Microplastic in Water and Sediment from the Middle Segment of Karang Mumus River, Samarinda City, East Kalimantan

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ABSTRACT

The increasing use of plastic causes an increase in plastic waste in the environment, especially waters. Plastic waste that enters the waters will then be degraded into polymers less than 5 mm called as microplastics. The purpose of this study was to determine the content of microplastics in water and sediment and the relationship between microplastics in water and sediment in the Karang Mumus River in Samarinda City. Sampling was carried out at 3 stations in the Karang Mumus River then sample analysis was carried out at the Water Quality Laboratory of Mulawarman University. Based on the results of the research obtained, the types of microplastics found are fiber, fragments, films and microbeads. The most type of microplastic was found is film. The mean concentration of microplastic in the water was 3,04 particles/L and in the sediment was 1322,22 particles/Kg.

INTRODUCTION

Environmental damage due to waste is a phenomenon currently occurring worldwide. In Indonesia, waste management remains an issue that has not been well-addressed. Plastic, as one of the easily identifiable types, is commonly used for various purposes due to its durable, lightweight, inexpensive, and readily available nature. As a result, the quantity of this inorganic waste type is increasing, eventually finding its way into water bodies. Plastics have a relatively long degradation period and require prolonged exposure to ultraviolet radiation, which is also influenced by the physical movement of water (Harpah et al., 2020).

Microplastics are degraded plastic fragments with particle sizes less than 5mm, originating from improperly managed plastic waste that is irresponsibly discarded into the environment. Microplastics can accumulate in significant amounts in seawater and sediments (Hidalgo-Ruz et al., 2012). Microplastics are categorized into primary and secondary microplastics. Primary microplastics are already micro-sized and stem from cosmetic care products containing microbeads, whereas secondary microplastics are derived from larger plastic items like packaging that breaks down in aquatic environments (Cordova et al., 2019).

The Karang Mumus River is a tributary of the Mahakam River, originating from a reservoir at its source and flowing into the Mahakam River. It exhibits diverse socio-economic activities along its course, leading to environmental pressures and pollution in its waters. Given the pollution present in the river's flow, it becomes necessary to conduct a study on the microplastic content in both water and sediments within the middle segment of the Karang Mumus River. The objective of this research is to determine the concentration of microplastics in the water and sediment of the middle segment of the Karang Mumus River.

METHODOLOGY

This research was conducted from October 2022 to December 2022. The field study took place in the middle segment of the Karang Mumus River in Samarinda City, East Kalimantan.

