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# ANALYSIS OF MICROPLASTIC CONTAMINATION ON WATER AND SEDIMENT IN THE BRANTAS SUBWATERSHED OF THE MALANG AREA

## Analisis Cemaran Mikroplastik Pada Air Dan Sedimen Di Sub Das Brantas Wilayah Malang Raya

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**ABSTRACT**

Microplastics are non-degradable contaminants that have been found in many river waters. Microplastics not only pollute water bodies but also become pollutants in river sediments. The Malang area is one of the areas passed by the Brantas River, which is the longest river in East Java and plays an important role for the community. The Brantas River has experienced a decline in water quality related to microplastic contamination. This study aims to analyze the types of microplastics and the abundance of microplastics found in water and sediment in the Brantas Subwatershed Malang Region. This study used a survey method and determined the sampling location point by purposive sampling. Microplastics identified in water and sediment samples have the same 3 types, namely fragments, fibers and films. The fragment type was found to dominate in water samples by 38.62% and also in sediment samples by 76.13%. The abundance of microplastics in water was highest at Station 5 at 686.67 particles/m$^3$ and lowest at Station 1 at 396.67 particles/m$^3$. While the abundance of microplastics in the sediment was highest at Station 3 at 2,517.15 particles/kg and lowest at Station 2 at 1,779.93 particles/kg.

**Keywords**: fragments, plastic, pollutants, river, sediment.

**ABSTRAK**

Mikroplastik merupakan kontaminan yang sulit terurai yang telah banyak ditemukan di perairan sungai. Mikroplastik tidak hanya mencemari badan air tetapi juga menjadi polutan di dalam sedimen sungai. Wilayah Malang Raya merupakan salah satu wilayah yang dilewati oleh Sungai Brantas yang termasuk sungai terpanjang di Jawa Timur dan berperan penting bagi masyarakat. Sungai Brantas telah mengalami penurunan kualitas air terkait dengan cemaran mikroplastik. Penelitian ini bertujuan untuk menganalisa jenis mikropastik dan kelimpahan mikroplastik yang ditemukan pada air dan sedimen di Sub DAS Brantas Wilayah Malang. Penelitian ini menggunakan metode survei dan penentuan titik lokasi pengambilan sampel secara *purposive sampling*. Mikroplastik yang teridentifikasi pada sampel air dan sedimen memiliki 3 jenis yang sama yaitu fragmen, fiber dan film. Jenis fragmen ditemukan mendominasi pada sampel air sebesar 38,62% dan juga pada sampel sedimen sebesar 76,13%.

Kelimpahan mikroplastik di air tertinggi pada Stasiun 5 sebesar 686,67 partikel/$m^3$ dan terendah pada Stasiun 1 sebesar 396,67 partikel/$m^3$. Sedangkan kelimpahan mikroplastik di sedimen tertinggi pada Stasiun 3 sebesar 2.517,15 partikel/kg dan terendah pada Stasiun 2 sebesar 1.779,93 partikel/kg.

**Kata Kunci**: fragmen, plastik, polutan, sedimen, sungai

## INTRODUCTION

The presence of microplastics in fresh water is an increasingly important problem for the environment, with several studies showing that high contamination has occurred worldwide (Dris *et al*., 2015). Although most studies on microplastics have been conducted in marine waters, the available information shows that the abundance of microplastics in fresh waters is comparable to the abundance of microplastics in marine waters (Li *et al*., 2018). Around 70-80% of microplastic sources come from land and rivers that then flow into the sea (Jambeck *et al*., 2015). Rivers flow through residential and industrial areas that directly transport domestic waste, agrocomplex waste, and industrial waste, and are very likely to include plastic waste, this is in accordance with Mani *et al*. (2015) who stated that in the Rhine River, where the river flows through the city center, the level of microplastic accumulation can increase.

Microplastics that are spread in the water will be carried by river flow, which causes their distribution to follow the river flow pattern. While those that are retained will settle and mix with the sediment below so that microplastics are spread not only in water bodies, but also in sediments (Claessens, 2013). The abundance of microplastics in water and sediments is thought to be interrelated, the distribution of microplastics in sediments is slower than the distribution of microplastics in the water column because of their nature of settling in sediments (Su *et al*., 2016). Research conducted by (Jiang *et al*., 2018) stated that the amount of microplastic exposure in sediments is greater than the microplastics exposed in the water column. In sediments, the abundance of microplastics was found to be greater than in waters, tentatively, on the deep seabed, microplastics can reach an average abundance of 0.5 microplastics per 25$cm^2$ (Claessens *et al*., 2013).

