Occurrence of Microplastic in surface water of Jatiluhur Reservoir

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Abstract. *Microplastic is generally defined as synthetic polymers which size less than 5 mm. Based on the latest research, microplastics pollutions have many impacts on the environment and human. Jatiluhur, as one of the biggest freshwater reservoir in Indonesia, has potential to be polluted by microplastics because the water source of this reservoir streamed from Citarum watershed. Citarum River is one of the most polluted river in Indonesia. To find the occurrence of microplastics and to facilitate future policies in order to overcome microplastic pollution which occurs in Jatiluhur Reservoir, a study of microplastic abundance is conducted. Primary data is obtained by using the volume reduced sampling method. Manta trawl is pulled beside a boat for 5-15 minutes for each sample and flow meter installed onto the mouth of manta trawl to determine the towing distance in surface water. Microplastic abundance in surface water presented in the form of microplastics amounts per unit surface area. Furthermore, microplastic characteristics analyzed with visual analysis, particle density analysis, and polymer analysis using FTIR. Based on seven sampling locations, microplastics have found in Jatiluhur Reservoir ranging from* $0.71x10^4$ – $4.59x10^5$ *particles/km*^{2}. *The most type of microplastic found is fragmented polyethylene.*

1. Background

Indonesia is one of the countries that have a high percentage of mismanaged plastics waste [1]. Mismanaged waste has a high potential to become microplastics. Microplastic is generally defined as a synthetic polymer under 5 mm [2]. Based on the process of forming, microplastic can be divided into two types, the first is primary microplastic, which is plastic that does have a micro size and is usually found in cleaning and cosmetic products [3]. The second source is secondary microplastic formed from plastics that already exists in the environment and it fragmented into a smaller plastics and become the microplastics [4].

Microplastic abundance found in many areas from freshwater to the pole areas [5], but the data of microplastic research in the freshwater, especially in lake and reservoir is limited. The latest research found the occurrence of microplastics in Three Gorges Reservoir [6] and Taihu Lake, China [7].

In general, potential sources of microplastics in freshwater ecosystem include wastewater treatment plants (WWTPs), beach litter, fishery, cargo shipping, and harbors [14]. Jatiluhur reservoir is one of the biggest reservoirs in Indonesia, and this reservoir has potential to be polluted by microplastics because the water of this reservoir is streamed from Citarum River, which has polluted by microplastic. Latest research told that microplastics has polluted a segment of Citarum River [8]. Furthermore, this river also has a long history of pollution, and even Citarum has been named as the top ten toxic threats in the world in 2013 [9] because of the high pollution and the enormous impact of pollution to the population around the Citarum River.

Jatiluhur Reservoir also has the enormous fisheries industries, these industries is using fishing net made from the plastics, if this net degraded and fragmented, it can be another source of microplastis. Moreover, in the upstream of Jatiuhur, there are two other Reservoirs (Cirata and Saguling), the activities in these reservoir also have potential to contribute the source of microplastics.

2. Methodology

2.1 Sampling location

This study conducted in Jatiluhur Reservoir, Purwakarta, West Java.

Sampling point in Jatiluhur Reservoir is determined based on purposive sampling. Sampling points is divided into 7 location, including discharge area, middle area, and outfall of Jatiluhur Reservoir. Location 1 and 2 is the inlet stream of Reservoir and location 6 is the outfall of Reservoir. The reason in determining the sampling locations in 3 different segments is to investigate the abundance of microplastics in each segment. Sampling location is presented at Fig 1 and Table 1.

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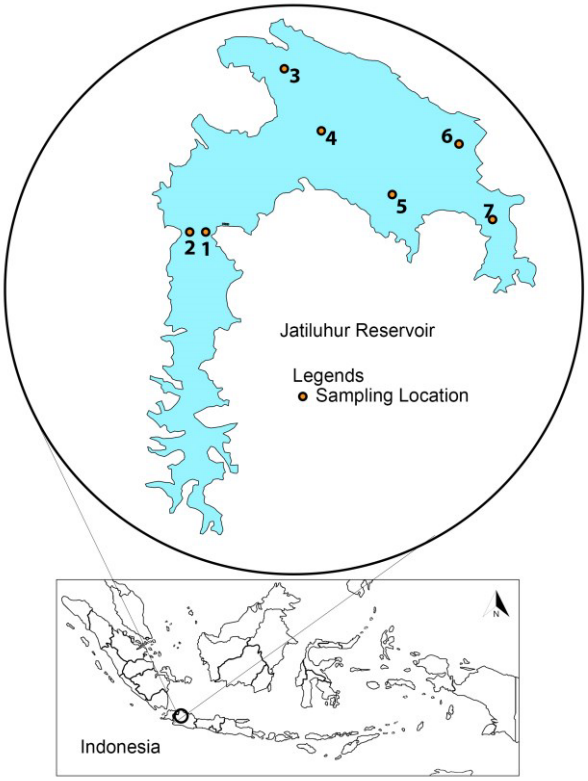


