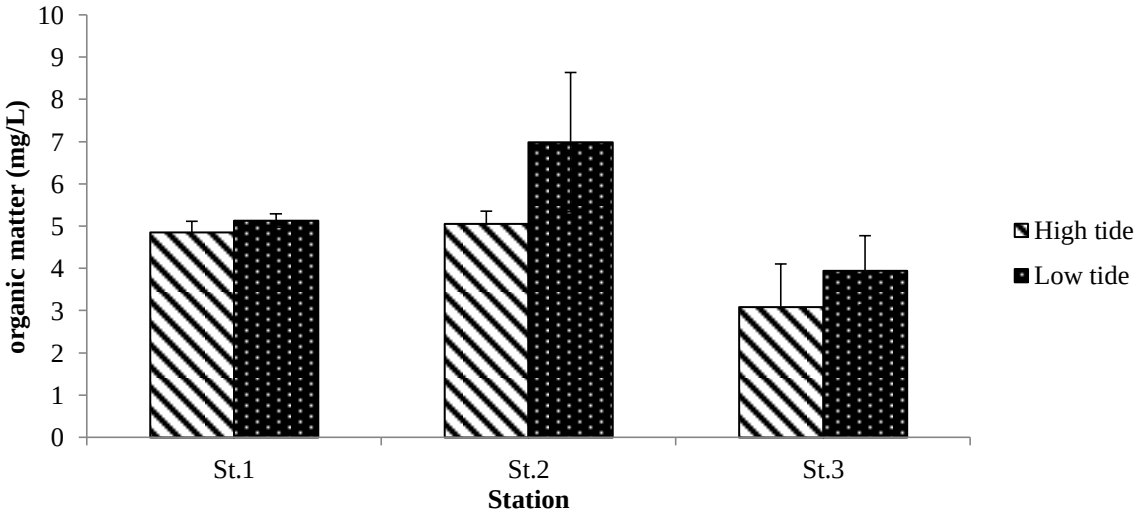


Figure 3. Sediment organic matter content

Sediment organic matter content at high tide ranges from 2.28-5.37% and at low tide ranges from 3.46-8.62%. At high tide, the highest sediment organic matter content is found at station II sampling point 2, which is 5.37%, and the lowest at station III sampling point 3, which is 2.28%. At low tide, the highest sediment organic matter content is found at station II sampling point 1, namely 8.62%, and the lowest at station III sampling point 1, namely 3.46%. In general, the sediment organic matter content at low tide is higher than the sediment organic matter content at high tide.

The content of sediment organic matter in the waters of the east coast of Bengkalis Island at station III at high tide conditions with an average of 3.09%. This value is in the category of very low sediment organic matter content. The content of sediment organic matter at station III in low tide conditions and at stations I and II in high and low tide conditions with an average in the range of 3.95-6.99%. The range of values is in the category of low sediment organic matter content. This indicates that the waters of the east coast of Bengkalis Island have not been polluted based on the parameters of sediment organic matter content.

The highest sediment organic matter content at high and low tide conditions at station II is 5.06% and 6.99% respectively,

this is thought to be caused by this area being a river estuary with a larger river width and length than other areas and this area is more densely populated than other areas. Population density can provide organic matter input to waters as a result of various activities such as plantations, development, and others. Community activities such as passing sea transportation, loading and unloading, disposal of residents' waste into the waters, and refueling can provide input of organic matter and can result in high organic matter content in a water body[15].

The lowest sediment organic matter content at high and low tide conditions at station III is 3.09% and 3.95% respectively, this is thought to be due to the distance of this area from the river and less mangrove vegetation compared to other areas. This is also reinforced by the lower number of settlements when compared to other areas. Mangrove vegetation is one of the contributors of organic matter input to coastal waters or beaches. The low mangrove vegetation in these waters results in low input of mangrove litter into the waters which ultimately results in low organic matter content in these waters. Based on the research of Lestaru et al.[16] states that mangrove density has an influence of 35.5% on sediment organic matter content

Sediment organic matter content is influenced by sediment type[17]. This statement is consistent with the results of the analysis of sediment organic matter content at stations I and II with mud sediment type higher than the sediment organic matter content at station III with sandy mud sediment type. Smaller sediment particles will accumulate much larger organic matter than sediments with larger particles. Fine sediments have smaller particle diameters and pore sizes. Organic matter along with water flows easily in large pores and small pores, water is retained resulting in the accumulation of organic matter[18].

Relationship between Water Organic Matter Content and Sediment in Tidal and Intertidal Conditions

Analysis of the relationship between organic matter content in water and organic matter content in sediment to show the effect of organic matter content in water on organic matter content in sediment. The relationship between organic matter content in water and organic matter content in sediment based on a simple linear regression test can be seen in Figure 4.

