Identification of microplastic waste in sea water, sediment in the sea waters of Dumai City, Riau Province

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Abstract. This study aims to determine the types of microplastics in the waters of Dumai City. The method used in this research is a survey method, namely by direct observation in the field and data analysis in the laboratory. Based on research from seawater and sediment taken from seawater in Dumai City, it was found three types of microplastics, referred to as Fiber, Fragment and Filament, whose abundance was significantly different. The average abundance of microplastics in seawater is 0.130-0.200 particles/L; The sediment was 193.33-746.67 particles/Kg.

1. Introduction
Plastics are a topic that is often discussed when discussing waste and environmental issues. Plastics are one of the most widely used materials in the world and are widely integrated into today's lifestyle and make a major contribution to almost all areas of products and services. Its distinctive characteristics make it very useful especially in regard to the fact that plastics are flexible and durable. This characteristic is very useful when plastic is used in everyday life. But when plastic is dumped into the environment it can last for a very long time. In other words a plastic ingredient that enters the environment as plastic waste will not decompose anytime soon. It takes hundreds of years for the plastic to degrade into microplastics and nano plastics through physical, chemical, and biological processes.

Microplastic is a plastic particle with a diameter of approximately 5 mm. Microplastic is divided into two big size categories, including (1-5 mm) and small (<1 mm) [1]. [2] states that microplastic particles are categorized into 4 different types: fiber, fragment, film and pellet (granules). Plastic particles are further analyzed and determined into 4 types of plastic products: fibers from ropes and fishing nets (polypropylene fibers), fragments resulting from plastic use, film derived from food packaging and pellets from plastic industrial raw materials; as well as five size categories based on dimension length measurements of each of the longest particles: 2.5-5mm, >5-10 mm, and >10 mm.

Common types of microplastics entering the water include: fragments, fiber, and film [3]. In addition to the surface of the water, microplastics are also found on the bottom of the water or sediment. Based on research conducted by [4] the results of the review showed that the highest concentration of microplastic concentrations was found in sediments compared to the surface of the water [5]. The presence of microplastics at the base of the sediment is influenced by gravitational forces and a higher density of plastic than water density causes plastic to sink and accumulate in sediment [6].

The sea water of Dumai is one of the coastal areas, located on the east coast of Sumatra’s island, support for various community activities (anthropogenic). It is thought to produce pollutants (domestic and industrial waste), including organic and inorganic materials. The waters of Dumai also gained high pressure due to infrastructure, settlement, landscaping, agriculture, fisheries, and industrial
development. The pollution directly or indirectly can cause a decrease in the quality of sea water, environmental damage and affect the life of marine biota.

2. Materials and Methods
This research was held in September 2020 with sampling in the sea waters of Dumai, Riau province. Further, samples in the analysis in Chemical Oceanography Laboratory of the Faculty of Fisheries and Marine of Riau University. Research location and station Point can be seen in Figure 1. Seven (7) sampling point can be seen in Table 1.

![Figure 1. (a) Map of research location (b) Station point map](image)

| Station | Location | Coordinate |
|---------|----------|------------|
| II      | beach of teluk makmur | 1°38°30.15483"N 101°32°45.89645"E |
| III     | pelindo port     | 1°41°16.43133"N 101°27°32.70201"E |
| IV      | kelurahan pangkalan sesai’s water | 1°41°25.85627"N 101°26°19.42299"E |
| V       | bandar bakau     | 1°41°26.23027"N 101°25°58.16179"E |
| VI      | TPI kelurahan pangkalan sesai | 1°41°45.42516"N 101°24°54.47716"E |
| VII     | marine station purnama | 1°43°0.42829"N 101°23°25.51687"E |

Sea water sampling was carried out by filtering seawater using plankton net with a size of 0.40 millimeters. The seawater was taken on the Surface water section with a 10 liter volume bucket with 10 retries. Microplastic identification was conducted in the Chemical Oceanography Laboratory of Marine Sciences Faculty of Fisheries and Marine of Riau University. The sea water samples that had been on at any point of the station are identified by using international methods conducted by [7].

Sample preparation was done by preparing samples, creating the logsheet of workmanship and preparing the materials and tools needed in the next process. Sample separation was filtered using a sieve smaller than 300 μm to separate the meso trash with micro. The water a sieve filtered back using whatman filter paper size 45 μm [8]. Then the samples that had been filtered out were visually observed under the microscope and microplastic found in the count based on the type found. The microplastic implousing can be calculated based on the number of particles found in the filtered water [9].

\[ C = \frac{n}{V} \]

Where, C is abundance (particle/L); n is the number of particles; and V is the volume of filtered water (L).
Sediment sampling used a 4 inch diameter PVC pipe, by sliding the paralon pipe to a subtract sediment. Sediment taken in section 0-10 cm. Microplastic separation from sediment was done by stages: (a) drying, (b) reduction of volume, (c) separation of density, (d) filtering, and (e) visually sorting [4].