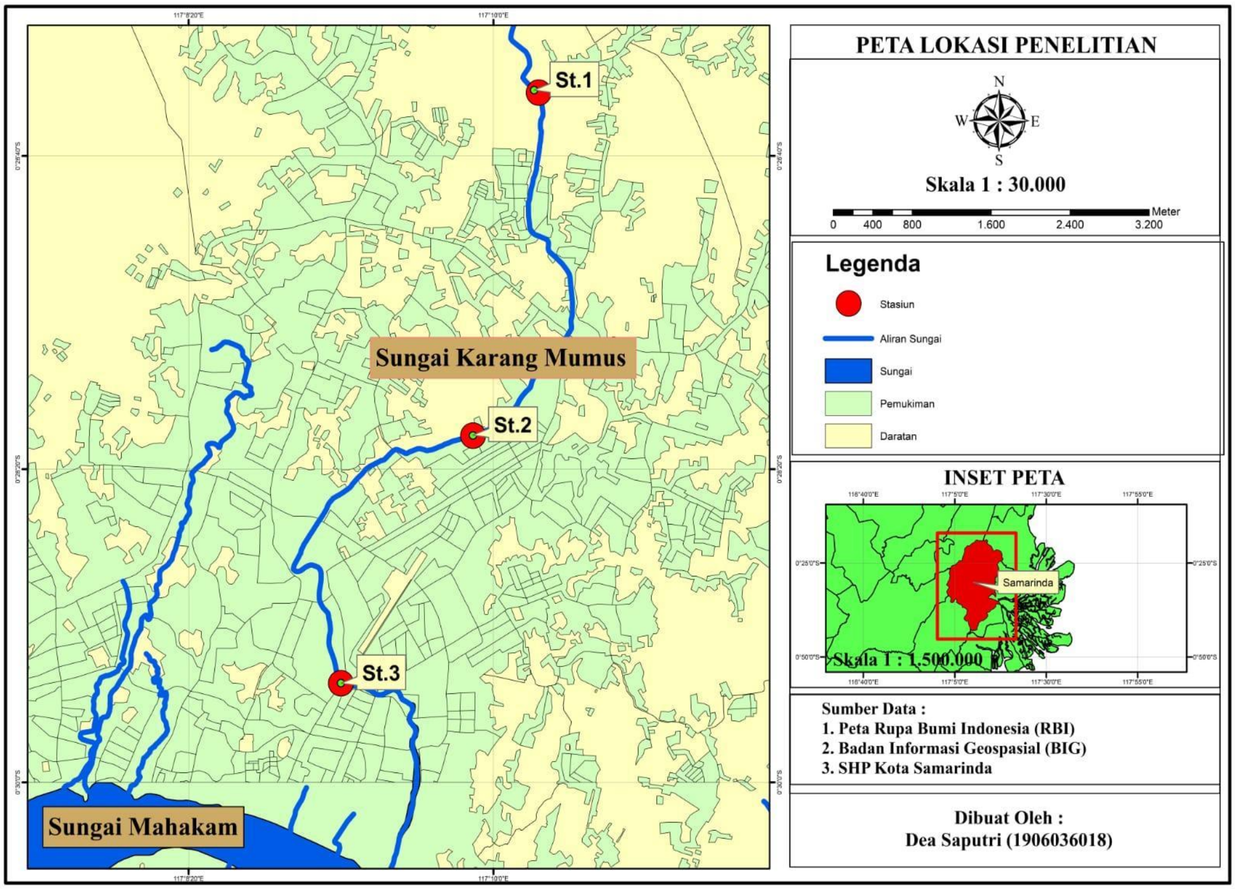

Figure 1. Research Location Map

Sampling was conducted at 3 stations. The station locations were determined using purposive sampling method, considering the surrounding conditions of the sampling area. Station 1 was situated in an area without any settlements, Station 2 was located in the midst of residential areas, and Station 3 was positioned in the urban center. Water and sediment samples were collected 3 times at each station. Water samples were collected in volumes of 25 liters using a 25-micron plankton net, while sediment samples were obtained using a sediment grab tool.

Water sample analysis involved filtering the water samples through 20-25µm pore size filter paper, which was then dried in an oven at approximately 100°C for about 2 hours. The filter paper was subsequently used for microplastic identification using a stereo dissecting microscope at magnifications of 10-45x. Sediment sample analysis included drying the sediment samples, taking 20 grams of dried sediment, and dissolving it in 30% NaCl solution to separate microplastics by density. The sample was then filtered using 20-25µm pore size filter paper, which was dried in an oven at approximately 100°C for about 2 hours. The filter paper was then used for microplastic identification using a stereo dissecting microscope at magnifications of 10-45x.

Table 1. Coordinates of Sampling Locations

Station	Sampling Location	Coordinate
1	Lempake Tepian Bridge	-0.4385, 117.17037
2	Jl. Pemuda III Bridge	-0.46916, 117.16479
3	Jl. Agus Salim Bridge	-0.49121, 117.15263

The analysis methods conducted include:

Microplastic Concentration

Calculating microplastic concentrations in water and sediment using the following formula:

Microplastic Concentration in Water (Eppehimer et al., 2021)

$$\text{Concentration} = \frac{\Sigma\, Microplastic}{Filtered\ water\ volume\ (liter)}$$

Microplastic Concentration in Sediment (Eppehimer et al., 2021)

$$\text{Concentration} = \frac{\Sigma\, Microplastic}{Dry\ sediment\ weight\ (kg)}$$

Simple Linear Regression Analysis

Simple linear regression analysis is conducted to determine the relationship between microplastic concentration in water and sediment using the following formula:

