Analysis of Organic Matter Content in Water and Sediment in The Coastal Waters of Bengkalis Island, Riau Province

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Abstract. Anthropogenic activities in the coastal waters of Bengkalis Island, Riau Province are thought to have increased due to human activities (settlements, ports, agriculture, households and industry). This caused an increase in organic matter in water and sediment in coastal waters. The content of organic matter in water and sediment can be used as an indicator of the quality of coastal waters. The research aimed to analyze the content of organic matter in water and sediment in the coastal waters of Bengkalis Island. The used purposive sampling. The research was carried out in April – July 2021, consisting of 4 research stations and each station consisted of 3 sampling points. Sampling was carried out in the intertidal zone in the north and south of Bengkalis Island, namely station I (Air Putih Village), Station II (Jangkang Village), station III (Selat Baru Village) and station IV (Liong Estuary). The results of the analysis of organic matter content in seawater ranged from 32.39-34.89 mg/l, the highest was at station I and the lowest was at station II. The results of the analysis of organic matter content in sediment of Bengkalis Island ranged from 0.01-0.31%, the highest was at station I and the lowest was at station II. A simple linear regression test showed that the relationship between the organic matter content of seawater and sediments in the coastal waters of Bengkalis Island was classified as a strong relationship with a correlation coefficient (r) 0.720 and a coefficient of determination (R²) 0.518. The results also show that the coastal waters of Bengkalis Island have a type of sediment fraction which is dominated by sandy mud.

1. Introduction
Bengkalis Regency is one of the districts in the Riau Province. Bengkalis Regency as a whole has an area of 7,773.93 km². The area of Bengkalis Regency consists of the mainland of the eastern part of Sumatera and the archipelago. Administratively, Bengkalis Island is one of the islands in Bengkalis Regency, Riau Province with and area of 938,40 km². Geographically, Bengkalis Island is located in the Malacca Strait which is directly adjacent to with Malaysia, at coordinates 01° 31’29” North Latitude and 102° 28’13” East Longitude [1].

The coastal waters of Bengkalis Island contain organic material originating from the mainland, flowing into the estuary and sea through the movement of currents, winds and river water flows. [2] States that organic matter in marine ecology acts as a source of energy (food), as an ingredient for bacteria, plants and animals, sources of vitamins, as nutrients that can accelerate and inhibit growth so that it has an important role in regulating the life of phytoplankton in the sea.

The organic matter (MO) was assumed to be stable and relatively resistant to transformations within coastal and estuarine systems [3]. There was an expressed discrepancy between the high...
amounts of carbon being transported from land to coasts, compared to the relatively small amounts of terrestrial carbon detectable in oceanic waters and sediments [4].

There is strong evidence that significant transformations of both particulate and dissolved organic matter fractions occur in coastal and estuarine waters, as well as along their transport downstream [5; 6]. These transformational processes are photo degradation, biodegradation and flocculation (causing increased sedimentation), and the relative importance of these processes will vary along the salinity gradient [7; 8; 6; 4]. Natural organic matter is a complex mixture of organic compounds that are present on the sea surface and some of it settles in the sediment. Natural organic materials consist of aliphatic to aromatic compounds. According to [9], when plant parts such as leaves are carried away by rainwater flows into water bodies, the foliage will release large amounts of organic when it remains submerged in water. This indicates that plant degradation is one of the sources for the formation of natural organic matter. [10] Stated that organic matter is a collection of complex organic compounds that are or have undergone a decomposition process, which can have an impact on decreasing dissolved oxygen content.

According to [11], all organic matter found in waters contains carbon (C) which in combination with one or more other elements. Main ingredients organic compounds are carbohydrates, proteins, fats and nucleic acids (nucleic acid). Every Organic materials have different physical, chemical and toxic characteristics. Organic materials of various types found in nature will be overhauled (decomposition) through the oxidation process. Oxidation can take place in an aerobic atmosphere (presence of oxygen) and anaerobic atmosphere (no oxygen).

Coastal waters on Bengkalis Island have also been used for various community activities such as tourism, settlement, tourism, fishing, ship transportation, industrial waste disposal and domestic waste (anthropogenic). The increased anthropogenic activity in the coastal waters of Bengkalis Island has the potential to increase the organic matter content in seawater and sediments, causing the waters to be polluted. According to [12], sediment in coastal waters greatly affects the quality of the water above it, especially when there is agitation either as a result of turbulence or upwelling. At this time, it can directly and indirectly affect water quality standards and marine life. The presence of organic waste in monitoring waters can also be seen from two different sides, when the concentration exceeds the standard threshold, the effect on the aquatic environment becomes negative.