Samples of sediments were taken as much as 50 g and then in the oven with a temperature of 105 °C for 24 hours (depending on the sedimentary condition). Sediments that had been dried, then smoothed using mortar [10], the sediment that had been mashed on the move into the glass beaker to be mixed with NaCl solution for density separation and re-let for 24 hours. After 24 hours the sample was with under the microscope and recorded every type of microplastic found. Based on the initial weight of the sample used as much as 50 g, the result of each sample in the analysis is converted to 1 kg by transferring it to 20 [11] with particle/Kg parameter units.

The abundance data of microplastic particles was then tabulated and analysed statistically. The abundance of particles each station point was analyzed by ANOVA one-way test. Data analysis was done using Microsoft Excel and SPSS 19 software.

3. Results and Discussion

3.1. Microplastic Abundance

The abundance of microplastics in seawater and sediment in the marine waters of Dumai during research shown a varied amount. The average abundance of microplastics in seawater and sediment found in all seven research stations in the sea waters of Dumai can be seen in Table 2 and Table 3.

### Table 2. The average abundance of microplastics found in seawater in the sea water of Dumai

| Station | Total Microplastic | Average Abundance Microplastic (partikel/L) |
|---------|-------------------|------------------------------------------|
| Sea Water |                  |                                          |
| I       | 57                | 0.190 ± 0.0346                           |
| II      | 54                | 0.180 ± 0.3605                           |
| III     | 78                | 0.260 ± 0.1122                           |
| IV      | 39                | 0.130 ± 0.3605                           |
| V       | 49                | 0.130 ± 0.1012                           |
| VI      | 60                | 0.200 ± 0.0529                           |
| VII     | 50                | 0.166 ± 0.0550                           |

### Table 3. Average abundance of microplastic found in sediment in sea water of Dumai

| Station | Total Microplastic | Average Abundance Microplastic (partikel/Kg) |
|---------|-------------------|------------------------------------------|
| Sediment |                  |                                          |
| I       | 49                | 326.67 ± 254.82                          |
| II      | 112               | 746.67 ± 174.73                          |
| III     | 67                | 446.67 ± 161.65                          |
| IV      | 61                | 406.67 ± 150.11                          |
| V       | 61                | 406.67 ± 213.85                          |
| VI      | 47                | 313.33 ± 80.82                           |
| VII     | 44                | 293.33 ± 94.51                           |

Based on Table 2 and Table 3 it can be seen that the average abundance of microplastics in seawater ranges between 0.130-0.200 particle/L, whereas in sediment ranges from 293.33-746.67 particles/Kg. The results of the study also showed that the average The highest microplastic abundance in seawater is III (0.260 particle/L), sediment in the highest sediment is the research station II (746.67 particle/Kg).

3.2. Microplastic Type

The list Identification of microplastic samples from all seven research stations in seawater obtained 3 types of microplastics referred to as fiber, fragment and filament can be seen in Figure 2. The average type of microplastic found in the sea waters of Dumai for more details can be seen in Figure 3.

Based on Figure 3 can be seen that the average type of microplastic found in seawater is fiber ranging from 6.0-11.0 particles/L; Fragment ranges from 2.7-6.0 particles/L; and filament ranges between 2.7-8.7 particles/L. The highest type of fiber is found on the station III and the lowest is on the IV stations.
The highest type of fragment microplastic is on station III and the lowest is on station IV. While the highest type of film microplastic is on the III station and the lowest is on the II, V and VII stations.

Identification of microplastic samples from all seven research stations on the sediment of Dumai sea water obtained 3 types of microplastics referred to as fiber, Fragmet, film for more details can be seen in Figure 4. The average type of microplastic found can be seen Figure 5.

Based on Figure 5 can be seen below the average type of microplastic that is found in sediment fiber 4.3-14.0 particles/Kg; Fragment 2.7-12.0 Particles/Kg, Film 2.3-11.3 particles/Kg. The highest type of fiber is on the station II and the lowest is on the I station. The highest type of fragment microplastic is on station II and the lowest is on the VII station. While the highest type of film microplastic is on the station II while the lowest is on the VII station.