The water quality in the Brantas River area in the Malang area has decreased due to domestic waste and on the other hand the community also depends on the river water for their water needs (Yetti *et al*., 2011). The Brantas River is very important for the community, especially the people of East Java whose flow passes through Batu City, Malang, Blitar, Tulungagung, Kediri, Jombang, Mojokerto. The river then branches into two into the Porong River towards Porong in Sidoarjo Regency and the Mas River towards Surabaya (Ministry of Public Works, 2010). Based on research conducted by National Geographic Indonesia in 2018, the water in the upper reaches of the Brantas River is polluted by microplastic waste originating from the process of disposing of baby diapers. According to Radar Surabaya news (2019), in addition to the findings of plastic in the Brantas River, plastic fragments measuring 0.5 mm were also found which were suspected to be microplastics. The purpose of this study was to analyze the types, abundance and distribution of microplastic contamination in water and sediment in the Brantas Sub-DAS in the Malang Raya Region.

## RESEARCH METHODS

### Place and Time

The research was conducted in July to August 2024 with locations in the Malang Raya river basin area with 5 station locations which each have their own land use as follows.:

1. Stasiun 1 ($7^0$51’20” LS $112^0$31’24” BT) located in Sidomulyo Village, Batu District, is agricultural land.

2. Stasiun 2 (7$^0$54’8” LS 112$^0$34’33” BT) located in Pendem Village, Junrejo Batu District, where there are cooking oil industry activities.
3. Stasiun 3 (7$^0$56’0” LS 112$^0$36’11” BT) Located in Tlogomas Village, Lowokwaru District, Malang, there are agricultural activities and chemical laboratories.
4. Stasiun 4 (7$^0$57’53” LS 112$^0$37’40” BT) located on Jalan Panggung Malang with land use as a residential area.
5. Stasiun 5 (7$^0$57’53” LS 112$^0$37’39” BT) located near Oro-oro Dowo Market in Malang, where there is a market waste drainage channel.

**Methods**

In this study, the purposive sampling method was used to collect samples in the Brantas Sub-DAS. The purposive sampling method aims to take samples with certain considerations that are in accordance with the needs determined by the researcher Sugiyono (2017). The research procedure is divided into several stages, namely:

**River Water Sampling**

River water sampling using a plankton net with a mesh size of 25 µm. This method involves filtering solids obtained in the net for surface sampling (eg plankton net for surface water sampling) through a 5.6 mm and/or 0.3 mm sieve to isolate solid materials (Masura *et al*., 2015). Microplastic samples in the waters were taken using a plankton net with a filter volume of 15 liters on the surface of the water, in which it was taken 3 times using a 5 liter bucket to obtain a sample of 15 liters (Ayuningtyas *et al*., 2019). To ensure that microplastic particles were not caught in the net, the plankton net that had been used was then cleaned with water. The samples were then transferred to sample bottles, labeled, and stored in a cool box for further analysis in the laboratory.