Simple Linear Regression Formula (Yuliara, 2016)

$$Y = a+bX$$

Explanation:

a = constant (Y-intercept)

b = coefficient of variable X

Y = dependent variable

X = independent variable

RESULT AND DISCUSSION

Microplastics in Water and Sediment

Identification of microplastic particle content was carried out on 9 water samples and 9 sediment samples from the middle segment of the Karang Mumus River using a stereo dissecting microscope at magnifications of 10-45x. The total number of microplastic particles found in the water samples was 685, including 216 fiber particles, 144 fragments, 324 films, and 1 microbead. The total number of microplastic particles found in the sediment samples was 238, including 65 fiber particles, 63 fragments, and 110 films. From the identification results of microplastic content in both water and sediment samples, four types of microplastics were found. The identified microplastic types include fiber, fragment, film, and microbead, as illustrated in the following figure:

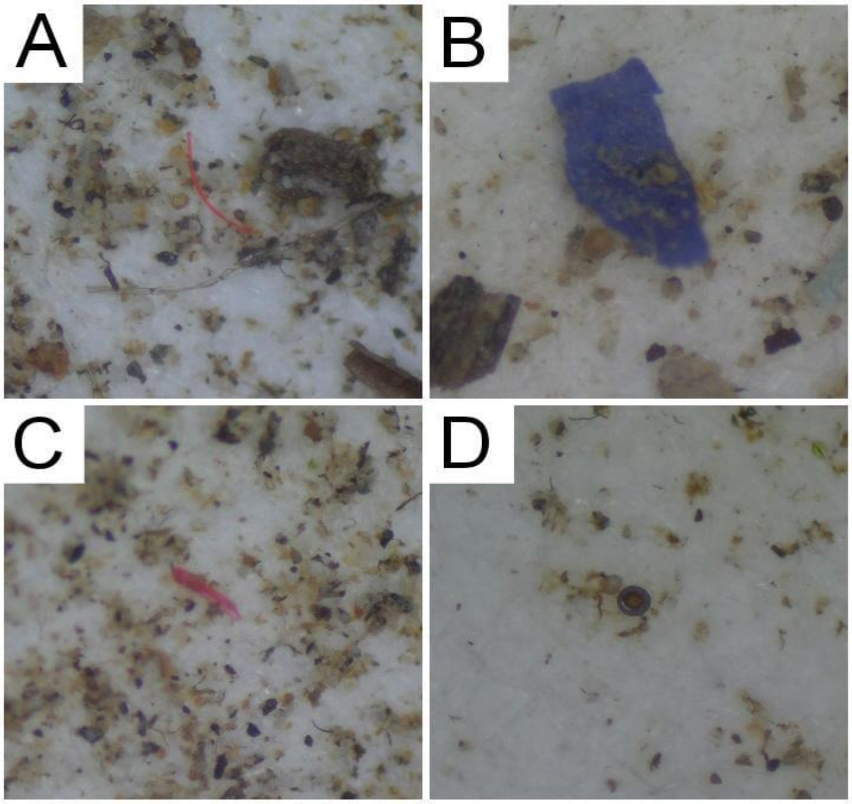

Figure 2. Results of Microplastic Identification: (A) Fiber; (B) Fragment; (C) Film; (D) Microbead

Microplastic Concentration in Water

In the water samples collected from the 3 stations in the middle segment of the Karang Mumus River, microplastics were detected, comprising four types: fiber, fragment, film, and microbead. Fiber, fragment, and film types were found at all three stations, while the microbead type was only detected at station 2.