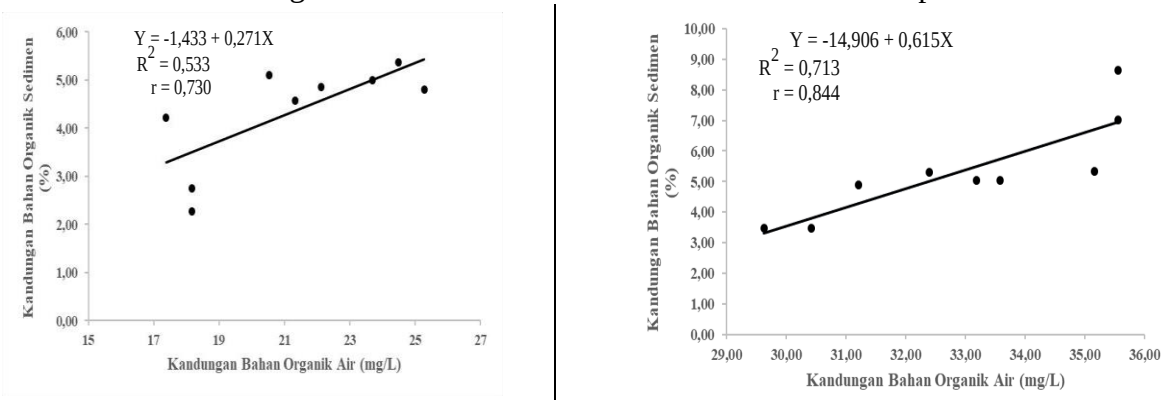
Based on Figure 4a, the results of the analysis of the relationship between the content of water organic matter with sediment at high tide conditions obtained the regression equation Y= -1.433+0.271X with the coefficient of determination (R^2) is 0.533 with the correlation coefficient (r) is 0.730 which indicates that there is a strong correlation relationship (positive) between the content of water organic matter with sediment at high tide conditions, with an influence value of 53.3%.

In Figure 4b, the results of the analysis of the relationship between water organic matter content and sediment at low tide conditions obtained a regression equation Y=-14.906+0.615X with a coefficient of determination (R^2) of 0.713 with a correlation coefficient (r) of 0.844 which indicates that there is a very strong (positive) correlation between water organic matter content and sediment at low tide conditions, with an influence value of 71.2%.

The content of organic matter suspended in the water column will accumulate to the water substrate over time and conditions. The accumulation of organic matter content in the aquatic substrate will increase the organic matter content of the sediment. The accumulation time of organic matter from water to sediment is influenced by the oceanographic factors of the waters themselves.

Winanda[12] states that the lower the current speed of a body of water, the faster the water organic matter from the water

column accumulates to the substrate or sediment, this results in organic matter from the water column moving to the sediment. Jubaedah et al.[19] state that organic matter in water will gradually settle to the bottom of the water if the current speed is low.



(a) (b)

Figure 4. Relationship between water organic matter content and sediment organic matter content: (a) Tidal Condition, (b) Low tide condition

The results of this study are quite different from the research conducted by Sihaloho[20] in the waters of Cermin Beach, Serdang Bedagai Regency, North Sumatra Province which states that the content of water organic matter has a weak relationship with the content of sediment organic matter. This is thought to be caused by the factor of different types of sediments from the waters studied. In this study, the sediment type is more dominant in mud while the sediment type in Cermin Beach is more dominant in muddy sand and gravelly sand.

4. CONCLUSION

The organic matter content of water at high tide conditions ranged from 17.38-25.28 mg/L and at low tide conditions ranged from 29.63-35.55 mg/L. This condition is categorized as not exceeding the predetermined quality standard threshold. Sediment organic matter content at high tide ranged from 2.28-5.37% and at low tide ranged from 3.46-8.62%. These conditions indicate that the sediment organic matter content is in the very low and low categories.

REFERENCES

1. Setiadi, D., Brown, A., Bustari. Distribution Target Strength in Waters Bengkalis Demersal Fish Province Riau. *Jurnal Online Mahasiswa Fakultas Perikanan dan Ilmu Kelautan Universitas Riau,* 2015.
2. Ginting, R.S., Elvira, R., Yusfiati. Inventarisasi Jenis-jenis Ikan Buntal (Famili *Tetraodontidae*) di Muara Perairan Bengkalis, Kabupaten Bengkalis, Provinsi Riau. *JOM FMIPA*, 2015; 2(1):43-56.
3. Hadinafta, R. *Analisis Kebutuhan Oksigen untuk Dekomposisi Bahan Organik di Lapisan Dasar Perairan Estuari Sungai Cisadane, Tangerang. Skripsi*. Institut Pertanian Bogor, Bogor. 2009.
4. Maslukah, L., Indrayanti, E., Rifai, A. Sebaran Material Organik dan Zat Hara Oleh Arus Pasang Surut di Muara Sungai Demaan, Jepara. *Ilmu Kelautan,* 2014; 19(4): 189 – 194.
5. BSN. *Air dan Air Limbah-Bagian 22: Cara Uji Nilai Permanganat secara Titrimetri*. Badan Standar Nasional, Banten. 2004.
6. Mucha, A.P., Vasconcelos, M.T.S.D., Nordalo, A.A. Macrobentic Community in the Douro Estuary Relation with Trace Metals and Natural Sediment Characteristics. *Environment Pollution*, 2003; 121: 160-180.