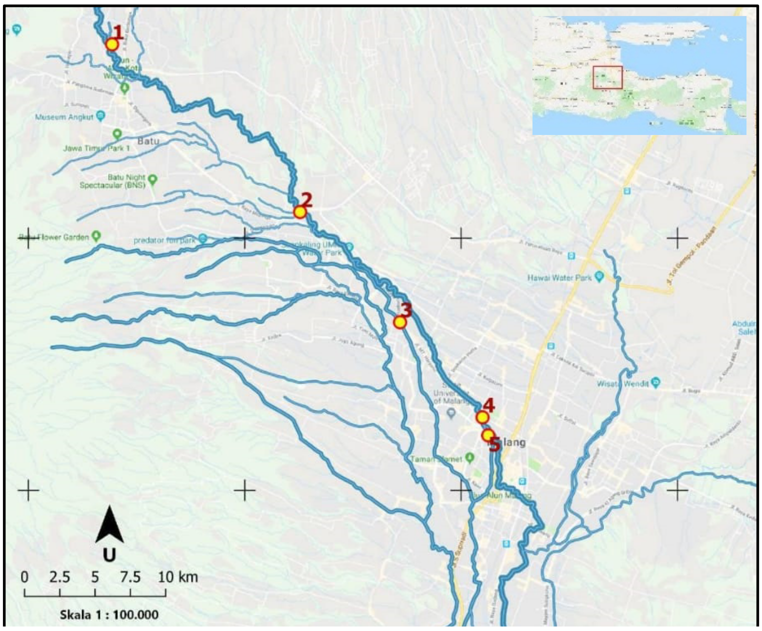


Figure 1. Sampling Locations in the Brantas Sub-DAS, Malang Raya Region

**Sediment Sampling**

Sediment sampling using an eckman grab. The procedure used is in accordance with Daulay (2014), To collect sediment samples on the surface, the eckman grab is slowly lowered from above, ensuring that the grab position remains upright until the base surface. Then the support on the eckman rope is released so that the grab can close and then the sediment sample can be collected. The sediment sample that has been collected in the eckman grab is then put into a zip plastic which is then analyzed in the laboratory.

**Identification of Microplastics in Water Samples**

Microplastic analysis in water samples is based on research conducted by Masura *et al*., (2015), After the water samples were collected, they were filtered using 5 mm and 0.3 mm porous steel sieves that had been stacked and drained into test tubes. The filtered water samples were then placed in an oven at a temperature of 80–90 °C for one day or more until the samples dried. Furthermore, 2 ml of 30% H2O2 was added to each sample to carry out the organic material destruction process. In the next step, microplastic particles were separated using Whatman No. 42 filter paper with the help of a vacuum suction pump. Furthermore, the filtered samples were put into a petri dish to be observed under an Olympus BX-41 microscope with a direct camera at 100x magnification. Masura *et al*., (2015) stated that the abundance of microplastics in water samples can be calculated using the following formula:

$$\text{Abundance of Microplastics (particles/m}^3) = \frac{\text{Number of microplastic particles}}{\text{Filtered water volume(m}^3)}$$

**Identification of Microplastics in Sediment Samples**

Identification of microplastic particles in sediment samples using the NOAA method has been carried out by Masura *et al*., (2015) by carrying out 4 processes, namely sample drying, sample sieving, density separation, and filtering of microplastic particles. The drying process of 150 grams of sediment samples from each sampling location using an oven for 24 hours at a temperature of 80-90 ° C. The sieving process is a further stage after drying by sieving using a sieve shaker. Sediment sieving using a sieve shaker is carried out to obtain sediment grains with a size of <45 µm and then the sediment results that have been collected on the bottom sieve are immediately weighed to determine the dry weight (Pratiwi *et al*., 2015). The next process is density separation by adding 20 ml of 0.05 M Fe (II) solution and 20 ml of 30% H2O2 solution. The sample is then heated at a temperature of 65 ° C for approximately 30 minutes and added with 6 grams of NaCl. Then the sample is inserted into the density separator to separate the microplastic particles based on their density and left for approximately 24 hours so that the non-microplastic particles settle. The process of filtering microplastic samples using Whatman No. 24 filter paper with the help of a vacuum pump suction machine. Then the filtered sample is inserted into a petri dish which will then be observed under an Olympus BX-41 microscope with a magnification of 100x. As stated by Dewi *et al*., (2015), calculating the abundance of microplastics in sediment samples is needed to determine the magnitude of the impact of microplastic pollution on the environment. The formula used to calculate the amount of microplastics found in sediment samples is as follows:

$$\text{Microplastic Abundance (particles/kg)} = \frac{\text{Number of Microplastic Particles}}{\text{Sediment Sample Weight(kg)}}$$

## RESULT

The types of microplastics found in water and sediment samples in the Brantas Sub-DAS in the Malang Raya Region can be seen in Figure 2.

