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# IDENTIFICATION OF TYPES AND ABUNDANCE OF MICROPLASTICS IN BEACH SEDIMENTS IN PADANG CITY, WEST SUMATRA

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## ABSTRACT

The presence of plastic waste in the ocean significantly impacts pollution. Lightweight plastic is transported by currents and waves, eventually accumulating in sediment. Its slow decomposition is influenced by composition and environmental conditions. Using a survey method at three stations in Padang City's coastal waters, this study aims to investigate the composition and quantity of microplastics in sediment. Variations in microplastic levels across stations were analyzed using One-Way ANOVA, and differences between dry and wet zones and depths of 0-10 cm and 10-20 cm were examined with Independent Samples T-tests. Three microplastic categories were identified: fibers, fragments, and films, with an average concentration of 100.55 particles/kg. The Ulak Karang Beach estuary exhibited the highest particle concentration (129.16 particles/kg), whereas Banana Beach, characterized by minimal human activity, displayed the lowest concentration. There were significant differences ($p<0.05$) in the abundance of microplastics between stations. It was observed that the dry zone exhibited a higher concentration of particles (125.00 particles/kg) in contrast to the wet zone (76.66 particles/kg). In the 0-10 cm depth range, there was a higher abundance of microplastics (111.66 particles/kg) compared to the 10-20 cm depth range (89.44 particles/kg). The abundance of microplastics was significantly different ($p<0.05$) between the two coastal zones but not significantly different ($p>0.05$) between depths. Several possible causes of these differences were examined, but further research is needed to investigate other oceanographic factors and gain a more comprehensive understanding.

**Keywords:** Microplastics, Pollution, Sediment, West Sumatra

## 1. INTRODUCTION

Plastic waste is the most significant waste component and the biggest pollution threat today. Indonesia is ranked 2nd as the world's largest producer of plastic waste, producing 3.2 million tons of plastic, of which around 1.29 million tons end up in the ocean[1]. Plastic waste can result from human activities through direct or indirect disposal. The plastic mass, which tends to be light, can easily be carried away by currents and waves and degrade over a long time to its smallest form. The results of the plastic degradation process are divided into four sizes: macroplastics, mesoplastics, microplastics, and nanoplastics[2].

The problem of plastic waste cannot be separated from urban areas such as Padang City, which is one of the beach tourist destinations. The high number of tourists and residents in the city of Padang can increase the production of plastic waste, most of which will decompose on land and be washed into the waters to become microplastics distributed in the ocean and beaches. Currents, waves, and tides influence the distribution of microplastics in the sea towards the coast[3], which will

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continue accumulating into the deepest layers of sediment over time. Apart from the sea and beaches, estuaries are also locations where microplastic pollutants might spread.

Microplastics have a detrimental effect on the aquatic environment, aquatic ecosystems, and even on human life. One of the damaging consequences involves the loss of aquatic organisms caused by the ingestion of indigestible microplastics by fish. Microplastics are small, leading to their mistaken consumption by marine animals like fish and bivalves, who often mistake them for food such as larvae or plankton[4]. When microplastics find their way into the bodies of marine organisms, it can have harmful consequences if humans consume these organisms. The presence of microplastic particles in the digestive system of aquatic animals can transfer these particles to the top of the food chain.

Research on solid waste pollution at Purus Beach, Padang City, was previously carried out by Yusra & Erlini[5], who explained that the abundance of marine waste was relatively high, weighing 287.34 kg. Research on microplastics in sediments in other coastal areas of West Sumatra has been carried out, such as the abundance of microplastics in the sediments of Carocok Beach in Pesisir Selatan Regency by Nedi et al.[6], the distribution of microplastics in sediments in Pariaman City by Sianturi et al.[7], and the distribution of microplastics in sediments on the coast of Bungus Bay Padang City by Islami et al.[8]. However, there has been no information about microplastic pollution at Purus Beach, Banana Beach, or Ulak Karang Beach in Padang City. Considering the large number of anthropogenic activities at this location, an abundance of microplastics can accumulate in the sediment. This is the basis for conducting this research regarding the identification and abundance of microplastics in sediment on beaches in Padang City.

## 2. RESEARCH METHOD

### Time and Place

This research was conducted in January - February 2024. This research used a survey method by observing and taking samples directly in the field. The data used in this study were oceanographic parameters and laboratory analysis results. The determination of sampling locations was carried out using purposive sampling. Sampling was carried out at 3 locations, that are: location I at Purus Beach, which is a dense tourist area; location II at Banana Beach, which is an area with little community activity; and location III at Ulak Karang Beach (Figure 1). Oceanographic parameters measured include water acidity (pH), temperature, salinity, and current speed as supporting data for water conditions.