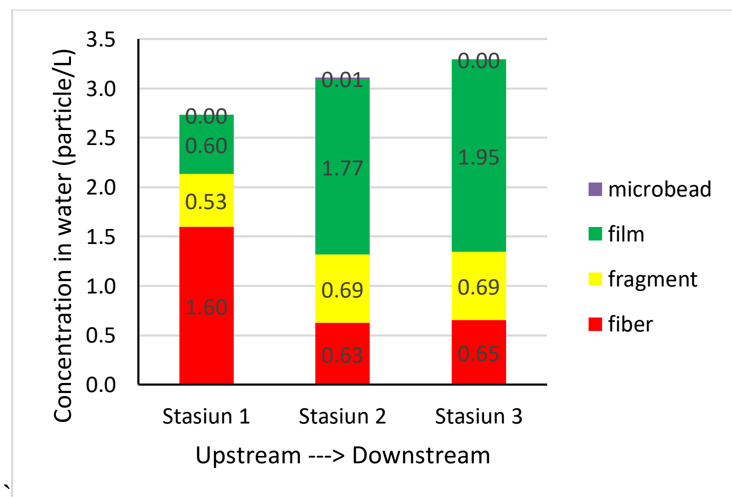

Figure 3. Graph of Microplastic Concentration in Water

From the results of microplastic identification at the three stations, the average microplastic concentration in water was found to be 3.04 particles/L. Station 1 exhibited a microplastic concentration of 2.73 particles/L. Station 2 had a microplastic concentration of 3.11 particles/L. Station 3 had a microplastic concentration of 3.29 particles/L.

Microplastic Concentration in Sediment

In the sediment samples collected from the 3 stations in the middle segment of the Karang Mumus River, microplastics were detected, comprising 3 types: fiber, fragment, and film. However, the microbead type of microplastic was not found in the sediment samples from all three stations. The microplastic concentration in sediment will be shown in the following figure:

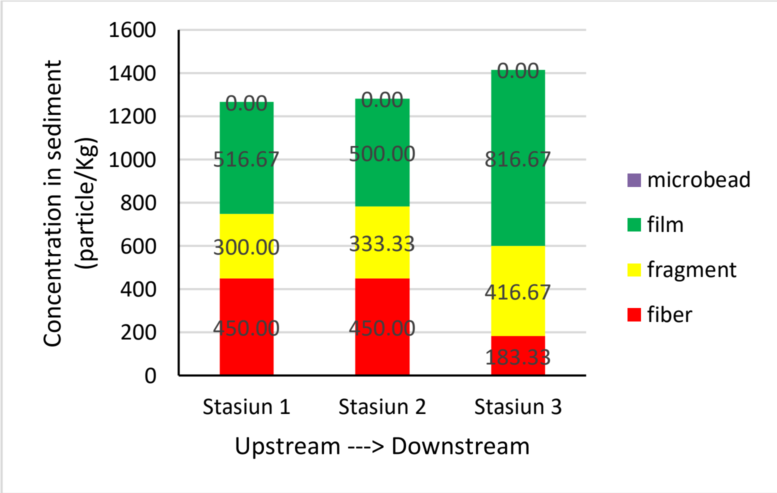

Figure 4. Graph of Microplastic Concentration in Sediment

From the results of microplastic identification at the three stations, the average microplastic concentration in sediment was found to be 1322.22 particles/kg. Station 1 exhibited a microplastic concentration of 1266.67 particles/kg. Station 2 had a microplastic concentration of 1283.33 particles/kg. Station 3 had a microplastic concentration of 1416.67 particles/kg.

Microplastic Concentration in Upstream and Downstream of the River

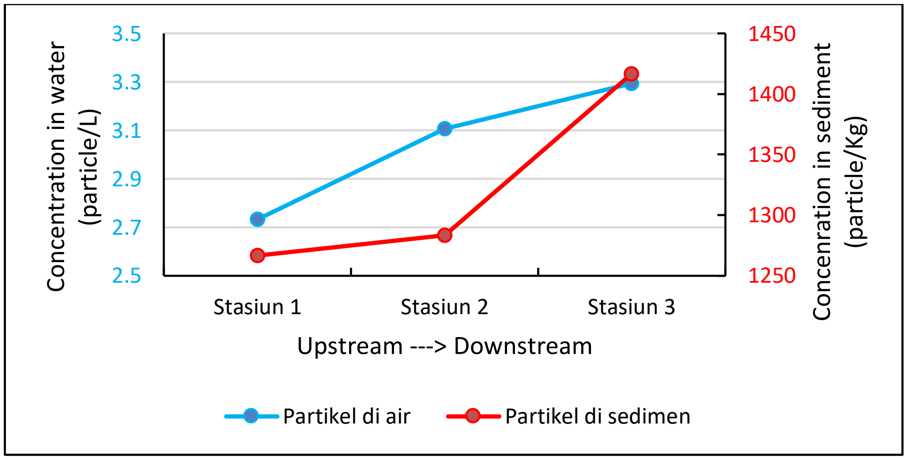

Figure 5. Graph of Microplastic Concentration from Upstream to Downstream of the River

