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*Research article*

# Distribution of Microplastic at Sediment on Balikpapan Coastal Area

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## Abstract

Coastal areas are often in the spotlight related to environmental problems, such as plastic waste. Coastal and coastal areas often face complex problems related to plastic waste, including microplastics. Microplastics (MPs) are tiny pieces of plastic that are as small as ≤ 5 mm and possibly pollute the environment. The study aimed to identify the presence and abundance of microplastics contaminating the coastal areas of Balikpapan City. Sediment samples were taken at a depth 0-10 cm. The observations were carried out in several stages; those stages are the drying stage, volume reduction, density separation, and counting using a microscope. The microplastic observation results with the microscope showed four types: fragment-shaped microplastics, phylum-shaped microplastics, fiber microplastics, and microbead-shaped microplastics. The highest number of microplastic particles was found at the Kampung Atas Air point, about 201 particles / 100 grams of dry sediment and the least number of microplastic particles were found at the Monpera point, about 16 particles / 100 grams of dry sediment. Microplastics with fiber form dominated all the study areas. Environmental conditions and pollutant sources influence the difference in the number of microplastics.

**Keywords:** microplastics, sediment, Balikpapan coastal

## 1. Introduction

The use of plastic materials is increasingly widespread. This is because plastic's nature is vital, not easily damaged, and easy to carry anywhere. Plastics that are not used, damaged, or not like their original function will become waste called plastic waste. Plastic waste is a problem that is of concern globally. The amount of plastic waste in Balikpapan City for the period 2017 - 2018 according to the National Waste Management Information System (SIPSN) from a total of 457.93 tons/day, the percentage of plastic waste is 14.41% of the total waste generation. Plastics are made of crude oil and have long, repeating carbon chains. This is what makes plastic challenging to break down by microorganisms. There are many news and journals about marine debris (Marine Debris) widely. However, the quantity of plastic waste entering the ocean from land-based waste is unknown. It is estimated that 192 coastal countries in 2010 produced 4.8 - 12.7 million tonnes of plastic waste entering the oceans (Jambeck *et al.*, 2015)

Marine debris or better known as marine debris is a form of solid objects with persistent properties, produced by humans, intentionally or unintentionally wasted or left in the marine environment (NOAA, 2013). In areas close to beaches or coastal areas, plastic waste is part of a complex problem requiring great attention from all parties (Dewi, Intan Sari, 2015). Most plastics are highly durable and persistent materials in marine environments, and some estimates refer to the potential lifespan of hundreds of years in the environment. Microplastic is a polymer that is broken into small pieces and has a size of> 5 mm. The source of microplastics is divided into two, namely primary and secondary origin. Microplastics derived from primary sources are microplastics that have been micro-sized since their source, for example, microplastic textile fibers due to the fabric washing process and cosmetics (facial cleanser) with the term "microbeads" or "micro exfoliates." They are larger due to physical, chemical, and biological processes, such as domestic waste, wastewater, etc. Most plastics are very durable and persistent materials in the marine environment, and some estimates refer to the potential lifespan of hundreds of years in the environment. Microplastic is one of the polymers divided into small parts and has a size of> 5 mm. The source of microplastics is divided into two, namely primary and secondary. Process s fabric washing and cosmetics (facial cleanser) with the terms "microbeads" or "micro exfoliates." The type of secondary source of microplastics comes from the degradation of more considerable plastic waste due to physical, chemical, and biological processes, such as domestic waste, wastewater, and so on (Guven *et al.,* 2017). The accumulation of microplastics from various sources that end up in the oceans has been many studies related to the distribution of microplastics in the sea and marine organisms.