According to [13], industrialization has a negative effect in the form of industrial waste, both solid and liquid, affecting the surrounding environment. If the waste is released into free waters, there will be a change in the value of the waters both in quality and quantity so that the waters can be considered polluted. According to [14], the material deposition process occurs due to the transport of weathering material from land to sea and material transport factors that occur in the sea. [15] Stated that marine sediments contain organic and inorganic content either dissolved or suspended with an unconsolidated particle texture.

Based on this, research on the analysis of organic matter content in seawater and sediments in the coastal waters of Bengkalis Island, Riau Province needs to be studied. This is for the sustainable management and sustainability of coastal waters ecosystems and while maintaining the natural environment of coastal ecosystems on Bengkalis Island. This study aimed to analyze the content of organic matter in seawater and sediments in the coastal waters of Bengkalis Island, Riau Province. The benefit of the research is to obtain information and databases on the content of organic matter in seawater and sediments in the coastal waters of Bengkalis Island, Riau Province.

2. Materials and Methods

The research was carried out in April – July 2021 in the northern and southern parts of the coastal waters of Bengkalis Island, Bengkalis Regency, Riau Province. The method used in the research is the survey method, which is carried out in the field directly to collect data and samples. Determination of the observation location by purposive sampling, consisting of 4 stations with each station consisting of 3 sampling points. Sampling was carried out in the intertidal zone, namely Station I located at the port of Air Putih Village, station II located in the coastal waters of Jangkang Village, station III located in
the coastal tourist area of Selat Baru Village and station IV located at the Liong River Estuary. For more details can be seen in Figure 1.

The materials used in the study were seawater and sediment samples taken from the coastal waters of Bengkalis Island. Data obtained directly (in situ) from the field consists of parameters of the quality of marine waters such as water brightness, temperature, acidity (pH), salinity and current speed. The seawater and sediment samples obtained were then taken to the Chemical Oceanography Laboratory, Department of Marine Science, Faculty of Fisheries and Marine Affairs, Riau University for analysis such as the total organic matter content of seawater, sediment and sediment type.

![Figure 1. Research Location Map in the coastal waters of Purnama Village.](image)

The data that has been obtained, then analyzed using the formula:

### 2.1 Total Organic Content of Water

Analysis of total organic matter content in water used the Titrimetric method of SNI 06-6989.22-2004 [16]. The first step was to heat 100 ml of distilled water at 70°C, and then added with 5 ml of sulfuric acid. The solution was added with 10 ml (V1) of 0.01N (N1) oxalic acid solution, then titrated with 0.01N potassium permanganate until it turned pink. The volume was recorded (V2) and the true normality of potassium permanganate (b) was calculated as:

\[
b = \frac{V_1 \times N_1}{V_2}
\]

The next step was to add 100 ml (d) of sample water, followed by three addition of 3 boiling stones and potassium permanganate until the solution turned pink. Next, 5 ml of 8N sulfuric acid (c) was added and heated on a hot plate at a temperature of 105°C ± 2°C to boiling and added 10 ml of 0.01N potassium permanganate, heated again to boiling for another 10 minutes. The solution was titrated with 0.01N potassium permanganate until it turned pink. The volume that was used for
titration (a) was recorded. If the volume for titration was more than 7 ml, then the samples was diluted (f) and repeated the titration. Total organic matter was calculated using the formula:

\[
\text{Total Organic Matter (mg/l)} = \left[ (10+a) b - (10xc) \right] 1 \times 31.6 \times 1000 \times f
\]

D

2.2 Sediment Organic Material Content
Analysis of organic matter content in sediments was carried out using the Loss on Ignition method [17]. The first step was done by placing the cup in the oven at a temperature of 105°C for 15 minutes then cooled in a desiccator for 15-20 minutes and weighed as the weight of the cup (b). The sediment sample was put in a ±50 gram cup and placed in an oven at 105°C for 24 hours, after that it was cooled in a desiccator for 15 minutes. Then weighed (a), the dried sample was burned in a furnace at a temperature of 550°C for 3 hours, cooled in a desiccator for 30-60 minutes and then weighed (c), calculated using the formula:

\[
\text{Organic Matter Content (\%)} = \frac{a - c}{a - b} \times 100
\]

2.3 Sediment Fraction
Sediment taken from the research site was used for sediment type analysis. The stages of sediment analysis followed [18], using the stratified sieving method to obtain 1-4 and the pipette method to obtain 5-7. Sediment fraction classification is based on the proportion of gravel, sand and silt particle content which is then plotted by the percentage value into Sheppard's triangle.