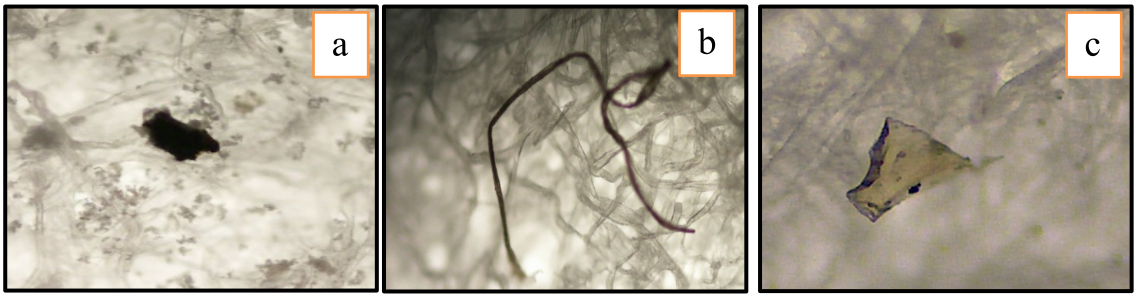


Figure 2. The types of microplastics found in water and sediment in the Brantas Sub-DAS in the Malang Raya Region are Fragments (a); Fiber (b); and Film (c) with a magnification of 100×

Table 1 shows data for water samples found that the fragment type dominates with a percentage of 38.6% followed by the fiber type at 38.4% and the film type at 23%. In sediment samples it was also found that the fragment microplastic type dominates at 76.13%, followed by the film at 23.5% and the lowest percentage in fiber at 0,4%.

Table 1. Percentage of Microplastic Types in Water and Sediment Samples

| **Type** | **Water Samples** | | **Sediment Samples** | |
|---|---|---|---|---|
| | **Particle** | **Percentage (%)** | **Particle** | **Percentage (%)** |
| Fragment | 16,2 | 38,6 | 153 | 76,1 |
| Fiber | 16,1 | 38,4 | 0,8 | 0,4 |
| Film | 9,7 | 23 | 47,2 | 23,5 |
| Total | 41,9 | 100 | 200,9 | 100 |

The abundance values of microplastics in water and sediment samples can be seen in Figures 3 and 4.