![Figure 2](image1.png)  ![Figure 3](image2.png)  ![Figure 4](image3.png)

**Figure 2.** Types of microplastics found in sea water of Dumai: (a) fiber; (b) Film; (c) fragment

**Figure 3.** Average type of microplastic on each station of the water Sea of Dumai.

![Figure 4](image4.png)

**Figure 4.** Types of microplastics found in sediment of marine waters of Dumai: (a) fiber; (b) Film; (c) fragment.
3.3. Quality Parameters of Dumai Sea Water

Measurement of sea water quality parameters Dumai in seven research stations is aimed to know the condition of the water is in good condition or not good. The results of the measurement of sea water quality parameters Dumai for more details can be seen in Table 4.

| Station | Repetition | Temperature (°C) | pH  | Salinity (ppt) | Brightness (cm) | Current speed (m/dt) | Deep (m) |
|---------|------------|-----------------|-----|----------------|-----------------|---------------------|----------|
| I       | 1          | 32              | 5   | 30             | 50              | 0.20                | 1.67     |
|         | 2          | 31              | 5   | 30             | 40              | 0.06                | 1.78     |
|         | 3          | 32              | 5   | 31             | 45              | 0.12                | 1.10     |
| II      | 1          | 31              | 7   | 30             | 50              | 0.12                | 0.48     |
|         | 2          | 29              | 7   | 33             | 80              | 0.08                | 1.18     |
|         | 3          | 29              | 7   | 32             | 73              | 0.15                | 0.97     |
| III     | 1          | 29              | 5   | 30             | 53              | 0.13                | 0.99     |
|         | 2          | 29              | 5   | 31             | 49              | 0.07                | 0.87     |
|         | 3          | 28.5            | 5   | 30             | 51              | 0.10                | 1.02     |
|         | 1          | 28.5            | 5   | 30             | 50              | 0.09                | 0.85     |
| IV      | 2          | 29              | 5   | 30             | 45              | 0.13                | 0.79     |
|         | 3          | 29              | 5   | 30             | 47              | 0.17                | 0.84     |
| V       | 1          | 30              | 5   | 30             | 65              | 0.17                | 0.93     |
|         | 2          | 32              | 5   | 30             | 45.5            | 0.15                | 0.91     |
|         | 3          | 32              | 5   | 30             | 68              | 0.11                | 0.88     |
| VI      | 1          | 30              | 5   | 30             | 62.5            | 0.18                | 1.19     |
|         | 2          | 32              | 5   | 30             | 65              | 0.15                | 1.41     |
|         | 3          | 32              | 5   | 30             | 47.5            | 0.11                | 1.03     |
|         | 1          | 29              | 5   | 30             | 50              | 0.17                | 0.75     |
| VII     | 2          | 30              | 5   | 31             | 32.5            | 0.12                | 0.81     |
|         | 3          | 32              | 5   | 30             | 57.5            | 0.16                | 0.83     |

Based on Table 4, it can be seen that the result of the measurement of the sea water quality parameters of Dumai in all seven research stations are in good condition or still under the pollution threshold. The average quality parameters of Dumai's sea waters are the temperature ranges between 28.8-31.7 °C; pH levels 5-7; Salinity ranges between 30-31.7 ppt; Brightness ranges between 46.7-67.7; and current velocity ranges between 0.10-0.14 m/sec and Deep ranges between 0.79-1.52 m.
Apart from the parameters above, organic matter content is also one of the factors affecting water quality. As for organic matter in the seven research stations in Dumai sea waters, it can be seen in Table 5.

| Station | Repetition | Organic matter component (%) |
|---------|------------|------------------------------|
| I       | 1          | 0.74                         |
|         | 2          | 1.33                         |
|         | 3          | 0.75                         |
|         | 1          | 1.25                         |
| II      | 2          | 0.01                         |
|         | 3          | 1.46                         |
|         | 1          | 0.20                         |
| III     | 2          | 0.05                         |
|         | 3          | 0.27                         |
|         | 1          | 2.12                         |
| IV      | 2          | 1.89                         |
|         | 3          | 1.86                         |
|         | 1          | 0.22                         |
| V       | 2          | 0.76                         |
|         | 3          | 1.71                         |
|         | 1          | 1.08                         |
| VI      | 2          | 3.03                         |
|         | 3          | 3.95                         |
|         | 1          | 4.77                         |
| VII     | 2          | 7.34                         |
|         | 3          | 13.82                        |

The high amount of organic matter that enters the water comes from increased activity on land such as fertilization in rice fields and ponds, cultivation of both plants and fish in ponds, industry and household activities that enter the body of water and settle at the bottom of the water [12].