2.4 Relationship between Total Organic Matter Content of Seawater and Sediment
The analysis used is simple linear regression analysis using SPSS software. Linear regression analysis to see the relationship between one independent variable (X) and the dependent variable (Y) or in the sense that there are variables that influence and there are variables that are influenced.

3. Results and Discussion

3.1. Total Organic Matter Content in Bengkalis Island Seawater
The presence of organic matter in seawater greatly determines the environmental quality of the coastal waters of Bengkalis Island. If the organic matter content increases, it can cause changes in the coastal water environment. The content of total organic matter of seawater on Bengkalis Island at the four research stations ranged from 31.60-35.16 mg/l. The results of the analysis of the total organic matter content in Bengkalis Island seawater can be seen in Table 1.

| Table 1. Total organic matter content in Bengkalis Island seawater. |
|---------------------------------------------------------------|
| Station | Sampling Point | Total Organic Matter (mg/l) |
|---------|----------------|----------------------------|
| I (Air Putih Village) | 1 | 35.16 |
| | 2 | 34.76 |
| | 3 | 34.76 |
| Average | | 34.89 |
| II (Jangkang Village) | 1 | 33.18 |
| | 2 | 32.39 |
| | 3 | 31.60 |
| Average | | 32.39 |
| III (Selat Baru Village) | 1 | 34.37 |
| | 2 | 34.37 |
| | 3 | 31.60 |
| Average | | 33.44 |
| IV (Liong Estuary) | 1 | 31.60 |
| | 2 | 34.76 |
Based on Table 1, it can be seen that the total organic matter content in seawater between research stations did not show a significant difference. The average total organic matter content of seawater on Bengkalis Island ranges from 32.39-34.89 mg/l. The highest total organic matter content of seawater was at station I (34.89 mg/l) and the lowest was at station II (32.39 mg/l).

The total organic matter content of Bengkalis Island seawater is still in the range of good quality standards and has not exceeded the threshold. According to [19], based on the Ministry of Population and Environment Decree Number 2 of 1988 concerning Wastewater Quality Standards, it is stated that the threshold for organic matter content in water is 80 mg/l.

Organic compounds come from compounds naturally occurring carbon. Carbon organic material consists of a) Organic carbon material from land carried by rain or river runoff (terrigenous), and b) Organic carbon material from the ocean in the form of the production of marine organisms (biogenous) such as biogenic carbonate derived from foraminifera or molluscs [20; 21]. Terrigenous material transported by rivers and rain runoff both are affected by high rainfall and ends up being deposited in the sea [20; 22].

3.2. Density of marine debris

Organic material that settles in the sediment (seabed) will also be deposited in the form of biological and non-biological materials, which are carried from land, air to coastal waters. According to [23], organic matter in sediments has a variety of sizes sediment grains as a result of dynamics sorting transport to deposition. Therefore, the sea plays an important role in the hydrological, chemical, climate and weather balance. The results of the analysis of sediment types in the waters of Bengkalis Island can be seen in Table 2.

| Station | Sampling Point | Sediment Fraction (%) | Sediment Types |
|---------|----------------|-----------------------|----------------|
|         |                | Gravel | Sand | Mud   |            |
| I       | 1              | 2,71   | 13,84| 83,45 | Mud         |
|         | 2              | 0,14   | 1,74 | 98,12 | Mud         |
|         | 3              | 0,07   | 2,22 | 97,72 | Mud         |
| II      | 1              | 1,01   | 47,17| 51,81 | Sandy Mud   |
|         | 2              | 0,05   | 66,25| 33,7  | Muddy Sand  |
|         | 3              | 0,08   | 54,35| 45,57 | Muddy Sand  |
| III     | 1              | 7,91   | 49,29| 42,8  | Muddy Sand  |
|         | 2              | 5,49   | 22,17| 72,34 | Sandy Mud   |
|         | 3              | 1,60   | 28,46| 69,95 | Sandy Mud   |
| IV      | 1              | 3,88   | 33,7 | 62,42 | Sandy Mud   |
|         | 2              | 5,03   | 30,49| 64,48 | Sandy Mud   |
|         | 3              | 22,26  | 38,0 | 39,74 | Gravel Sand Mud |

Based on Table 2 it can be seen that the sediment type at station I has a sediment type dominated by mud, station II has a sediment type dominated by muddy sand, station III has a sediment type dominated by sandy mud, and station IV has a sediment type dominated by sandy mud. The difference
in sediment type between stations is thought to be due to the influence of geographical conditions and water conditions at each station. Station I is located in the Bengkalis Island strait and the sediment type is influenced by the flow of two rivers flanking the station. Station II is located in the Malacca Strait, there is no influence of river flow. At stations III and IV, the water conditions are almost the same because they are located in a location that is fed by a large river.