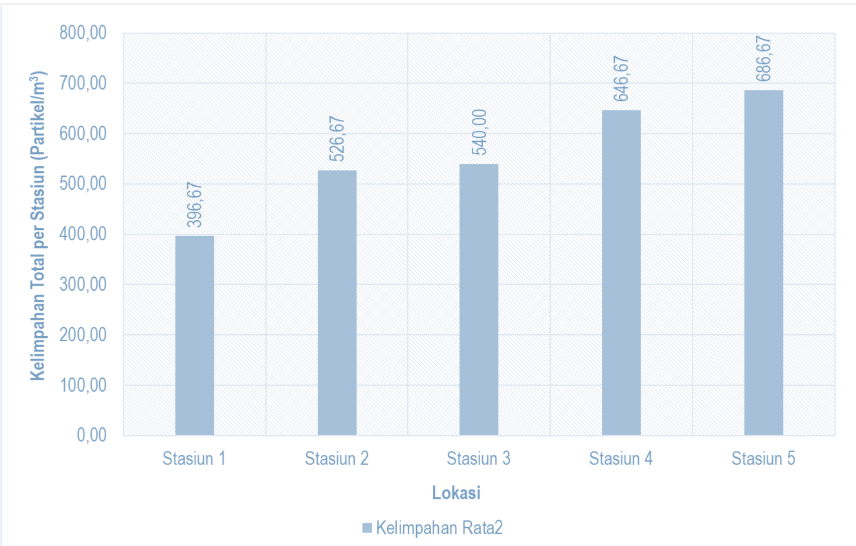


Figure 3. Microplastic Abundance Values in Water Samples

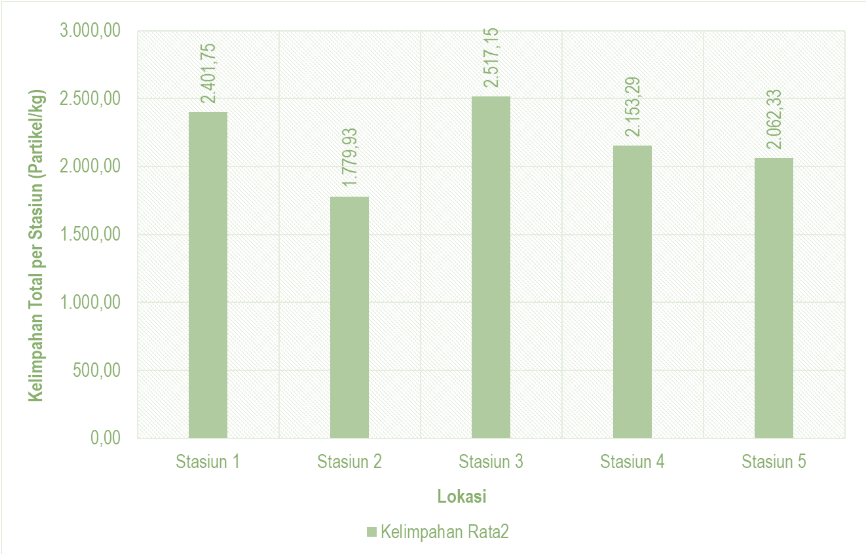


Figure 4. Microplastic Abundance Values in Sediment Samples

**DISCUSSION**

The results of the study showed that fragments, fibers, and films were the types of microplastics found in water and sediment samples of the Brantas Sub-DAS in the Malang Raya Region (Figure 2). According to Cormick *et al*., (2014), in general, fragments, fibers, and films are the types of microplastics most commonly found in river areas due to high levels of human activity. Fiber-type microplastics come from macro-sized plastic pieces such as bottles and bags, while fragment-type microplastics come from fishing line strings, nets, clothing fibers, synthetic fabrics, and net fibers (Kingfisher, 2011). Both types of microplastics can come from various human activities in waters, including the use of single-use plastic products (Dewi *et al*., 2015). Film-type microplastics can come from food packaging or from destroyed fragment plastic, which has a thinner surface than fragment microplastics (Claessens *et al*., 2013).

Station 1 had the lowest microplastic abundance of 396.7 particles/m3; Station 5 had the highest microplastic abundance of 686.7 particles/m3 in water samples. Station 5 is the station located most downstream compared to the other four stations which allows it to receive the least accumulation and distribution of microplastic contamination. The abundance of microplastics shows an increasing trend at Station 4 and followed by Station 5 which is caused by community activities around the river and the accumulation of river flow from downstream. The density of microplastics is closely related to the number of people living in a place. Plastic waste produced by human activities will accumulate and then be carried by the current and exposed to sunlight, becoming microscopic in size. (Barnes *et al*., 2009). The amount of microplastics is also influenced by domestic waste disposal, industrial waste disposal, and high levels of activity in urban areas (Zbyszewski *et al*., 2014). Household activities, especially waste production, are the influence of high plastic waste in the environment (Asia, 2017).

Different patterns are shown for the abundance of microplastics in sediments. The lowest abundance of microplastics was at Station 2 with an abundance value of 1,779.9 particles/kg and the highest was found at Station 3 at 2,517.15 particles/kg. The highest abundance at Station 3 was caused by the type of sediment found at Station 3, namely muddy. According to Dewi *et al*., (2015), soft-textured sediments or mud can capture more debris/microplastics than rocky or gravelly sediments. The movement or distribution of microplastics in sediments is not as easy as the movement of microplastics in water because it is influenced by the texture and weight of the sediment itself. At different sizes of sediment particles, the abundance of microplastics will be different (Mathalon & Hill, 2014). The force of gravity and the magnitude of the plastic density which is greater than the density of water causes microplastics to be deposited at the bottom of the sediment and accumulate in the sediment (Wright *et al*., 2013).

## CONCLUSION

The conclusion that can be drawn is that microplastic contamination has been found in the waters and sediments of the Brantas Sub-DAS in the Malang Raya Region with microplastic types in the form of fragments, fibers and films. Fragment-type microplastics were found to dominate in water samples and also in sediment samples. The results of the study showed that the highest abundance of microplastics in water was at Station 5 and the lowest abundance was at Station 1 which is included in the downstream location of the Brantas River. While the highest abundance of microplastics in sediment was found at Station 3 and the lowest at Station 2. This is due to the characteristics of river sediments not only from the location or position of the station which is downstream, middle or upstream

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