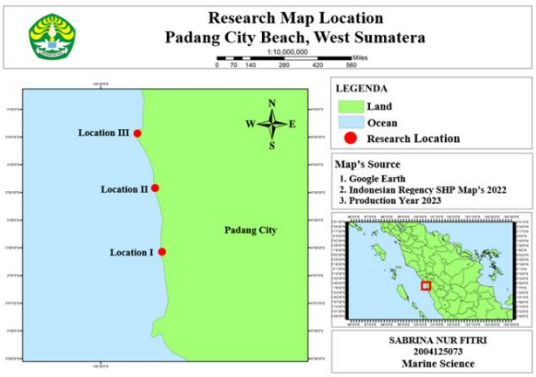


**Figure 1.** Map of locations and research stations

### Procedures

Sediment sampling is conducted at low tide, dividing each beach into zones[6]. Zone 1 is located at the highest tide (dry zone), which usually has an abundant amount of microplastics[3], and zone 2 is located at the lowest tide (wet zone), where the determination of the distance between

zones in this study is adjusted to daily tidal conditions in the field. In each zone, there are three transects as replications for one location with a size of 1x1 m, and the distance of each transect is determined from the beach length interval.

Sampling of sediment was conducted at two depths within each zone. The depths included 0-10 cm and 10-20 cm. A 500 g paralon pipe was utilized for this purpose. The collected sediment was then placed in a plastic sample container and preserved in a lugol solution. It was stored in an ice box to maintain the sample's integrity. The procedure for identifying microplastics in sediment in the laboratory refers to research methods[9].

The analysis results of sediment samples in the laboratory (100 g) were converted into units of particles/kg of dry sediment. The abundance of microplastics was calculated by dividing the number of microplastic particles by the mass weight of the sediment using the formula according to Laila et al.[10] as follows:

$$K = \frac{n}{m}$$

Information:

K : Microplastic abundance (particle/ kg)
n : Number of Microplastics (particles)
m : Dry Sediment Weight (kg)

**Data Analysis**

The comparison of the average abundance of microplastics between research locations was analyzed using the One-Way ANOVA test and the LSD follow-up test, while to find out the comparison of the average abundance of microplastics between zones and between depths, it was analyzed using the Independent Sample Test with the help of SPSS software.

## 3. RESULT AND DISCUSSION

**General Condition of the Research Area**

Padang City is a coastal area and the capital of West Sumatra Province, with an area of 1,414.96 km$^2$. The city of Padang has a sloping open coastal area with fine to coarse sand deposits of brownish-yellow to grayish color and directly faces the Indian Ocean.

Purus Beach is in Purus Village, Rimbo Kaluang, and Flamboyan Baru Village (Lat -0.93330°, Long 100.350246°). This beach is a tourist location, which is ±2.1 km long. The high level of anthropogenic activity at this location can cause high levels of pollutants to enter the Purus Beach environment through direct or indirect waste disposal by tourists and the public.

Banana Beach is in Lolong Belanti and Ulak Karang Selatan Villages (-0.919456 °S, 100.348292 °E) with a beach length of ±1 km. Banana Beach has little community and tourist activity because it is far from road access and is behind community housing. Because of this, the beach conditions do not get many pollutants directly from activities such as tourists.

Ulak Karang Beach is in the Ulak Karang Selatan and Ulak Karang Utara Villages (-0.905699°S, 100.345074°E) with a beach length of ±1.2 km. Ulak Karang Beach is close to the Ulak Karang estuary and is categorized as busy with ship traffic and residential areas, making it vulnerable to pollution.

Based on the results of measurements of oceanographic parameters in the field from the three research locations, they are not much different, where the pH value at the research location ranges from 8-7. Meanwhile, the water temperature of the 3 locations averages 31°C with the highest temperature at location I (32°C) and the lowest temperature at location III (30°C). The salinity value of the 3 locations has an average of 32.7 ppt, with the highest salinity at location I (34 ppt) and the lowest salinity at location II, with a value of (31 ppt). The current speed value from the 3 locations averages 0.46 m/s (Table 1).

**Types of Microplastics Found on Padang City Beaches**

After conducting analysis and observations in the laboratory, the

microplastics found on Padang City Beach at all 3 locations were grouped into three types of microplastics such as fiber, fragments, and film (Figure 2).

**Table 1.** Results of oceanographic parameter measurements in the field

| Parameters | Locations | | | Average |
|---|---|---|---|---|
| | I | II | III | |
| pH | 8 | 8 | 7 | 7,7 |
| Temperature (°C) | 32 | 31 | 30 | 31 |
| Salinity (ppt) | 34 | 33 | 31 | 32,7 |
| Current speed (m/s) | 0.42 | 0.51 | 0.47 | 0.46 |

(a) (b) (c)

**Figure 2.** Types of microplastics found on Padang City beaches

The source of fragment-type microplastics usually comes from single-use bottles and packaging with physical characteristics of irregular shape color and tends to be thick[11]. In contrast to fragments, films have physical characteristics that are more flexible and thin and come from single-use plastic pieces. Meanwhile, this type of fiber usually comes from cloth or rope.