In terms of microplastic concentration in water, Station 1 has a concentration of 2.73 particles/L. Station 2 has a concentration of 3.11 particles/L. Station 3 has a concentration of 3.29 particles/L. Meanwhile, in terms of microplastic concentration in sediment, Station 1 has a concentration of 1266.67 particles/kg. Station 2 has a concentration of 1283.33 particles/kg. Station 3 has a concentration of 1416.67 particles/kg. Based on the microplastic concentrations in water and sediment, it can be observed that Station 1, located upstream, has the lowest microplastic concentration. Station 3, located downstream, has the highest microplastic concentration, while Station 2, situated in the middle between them, has a microplastic concentration higher than Station 1 but lower than Station 3. From this description, it can be concluded that the microplastic concentration increases from upstream to downstream in the river.

Relationship Between Microplastic Concentration in Water and Sediment

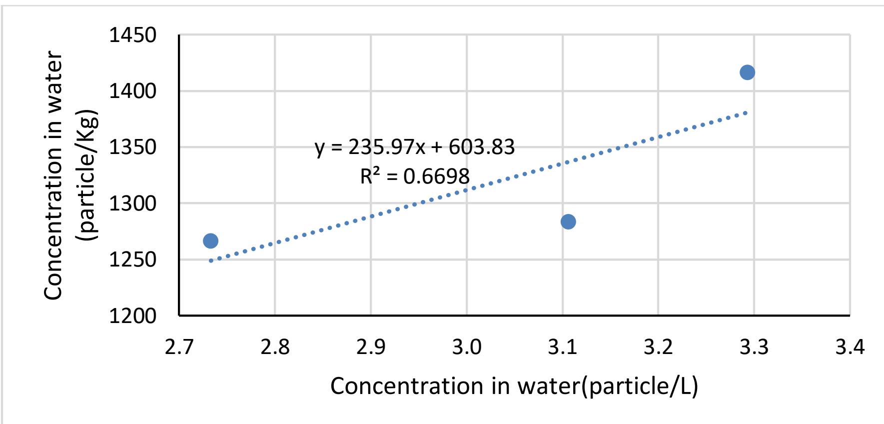

Figure 6. Graph of the Relationship Between Microplastic Concentration in Water and Sediment

The graph was generated by inputting sediment microplastic concentration data as the dependent variable and water microplastic concentration data as the independent variable, resulting in the following equation:

$$\Sigma \text{ MP sediment} = 235.97 \text{ x } (\Sigma \text{ MP water}) + 603.83$$

With this equation, it is possible to make estimations for calculating the microplastic concentration present in sediment based on the microplastic concentration in water.

CONCLUSION

1. From the microplastic identification results in the middle segment of the Karang Mumus River, various types of microplastics were found, including fiber, fragments, film, and microbeads. In water samples, a total of 685 microplastic particles were identified, consisting of 216 fiber particles, 144 fragments, 324 film particles, and 1 microbead particle. In sediment samples, 238 microplastic particles were found, comprising 65 fiber particles, 63 fragment particles, and 110 film particles. The microplastic concentration in the middle segment of the Karang Mumus River is predominantly composed of film-type microplastics. The average microplastic concentration in water is 3.04 particles/L, and the average concentration in sediment is 1322.22 particles/kg.
2. The microplastic concentration in the middle segment of the Karang Mumus River increases from upstream to downstream, corresponding to the rising human activities and population density along the river.

3. The microplastic concentration in sediment in the middle segment of the Karang Mumus River can be estimated using the equation Σ MP sediment = 235.97 x (Σ MP water) + 603.83, with an R2 value of 0.6698, indicating a reasonably strong relationship between the two variables.

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