The problem of plastic waste is becoming a global concern in general and in the City of Balikpapan. Along the coast of Balikpapan, of course, the potential for microplastic contamination, considering that Balikpapan City is dominated by tourism, industrial, fishery, and residential activities. There has been no further research to identify the number and types of microplastics on the Balikpapan coast. Therefore, it is essential to research the identification of microplastics in the coastal areas of Balikpapan City. This study aims to identify the existence (existing) of microplastics that pollute the coastal areas of Balikpapan City. Microplastics are categorized into several types based on their shape, shape, color, etc. Several categories are used in several pieces of literature, depending on the criteria chosen by the author. The types that often appear in various studies are pellets, fragments, granules, fibers, films, and styrofoam. However, the microplastic fiber's shape is easier to identify because of its different shape than the environment in the sample. Therefore, few studies have focused on fiber rather than other particle shapes (Van Cauwenberghe *et al*.,, 2015)

## 2. Method

### 2.1 Time and Location of Research

The sediment sampling location was selected based on location points that can have microplastics (purposive sampling). This method is used to approach concerning unique characteristics that are in line with the research objectives, which are expected to answer the research's objectives. Based on the predetermined method, the location used as a sampling point is the Manggar Baru Beach area representing the fishing settlement area. The beach is located on Jl Mulawarman Manggar, representing the estuary area, Klandasan Beach representing the trade and service area, Monpera Beach representing the tourism area, Margasari Kampung Beach Atas Air represents a residential area on the water, and Somber Waters represents a Mangrove area. Sediment sampling from the coastal waters of Balikpapan City was carried out on July 11, 2020. Meanwhile, the identification process of microplastics was carried out at the Environmental Technology Laboratory, Mulawarman University. Figure 1 is a map of the location for sediment sampling at six locations along the coast of Balikpapan City. The six locations of sediment sample collection points in this study are as follows :

a. Persatuan Manggar Baru street (1$^{o}$12”47’ LS - 116$^{o}$58”6’ LS)
b. Mulawarman Manggar street (1$^{o}$14”15’ LS - 116$^{o}$57”12’ LS)
c. Klandasarn Ulu (1$^{o}$16”41’ LS - 116$^{o}$49”49’ LS)
d. Jenderal Sudirman Monpera street (1$^{o}$16”46’ LS - 116$^{o}$49”22’ LS)

e. Margasari street (1$^{o}$14"17' LS - 116$^{o}$49"14' LS)
f. Somber area (1$^{o}$12"35' LS - 116$^{o}$50"0' LS )

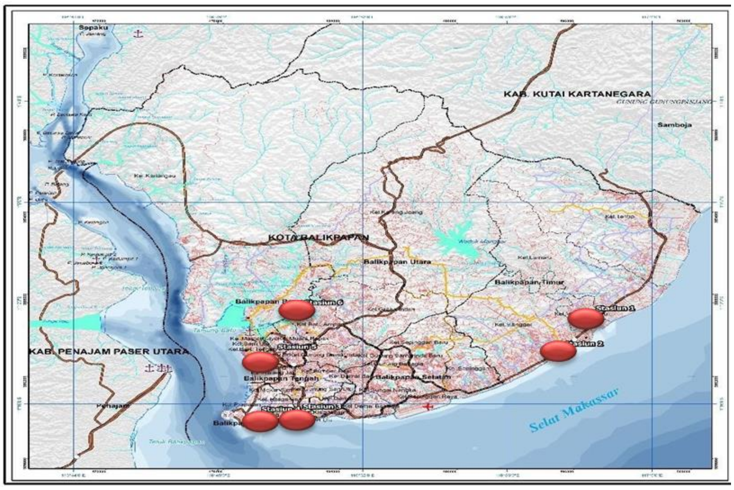


**Figure 1.** Map of sampling at six locations

## 2.2 Material

In this research, the tools and materials used include; Whatman GF / C filter paper, Light Microscope, beaker glass, Buchner funnel, vacuum pump, analytical balance, Ø 4 mm sand filter, magnetic stirrer, measuring cup, desiccator, transect with a size of 50 cm × 50 cm, the chemical used is NaCl .