**Abundance of Microplastic Types on Padang City Beaches**

The most dominant type of microplastic at Padang City Beach is the fragment type, followed by the film type, while the least abundant microplastic is the fiber type. The results of the analysis and calculation of the abundance of microplastic kinds can be seen in Table 2.

**Table 2.** Abundance of microplastic types found on Padang City beaches

| Locations | Microplastic (Particle/kg sediment ± Std. Dev.) | | | Average Amount |
|---|---|---|---|---|
| | Fiber | Fragment | Film | |
| I | 20.83 ± 20.20 | 54.16 ± 26.09 | 31.66 ± 14.66 | 106.66 ± 42.71 |
| II | 13.33 ± 12.30 | 25.00 ± 15.66 | 27.50 ± 11.38 | 65.83 ± 32.60 |
| III | 20.83 ± 14.43 | 57.50 ± 33.60 | 50.83 ± 25.74 | 129.16 ± 68.81 |
| Average | 18.33 ± 4.33 | 45.55 ± 17.87 | 36.66 ± 12.45 | 100.55 ± 32.10 |
| Percentage | 18.23% | 45.30% | 36.66% | 100% |

The highest abundance of microplastics was found in the fragment type, with an average of 45.55 particles/kg sediment (45.30%). The lowest abundance of microplastics was found in the fiber type, with an average of 18.33 particles/kg sediment (18.23%). Fragment and film-type microplastics were most commonly seen because, at the research location, there was high activity by tourists and the public and an estuary so that these microplastics could be found easily. This result aligns with the research of Layn & Emiyarti[9], where the microplastic fragment type was higher than the fiber type. Different results were obtained by Yoswaty et al.[12], where fiber-type microplastics were higher than film-type in the coastal waters of Dumai City.

The abundance of fragments comes from discarded rubbish, such as plastic bottles in rivers and beaches, especially in location I, a tourist area, and location III, an area near the estuary. At location II, film-type microplastics such as packaging wrap were found to be more abundant; this could be caused by the presence of plastic waste carried by currents and caught on rocks and wooden twigs until it degraded on the beach. Fiber-type microplastics, elongated fibers from clothing fibers, fishing lines, and ship ropes, were also found to be more abundant in locations I and III compared to location II. According to Amin et al.[13], differences in the abundance of microplastics are caused by several things, such as differences in regional characteristics, differences in population activities around the location, and environmental factors (currents, waves, salinity, and temperature).

**The abundance of Microplastics between Locations on Padang City Beaches**

The abundance of microplastics between locations has an average value of 100.55 particles/kg sediment. The highest abundance of microplastics was at location III, with a value of 129.16 particles/kg sediment, while the lowest was at location II, with a value of 65.83 particles/kg sediment. The results of calculating the abundance of microplastics between locations can be seen in Figure 3.

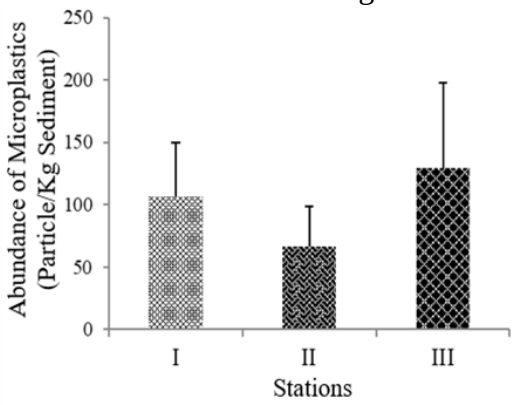


**Figure 3.** Microplastic abundance between locations on Padang City beaches

The research location has different beach characteristics. Locations I and III have more community activity and a river estuary, while location II has less community activity. The results of the One-Way ANOVA test analysis showed that the sig value was (0.014) < (0.05), indicating that there was a significant difference in the abundance of microplastics between beach locations in Padang City. Higher results were obtained in the research of Amin et al.[13] on Karimun Besar Island, where the abundance of microplastics ranged from 1976.67−2203.33 particles/kg sediment.

**The Abundance of Microplastics between Each Zone on Padang City Beaches**

The abundance of microplastics between coastal zones has different average values. Microplastics were more abundant in the dry coastal zone (zone I) than wet coastal zone (zone II). The results of calculating the abundance of microplastics between coastal zones can be seen in Table 3.