The average content of organic matter found in Dumai sea waters is still in the category of very low and medium and high. The average value of organic matter at station I is 1.82%, station II 2.17%, station III 0.57%, station IV 4.73%, station V 2.96%, station VI 12.25%, and station VII is 22.53%. The value of organic materials is grouped based on the criteria of organic matter in sediment so that it is obtained the value of organic material content in stations I, II, IV, and V belongs to the low category of 3.5 – 7% and station VI belongs to the moderate category of 7 – 17%, while station VII belongs to the high category of >17%. [13]. Organic matter will have a strong relationship with the texture of the sediment. The texture of sediments that have a smaller grain size will contain higher organic matter as well as vice versa, if the size of the sedimentary grain is larger, the organic material contained will be less.

According to [14] in fine sediments the percentage of organic matter is higher than the rough sediment, it is also influenced by environmental conditions, where a calm environment allows the deposition of mud followed by the accumulation of organic matter to the bottom of the water, while in rough sediments, the content of organic matter is low because the finer particles do not settle. The high amount of organic matter that enters the water comes from increased activity on land such as fertilization in rice fields and ponds, cultivation of both plants and fish in ponds, industry and household activities that enter the body of water and settle at the bottom of the water [15].

4. Conclusion
The type of microplastic obtained on each sample is fiber, fragment, film. The most type of fiber, film, and fragment microplastic particles found on each sample, except pellets. On the average sea water sample the highest abundance of microplastic particles is found on the station VI, on the sediment sample station II was a station with an average abundance of the highest microplastic particles. On the
lowest average sea water sample of microplastic particles is found at station IV, on the average sedimentary sample of the abundance of microplastic particles on the VII station.

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References
[1] Tankovic M, Perusco V S, Godrijan D and Pfannkuchen M 2015 Marine plastic debris in the northeastern Adriatic Book of abstracts National Oceanic and Atmospheric Administration Programmatic environmental assessment (PEA) for the NOAA Marine Debris Program (MDP)
[2] Claessens M, Meester S D, Landuyt L V, Clerck K D and Janssen C R 2011 Occurrence and distribution of microplastics in marine sediments along the Belgian coast Marine Pollution Bulletin 62 2199–2204
[3] Dewi I S, Budiarsa A and Ritonga I R 2015 Distribusi mikroplastik pada sedimen di Muara Badak, Kabupaten Kutai Kartanegara Depik 4 121–131
[4] Hidalgo-Ruz V, Gutow L, Thompson R C and Thiel M 2012 Microplastics in the marine environment: A review of the methods used for identification and quantification. Environmental Science and Technology
[5] Chubarenko I, Bagaev A, Zobkov M and Esiukova E 2016 On some physical and dynamical properties of microplastic particles in marine environment Marine Pollution Bulletin
[6] Woodall L C, Gwinnett C, Packer M, Thompson, R C, Robinson, L. F and Paterson G L J 2015 Using a forensic science approach to minimize environmental contamination and to identify microfibres in marine sediments Marine Pollution Bulletin
[7] Kovač V M, Palatinus A, Koren Š, Peterlin M, Horvat P and Kržan A 2016 Protocol for microplastics sampling on the sea surface and sample analysis Journal of Visualized Experiments
[8] Hastuti A 2014 Distribusi spasial sampah laut di ekosistem mangrove Pantai Indah Kapuk Jakarta (Bogor: Institut Pertanahan Bogor)
[9] National Oceanic and Atmospheric Adminisration 2013 Programmatic environmental assessment (PEA) for the NOAA Marine Debris Program (MDP) NOAA
[10] Mohamed N N H and Obbard J P 2014 Microplastics in Singapore’s coastal mangrove ecosystems Marine Pollution Bulletin
[11] Qiu Q, Peng J, Yu X, Chen F, Wang and Dong F 2015 Occurrence of microplastics in the coastal marine environment: First observation on sediment of China Marine Pollution Bulletin 98 274–280
[12] Lestarai S 2018 The dark side of the Lasem Maritime Industry Journal of Maritim Studies and National Integration 2 91-100
[13] Rosmarkam A and Yuwono N W 2002 Ilmu Kesuburan Tanah (7th ed.) (Surabaya: Kanisius)
[14] Nelson D W and Sommers L E 2018 Total carbon, organic carbon and organic matter https://doi.org/10.2136/sssabookser5.3.c34
[15] Faizal A, Jompa J, Nessa N and Rani C 2011 Dinamika spasio-temporal tingkat kesuburan perairan di Kepulauan Spermonde Jurnal Ilmu Kelautan 3(2) 1–16