According to [24], river flow affects the size of the floating sediment discharge value. The greater the river flow discharge, the higher the floating sediment discharge value. Vice versa, the smaller the flow rate, the smaller the floating sediment discharge value. In addition, influenced by the presence of river flow, the type of sediment is also influenced by oceanographic factors in the area. Sediment deposits are widely distributed on land, coast and sea. Sediment characteristics such as grain size, grain shape, texture, sorting, and the mineral composition of a deposit will differ from place to place other. The characteristics of these sediments are highly dependent on the type and location origin of rock sources and characteristics of sedimentary processes.

3.3. Organic Matter Content in Bengkalis Island Sediment

Accumulation of various chemical compounds in marine sediments comes from the seawater column. This can increase the content of phosphate and organic carbon in the sediment (seabed) higher than at sea level. However, tides and currents can cause these chemical compounds are lifted back from the sediments into the seawater column. The results of the analysis of the organic matter content of the sediment at each sampling point can be seen in Table 3.

### Table 3. Organic matter content in Bengkalis Island sediments.

| Station | Sampling Point | Organic Matter Content (%) |
|---------|----------------|---------------------------|
| I       | 1  | 33.98          |
|         | 2  | 36.98          |
|         | 3  | 21.40          |
| Average |    | 30.79          |
| II      | 1  | 2.53           |
|         | 2  | 0.50           |
|         | 3  | 0.35           |
| Average |    | 1.13           |
| III     | 1  | 4.61           |
|         | 2  | 4.18           |
|         | 3  | 1.48           |
| Average |    | 3.42           |
| IV      | 1  | 1.02           |
|         | 2  | 11.21          |
|         | 3  | 7.28           |
| Average |    | 6.50           |

Based on Table 3, it can be seen that the average percentage of organic matter content in Bengkalis Island sediments varies widely between research stations, which are in the very low-high category. The average value of the percentage of Bengkalis Island sediment organic matter content ranged from 1.13-30.79%. The lowest value of sediment organic matter content was found at station II and the highest was at station I.

Research results showed that Station I has a high classification, stations II and III are in a low classification, and station IV is in a medium classification. The value of organic matter content was classified using Reynolds classification in [25], sediment organic matter content consists of 5 classes, namely: > 35% (very high organic matter content); 17-35% (high organic matter content); 7-17% (medium organic matter content); 3.5-7% (low organic matter content).
Differences in the value of sediment organic matter content between stations can be caused by the entry of organic matter from litter originating from mangroves and different types of sediment at each research station. The low average organic matter content at stations II and III is thought to be influenced by the base substrate of this station having a fraction dominated by muddy sand and sandy silt, where these fractions accumulate less organic matter carried by seawater flows. The high organic matter content at station I was caused by the base substrate from station I having a mud fraction and was located in the port area and mangrove forest. According to [26], sandy sediments have low organic matter content. This is because these sediments allow good oxidation due to larger pore water, so that organic matter will run out quickly. On the other hand, in the type of mud sediment which has a finer texture, the organic matter content is relatively high.

3.4. Measurement of Bengkalis Island Coastal Water Quality Parameters

The results of the measurement of the quality of the coastal waters of Bengkalis Island aim to describe the condition of the coastal waters at the time the research was carried out, including of organic matter content in seawater and sediments. For more details can be seen in the Table 4.

Table 4 The results of the measurement of the quality of the coastal waters of Bengkalis Island