Based on the results of calculating the abundance of microplastics between zones for each location, it shows that the highest abundance in zone I was at location III with a total of 165.00 particles/kg of sediment, and the lowest was at location II with a total of 90.00 particles/kg of sediment. In zone II, the highest abundance was in location I, with an abundance of 95.00 particles/kg of sediment, and the lowest was in location II, with an abundance of 41.66 particles/kg of sediment. Microplastics were found to be more abundant in zone I, with an average total of 125.00 particles/kg sediment, compared to zone II, with an average total of 76.66 particles/kg sediment. The results of

the Independent Sample T-test in both zones obtained a Sig value. (2-tailed) 0.008 < 0.05 indicates a significant difference in abundance between dry and wet zones on the coast of Padang City.

**Table 3.** Abundance of microplastics by type between zones and beach locations Padang city

| Locations | Zone (particles/kg sediment ± Std. Dev) | |
|---|---|---|
| | I (day zone) | II (wet zone) |
| I | 120.00 ± 53.67 | 95.00 ± 30.16 |
| II | 90.00 ± 26.07 | 41.66 ± 16.02 |
| III | 165.00 ± 71.76 | 93.33 ± 46.76 |
| Average | 125.00 ± 59.70 | 76.66 ± 40.43 |

Results that were not much different were found in research by Nedi et al.[6] at Carocok Pesisir Selatan Beach, where microplastics were more abundant in the high tide zone with a total of 195.56 particles/kg of sediment compared to the lowest low tide zone with a total of 177.77 particles/kg of sediment. Tidal currents greatly influence the distribution of microplastics on coastlines, where the highest tidal zones have abundant amounts of microplastics[3]. Zone I, the dry coastal zone, is static or remains constant due to the minimal influence of ocean currents and waves. Meanwhile, zone II (wet zone) is more influenced by ocean currents and tidal waves, resulting in sediment stirring affecting microplastic distribution.

**The Abundance of Microplastics between Each Depth on Padang City Beaches**

The abundance of microplastics between depths in sediments has different average values. Microplastics were found to be more abundant in sediments with a sediment depth of 0-10 cm compared to those at a depth of (10-20 cm). The results of calculating the abundance of microplastics between coastal sediment depths can be seen in Table 4.

**Table 4.** Abundance of microplastics by type between depths and beach locations Padang city

| Locations | Depth (particles/kg sediment ± Std. Dev.) | |
|---|---|---|
| | 0-10 cm | 10-20 cm |
| I | 120.00 ± 50.59 | 93.33 ± 32.04 |
| II | 73.33 ± 36.14 | 58.33 ± 29.94 |
| III | 141.66 ± 82.80 | 116.66 ± 56.45 |
| Average | 111.66 ± 63.36 | 89.44 ± 45.95 |

Microplastics were more abundant at location III, followed by location I, and the lowest at location II. Microplastics were found to be more abundant in sediment at 0-10 cm depth with an average total of 111.66 particles/kg of sediment compared to sediment at a depth of 10-20 cm with an average total of 89.44 particles/kg of sediment. Independent sample T-test results at both sediment depths obtained Sig. (2-tailed) 0.237 > 0.05 indicates no significant difference in microplastic abundance between coastal sediment depths.

The higher abundance value was found in research by Amin et al.[13] in the waters of Karimun Besar Island, where the highest abundance of microplastics was found in the sediment at a depth of 0-10 cm with a total of 2171.11 particles/kg of sediment. In comparison, the lowest was found in the sediment at a depth of 10 cm. -20 cm with a total of 1953.33 particles/kg sediment. The highest abundance value in sediment at a depth of 0-10 cm is caused by the movement of currents and waves and the continuous water overflow at the research location. Hence, the distribution of

microplastics is higher at this depth[13]. Differences in environmental characteristics and continuously high levels of anthropogenic activity on land can result in large amounts of rubbish accumulating on beaches. More microplastics accumulate in the upper layers because they directly interact with community activities.

## 4. CONCLUSION

Fiber, fragment, and film-type microplastics were found on Padang City beaches at Purus Beach, Banana Beach, and Ulak Karang Beach. Fragment-type microplastics were found in greater numbers compared to fewer fibers. The abundance of microplastics has an average value of 100.55 particles/kg sediment, with the highest abundance found at location III on Ulak Karang Beach with a value of 129.16 particles/kg sediment. In comparison, the lowest abundance is found at location II on Banana Beach, with a 65.83 particle/kg sediment value.

Microplastics were found to be more abundant in Zone I (dry zone) than in Zone II (wet zone), and there were significant differences in the abundance of microplastics between zones. Microplastics were also found to be more abundant in sediment at 0-10 cm depth than in sediment at a depth of 10-20 cm. The abundance between locations, zones, and depths can be caused by differences in beach characteristics, anthropogenic activities, and environmental factors at the research location.

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