## 2.3 Transect Design and Sampling Schemes

In taking samples of coastal sediments that need to be considered is the tidal line. Transect placement is helpful to provide boundaries where sediment will be excavated according to the desired depth. The shape of the transect is a rectangle with a length × width of 50 cm. Figure 2 shows the transect design measuring 50 cm × 50 cm placed above the tide line, leaving shells, algae, debris that has not been decomposed, and other organic material or what is commonly called the Wreck Line.

A sampling at each coastal location is expected to be representative in accordance with the environmental conditions of that point. So that in one location, there are three points of the collection with a distance of each point along 100 m. Transects have been used as a method; It is hoped that transects can represent the extent of the coastal area. The substation distance interval is calculated based on the long beach distance (Putri *et al.*, 2014; Sagawa *et al.*, 2018). The transect function itself is a barrier for mesoplastic and microplastic sampling (Yona *et al.*, 2020). Figure 2 is a sediment sampling scheme on the shoreline (Wreck line).

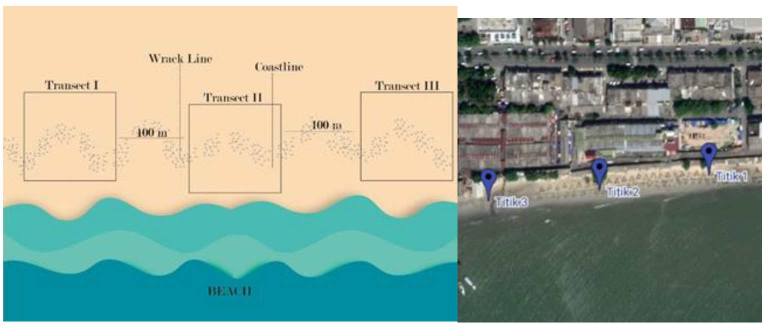


**Figure 2.** Sediment sampling schemes and points

### 2.4 Microplastic Identification Process

The procedure for identifying microplastics in sediment is divided into three interrelated processes: the drying stage, the volume reduction stage, and the density separation stage. 1 kg of wet sediment samples were dried in an oven at 105 ° C for 48 hours. The dry sediment was then taken 100 grams of duplicates, and 400 ml of 30% NaCl solution was dissolved with the dry sediment sample, then stirred using a stirring spoon for 2 minutes. After stirring, let it sit for a while until the material floating between the supernatant is no longer visible. The material floating in the supernatant was then filtered using a vacuum pump on filter paper with 1.2 μm glass microfiber filter paper specifications (Whatman GF / C). After filtered, Whatman paper was dried in an oven at 105 ° C. The filtered material on filter paper was then observed using a light binocular microscope with a magnification of 40 times.

Furthermore, the microplastic particles were sorted and observed using a microscope and then grouped based on the microplastic shape and produced the four most significant types, namely fiber, phylum, fragments and granules. The test parameter used is to calculate the abundance of microplastic particles per 100 grams of dry sediment. Figure 3 is a schematic flow diagram of the identification process of microplastics in sediments.