| Station | Sampling Point | Water Brightness (cm) | pH | Temperature (°C) | Salinity (ppt) | Current Speed (m/s) |
|---------|----------------|-----------------------|----|------------------|---------------|-------------------|
| I       | 1              | 17,5                  | 6,0 | 33,0             | 25            | 0,02              |
|         | 2              | 17,5                  | 6,0 | 31,0             | 25            | 0,02              |
|         | 3              | 18,5                  | 6,0 | 33,0             | 25            | 0,02              |
|         | Average        | 17,8                  | 6,0 | 32,3             | 25            | 0,02              |
| II      | 1              | 15,0                  | 7,0 | 30,0             | 28            | 0,02              |
|         | 2              | 16,5                  | 7,0 | 30,0             | 28            | 0,02              |
|         | 3              | 17,5                  | 7,0 | 31,0             | 28            | 0,02              |
|         | Average        | 16,3                  | 7,0 | 30,3             | 28            | 0,02              |
| III     | 1              | 10,0                  | 7,0 | 34,0             | 28            | 0,02              |
|         | 2              | 12,5                  | 6,0 | 34,0             | 28            | 0,03              |
|         | 3              | 12,0                  | 7,0 | 34,0             | 28            | 0,03              |
|         | Average        | 11,5                  | 6,7 | 34,0             | 28            | 0,03              |
| IV      | 1              | 42,5                  | 6,0 | 33,0             | 21            | 0,13              |
|         | 2              | 40,0                  | 6,0 | 32,0             | 21            | 0,10              |
|         | 3              | 41,5                  | 6,0 | 32,0             | 21            | 0,10              |
|         | Average        | 41,3                  | 6,0 | 32,3             | 21            | 0,11              |

Based on Table 4, it can be seen that the average measurement results of the degree of acidity (pH) ranged from 6-7, the brightness of the waters ranged from 11.5-41.3 cm, the water temperature ranged from 30.3-34.0 °C, the salinity of the waters was ranged from 21-28 ppt and the current speed ranged from 0.02-0.11 m/s.

For the survival of marine biota, there are parameters that support life such as water physics parameters, chemistry waters and sediment chemistry that is a place for marine life to live. Changes in the physical and chemical components, in addition to causing a decrease in sea water quality also causes the bottom of the water (sea sediment) to decrease. This matter can affect the life of aquatic biota, especially on the structure of the biotic community. Decreasing environmental quality can be identified from changes in the physical, chemical and biological components of sea waters [27].

3.5 Relationship of Total Organic Matter Content in Seawater and Sediment in the coastal waters of Bengkalis Island
The results showed that there was a relationship between the content of organic matter in seawater and the content of organic matter in sediments in the coastal waters of Bengkalis Island. For more details can be seen in Figure 2.

Based on Figure 2, it can be seen that the correlation value (r) is quite strong, which is 0.720 with R^2 of 0.518 (51.8%). This explains that the total organic matter content of seawater and sediment in the coastal waters of Bengkalis Island has a strong relationship. Value of Sig. 0.008 (0.008 <0.05) explains that the organic matter content of seawater affects the organic matter content of sediments in the coastal waters of Bengkalis Island. Organic material carried by currents, both by ocean currents and from rivers over time will experience deposition in sediments. The deposition of organic matter in the sediment can increase the concentration of organic matter in the sediment.

According to [28], organic matter comes from the process of decomposition, weathering, plant decomposition, the rest of dead organisms, waste disposal and leftover feed with the help of bacteria to decompose into nutrients. The remaining organic compounds that are not utilized by organisms on the surface of the water will eventually dissolve in the water and settle to the bottom of the water. This causes sediment particles at the bottom of the water to contain nutrient-rich substances, which come from the decomposition of sediments and compounds from dead flora and fauna bodies.

The content of organic matter in seawater and sediments in the coastal waters of Bengkalis Island can be used as an indicator of the quality of coastal waters. The results showed that the organic matter content in the water and sediment had not exceeded the threshold or the carrying capacity of the coastal waters of Bengkalis Island. This also has not caused the impact of decreasing the quality of coastal waters or silting (sedimentation) in the coastal waters of Bengkalis Island.

4. Conclusion
The coastal waters of Bengkalis Island have a sediment type that is dominated by sandy mud. The total organic matter content of seawater in the coastal waters of Bengkalis Island ranges from 32.9 to 34.89 mg/l, including the category of good quality standards. The highest total organic matter content of seawater is found at the port location (station I) which is flanked by two rivers. The organic matter content of the sediment ranged from 1.13-30.79%. The highest total organic matter content was at the port location (station I) with mud sediment type.

The content of organic matter in seawater and sediments in the coastal waters of Bengkalis Island has differences, the value of total organic matter content in seawater is more with an average of 33.51 mg/l, while the total organic matter content in sediments is 10.46%. The relationship between the total
organic matter content of seawater and sediment is indicated by the values of \( r = 0.720 \) and \( R^2 = 0.518 \) (51.8%). This means that the total organic matter content of seawater and sediment has a strong relationship. Further research needs to be done regarding the content of nitrate, phosphate, chlorophyll and phytoplankton in the coastal waters of Bengkalis Island.

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