7. Rifardi. Study on Sedimentology from the Sungai Mesjid Estuary and its Environs in the Rupat Strait, the East of Sumatra Island. *Journal of Coastal Development*, 2008; 4(2):1-2.
8. BPS Bengkalis. *Kabupaten Bengkalis dalam Angka.* BPS Kabupaten Bengkalis, Bengkalis. 2020.
9. Mason, C.F. *Biology of Freshwater Pollution*. Longman, New York. 1981.
10. Yogaswara, G.M., Indrayanti, E., Setiyono, H. Pola Arus Permukaan di Perairan Pulau Tidung, Kepulauan Seribu, Provinsi DKI Jakarta pada Musim Peralihan (Maret-Mei). *Jurnal Oseanografi*, 2016; 5(2): 227– 233
11. Amri, K., Priatna, A., Muchlizar. Karakteristik Oseanografi Fisika Perairan Estuaria Bengkalis Berdasarkan Data Pengukuran In-Situ. *Jurnal Segara*, 2018; 14(1): 43-56.
12. Winanda, H. *Analisis Keanekaragaman Jenis Ikan Menggunakan Environmental DNA (eDNA) Metabarkoding di Perairan Desa Air Putih Kabupaten Bengkalis Provinsi Riau. Skripsi*. Fakultas Perikanan dan Kelautan, Universitas Riau. Pekanbaru. 2022
13. Supriyantini, E., Nuraini, R.A.T., Fadmawati, A.P. Kandungan Bahan Organik pada Beberapa Muara Sungai di Kawasan Ekosistem Mangrove, di Wilayah Pesisir Pantai Utara Kota Semarang, Jawa Tengah. *Buletin Oseanografi Marina*, 2017; 6(1): 29-38.
14. Merian, R.D., Mubarak., Sutikno. Analisis Kualitas Perairan Muara Sungai Dumai ditinjau dari Aspek Fisika, Kimia dan Biologi. *Dinamika Lingkungan Indonesia*, 2016; 3(2): 107-112.
15. Rofiki, N., Amin, B., Siregar, S.H. Analisis Bahan Organik dan Kelimpahan Fitoplankton di Perairan Muara Sungai Guntung Kecamatan Kateman Kabupaten Indragiri Hilir Provinsi Riau. *Berkala Perikanan Terubuk*, 2019; 47(3): 1-11.
16. Lestaru, A., Saru, A., Lanuru, M. Konsentrasi Bahan Organik dalam Sedimen Dasar Perairan Kaitannya dengan Kerapatan dan Penutupan Jenis Mangrove di Pulau Pannikiang Kecamatan Balusu Kabupaten Barru. Prosiding Simposium Nasional Kelautan dan Perikanan V Universitas Hasanudin, Makassar. 2018
17. Munandar, R.K., Muzahar., Pratomo, A. *Karakteristik Sedimen di Perairan Desa Tanjung Momong Kecamatan Siantan Kabupaten Kepulauan Anambas*. Fakultas Ilmu Kelautan dan Perikanan Universitas Maritim Raja Ali Haji. Tanjungpinang. 2014.
18. Simanjuntak, S.L., Muskananfola, M.R., Taufani, W.T. Analisis Tekstur Sedimen dan Bahan Organik terhadap Kelimpahan Makrozoobentos di Muara Sungai Jajar, Demak. *Journal of Maquares*, 2018; 7(4): 423-430.
19. Jubaedah, S., Wulandari, S.Y., Zainuri, M., Maslukah, L., Ismunarti, D.H. Pola Sebaran Bahan Organik di Perairan Muara Sungai Jajar, Demak, Jawa Tengah. *Indonesia Journal of Oceanography (IJOCE)*, 2021; 3(3): 7-13.
20. Sihaloho, E. *Kandungan Bahan Organik pada Air dan Sedimen di Perairan Pantai Cermin Kabupaten Serdang Bedagai Provinsi Sumatera Utara. Skripsi.* Fakultas Perikanan dan Kelautan Universitas Riau, Pekanbaru. 2018.