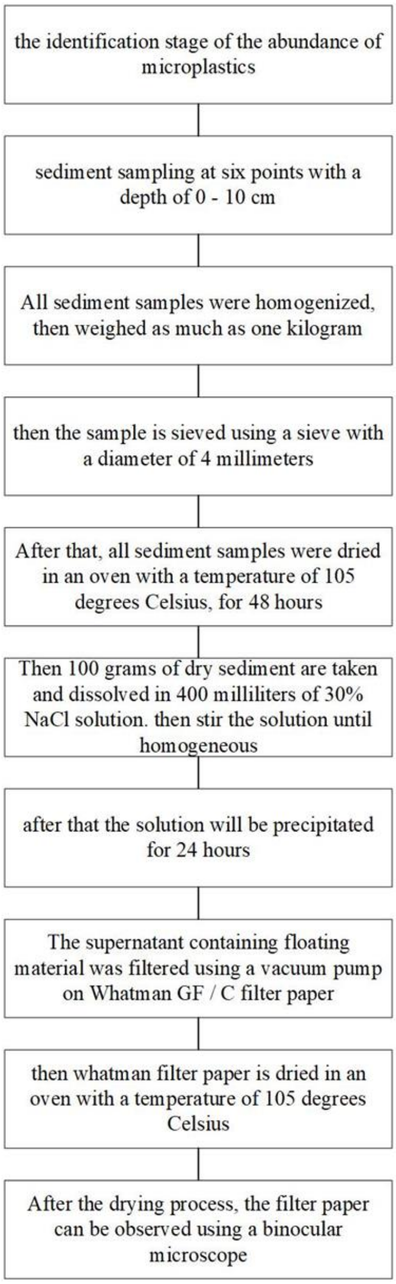

**Figure 3.** Schematic of microplastic abundance identification flowchart

The results of microplastic observations from all sampling locations will be analyzed descriptively and displayed in tables, numbers and graphs and processed with the Microsoft Excel application.

## 3. Result and Discussion

The sampling locations at six points found varying amounts of microplastic contamination—sampling at each point representing the area where the pollutant source occurs. The result of visual identification of the supernatant screening process contains the abundance of microplastics in the sediment. Microplastic analysis on sediment found four microplastics, namely fragments, fibers, phyla, and microbeads. According to Free *et al.* (2014), the classification of shapes is classified into line/fiber, namely flat shaped like fiber, straight plastic; fragments are complex, irregular plastic, foam (light, sponge-like), or film (flat like thin plastic) (Free *et al.,* 2014). According to Cole, *et al.* (2011), microplastics can be classified as primary and secondary microplastics depending on the actual source. Primary microplastics are usually shaped like microbeads or round shapes deliberately made by the plastics industry for use in cosmetics, personal care products, skin exfoliators, cleaning agents, and sandblasting. Secondary microplastics are irregular pieces of plastic that are accidentally generated due to the degradation of larger plastic pieces, such as plastic bags, crates, bottles and especially ropes and nets. Over some time, these large plastic chunks will degrade due to exposure to ultraviolet light from the sun and by mechanical means, such as tidal waves, to form smaller pieces of plastic. According to Marine & Environmental Research Institute, (2015) The form of microplastics can be divided into the following forms:

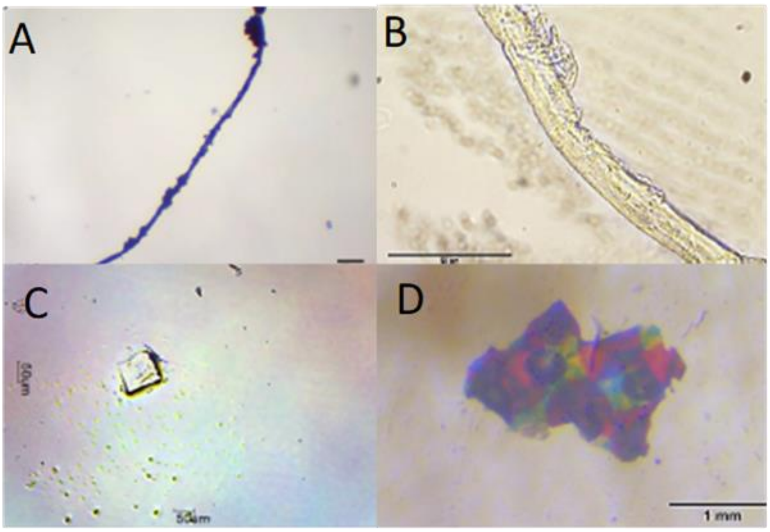


**Figure 4** ***A.*** *Colored fiber. B. clear fiber. C. filum. D. colored fragment*

The most abundance is found in the village's location over water, which is 201 particles / 100 gr of sediment. The number of particles and types of microplastics at the six sampling locations can be seen in Table 1, while the graph of the identification of the distribution of microplastics in the sediments at six coastal locations in Balikpapan City can be seen in Figure 5. Meanwhile, sample observations used a light microscope with a 40x magnification (total magnification of 400x). ) on the Whatman GF / C filter paper can be seen in Figure 6.

**Table 1.** Microplastic abundance every 100 gr of dry sediment samples

| Location | Microplastics type | | | | |
|---|---|---|---|---|---|
| | **Filum** | **Fragment** | **Fiber** | **Granule/ Microbeads** | **Total** |
| Manggar Baru | 9 | 6 | 26 | 3 | 44 |
| Mulawarman Manggar street | 1 | 2 | 36 | 1 | 40 |
| Klandasan Ulu | 10 | 5 | 15 | 7 | 37 |
| Monpera | 2 | 7 | 6 | 1 | 16 |
| Kampung atas Air | 13 | 12 | 126 | 50 | 201 |
| Somber | 4 | 1 | 28 | 6 | 39 |
| Average | 7 | 6 | 40 | 11 | 63 |

The total average abundance of microplastics in dry sediment for the six sampling locations at a depth of 0-10 cm ranged from 16-201 particles / 100 grams of dry sediment. The sediment characteristics obtained mainly indicate the texture of the sand. From the observations on the sediment samples at six locations, it was shown that the average number of microplastics was 63 particles / 100 g of sediment, with the most significant number of microplastics being in the location of Kampung Atas Air which was 201 particles / 100 g of sediment.

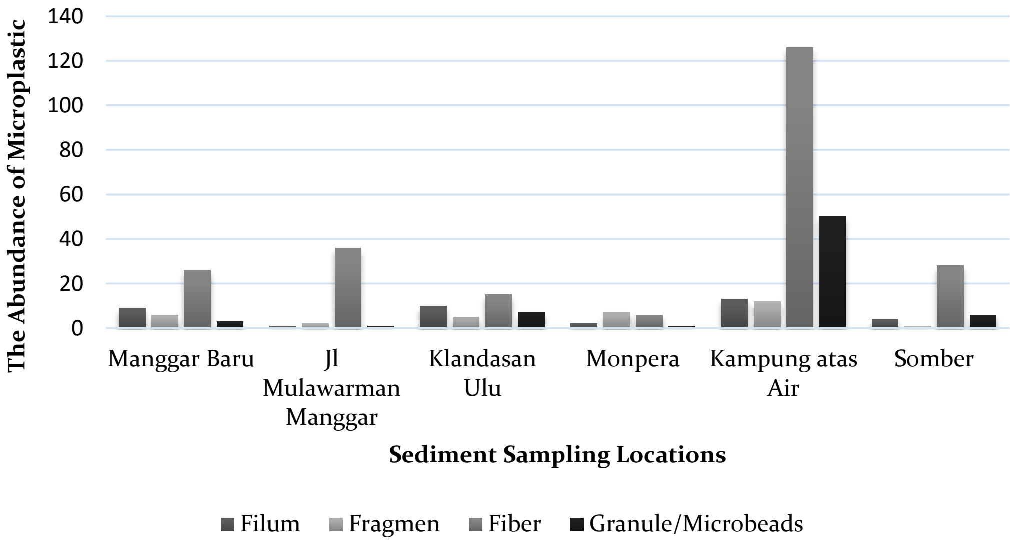


**Figure 5.** Microplastic distribution identification graph

Based on observations, microplastics with the phylum type an average of 7 particles / 100 grams of dry sediment. According to Kingfisher (2011), phylum-type plastics are secondary plastic polymers with low density and come from the fragmentation of packaging plastics. From the results of observations on sediment samples, it was found that the number of microplastic fragment types was 6 particles / 100 g of dry sediment. The number of microplastic fragments was not found in the sediments. This can be due. Fragment plastics are plastics made from synthetic solid polymers that tend to be difficult to break or break and easily sink to the ocean's bottom. Fragment type microplastics are influenced by activities such as the fishing process using fishing nets and are also influenced by factors from movement in the sea, such as tides and water currents. So with this movement, microplastic particles can be trapped in the sediment around 0-10 cm (Dewi, Intan Sari, 2015)

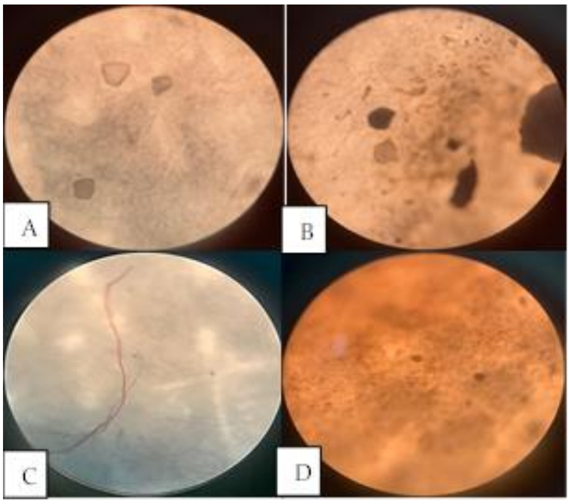


**Figure 6.** (A) Filum, (B) fragment, (C) Fiber, (D) Microbead with magnification 40 times

The most microplastic types for the four types of microplastics at the six sampling locations were fiber types. This study's results are also corroborated by the tests that produce the conclusions carried out (Azizah *et al*., 2020) shows that fiber type microplastics generally dominate compared to fragment, film, and pellet types in sediments in Kartini Beach, Central Java. Fiber-type plastics are common in some waters and are widely distributed in the oceans. This fiber comes from fishermen's activities using nets and fishing rods as fishing gear and is influenced by human domestic activities. Plastic fibers with elongated characteristics originate from fragmentation in the monofilament of fishing nets; synthetic fabrics; and the rope can be called a fiber type microplastic. Based on observations, the highest number of fiber microplastics is at a location in Kampung Atas Air. This area is located in Margasari Village, West Balikpapan, representing settlements on the water with the surrounding environment's physical condition; many boats are leaning, residential settlements, and mangroves. Apart from that, the residents' sanitation conditions are poor, who carry out bathing, washing, and toilet activities directly in the river. Washing activities can produce fibers that are released from clothes or the use of detergents that can contain microplastics. Microplastics can also be produced from the breakdown of mineral plastic bottles. Microplastics in sediments can be influenced by many factors, primarily due to environmental conditions around the water. The more human activity in an area, the higher the microplastic pollution in the environment (Widianarko and Hantoro, 2018).

Environmental factors are said to be the things that influence the type and shape of microplastics that pollute the water area. As in previous studies, resin pellet type microplastics were found to dominate the microplastics that pollute Lake Huron and Lake Erie, where these locations are adjacent to the industrial zone. (Zbyszewski and Corcoran, 2011). Microplastics are seen more frequently in densely populated areas. The study analyzed sediments from 18 locations representing six continents (Browne *et al*.,, 2011), showing a positive relationship between microplastics and human population density. The link between microplastic pollution in sediments and human activities was also reported by (Claessens *et al*., 2011), which detected high concentrations of microplastic granules in sea ports' sediments

## 4. Conclusion

After identifying and analyzing, it was found that there were four types of microplastics from the results of microplastic analysis on the sediment, namely fragments, fibers, phyla, and microbeads. Based on observations, the average microplastic at the six points is microplastic with an average phylum type of 7 particles / 100 grams of dry sediment, the number of fragment type microplastics is six particles / 100 g of dry sediment, the number of fiber type microplastics is 40 particles / 100 g dry sediment, and the amount of microbeads type microplastic is 11 particles / 100 g dry sediment. The most significant number of microplastic particles was found at the sampling location (point) of Kampung Atas Air, namely 201 particles / 100 gr of dry sediment, and the smallest number of microplastic particles were found at the Monpera point, namely 16 particles / 100 gr of dry sediment. Microplastics in the form of fibers dominate the form of microplastics found in sediments in the coastal waters of Balikpapan. Environmental conditions and sources of pollutants play a role in differences in the amount of abundance of microplastics.

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