Fig 1. Sampling Location

Table 1. Coordinate of Sampling Locations

Location	Longitude	Latitude
1	S06° 33.477	E107° 18.235
2	S06° 33.432	E107° 17.855
3	S06° 30.559	E107° 20.532
4	S06° 31.782	E107° 20.837
5	S06° 32.652	E107° 22.397
6	S06° 31.723	E107° 23.267
7	S06° 32.527	E107° 23.119

2.2 Sampling method

Microplastic in the water surface was collected in May 2nd, 2019 using manta trawl with a rectangular shape, 30 cm high by 100 cm wide and 2.5 m long with 125 mesh size. Manta trawl was towed beside the boat with research boat and the speed was 5 km/h. Each sample was multiplying the towing distance with the width of the manta trawl to calculate the the area of sample. After microplastic took from surface water and preserved with formaldehyde 5%, water sample was separated by a mesh according to the mesh used at manta trawl (125µm), extraction of microplastic begins with dried the sample by the oven with 60°C until it dries and then was destruction used Fenton Oxidation method where using H_2O_2 and $Fe_2(SO_4)_3$ to clean the organic matters in 75°C [10]. Particles that suspected as microplastics were picked and put to the Petri disk. The scheme of microplastic analysis is described in Fig 2.

Visualization with a microscope was conducted to determine the shape and size of microplastic. The photographic results from micropscope was analyzed with ImageJ software to measure the size of microplastics. The type of plastic polymer determined using FT-IR. Wavelength setting of FTIR in this research ranging from 550 – 4000 cm^{-1}, and the result were compared with reference spectrum of plastic polymer.

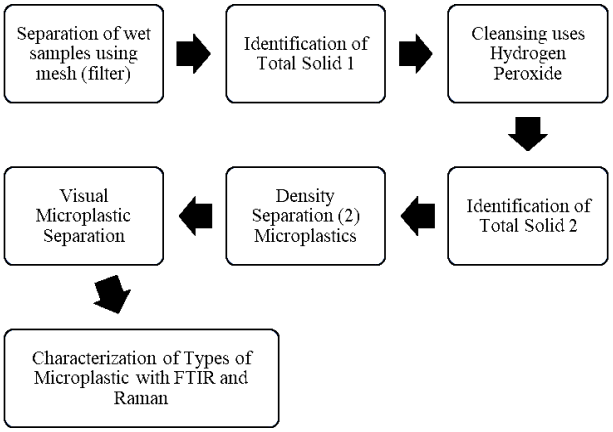


Fig 2. Microplastics Analysis Scheme [15]

3. Result and discussion

3.1 Microplastic concentration in surface water

Microplastics were found in all 7 sampling location in Jatiluhur Reservoir **(Table 2)**. The abundance of microplastics ranged from 6.71 x 10^4 – 4.59 x 10^5 particles/km^2. Observations on surface water showed that the average of microplastic concentration was 2.58 x 10^5 particles per km^2.

Table 2.
Microplastic Concentration by the points

Location (Points)	Towing Distance (m)	Amount of Microplastic	Particles per km^2)
1	108.92	50	4.59 x 10^5
2	122.91	46	3.74 x 10^5
3	122.42	11	0.89 x 10^5
4	110.14	18	1.63 x 10^5
5	115.18	27	2.34 x 10^5
6	112.84	47	4.16 x 10^5
7	148.93	10	0.67 x 10^5
Average			2.58 x 10^5

Sampling location 1 and 2 in this research are the inlet and main stream of the Reservoir and the abundance of microplastics are higher than other locations. High abundance of microplastics in inlet/upstream of Jatiluhur may affected by the high human activities and microplastics transfer from reservoir in upstream, Saguling and Cirata. These two reservoir also have massive activities in fisheries e.g. fish net. In the sampling location near from the dam (location 6), microplastic abundance increase, because microplastics cannot pass the dam and accumulate behind the dam. Microplastic in surface water can only be removed by sedimentation process and settled in bottom of reservoir [11] or

completely degraded, or accidentally ingested by aquatic organisms [6]

Table 3.
Comparison of microplastic concentration from Jatiluhur Reservoir with other areas

Study Area	MPs Size	MPs Abundance (10^5 counts km^{-2})	References
Lake Huron	>0.333	0.028	[12]
Lake Erie	>0.333	1.05	[12]
Three Gorges Reservoir	0.112–5	84.65	[6]
Jatiluhur Reservoir	0.125–5	2.58	This Research

In comparison with other reservoir and lake, Jatiluhur is higher than Lake Huron and Lake Erie in North America, but lower than microplastics abundance in Three Gorges Reservoir, China. (Table 3). The difference of microplastic number in compared reservoir affected by many factors, such as the other reservoir in upstream of Jatiluhur, human activities, and massive fisheries activities in Jatiluhur reservoir.

3.2 Microplastic size and shape

Based on the size, microplastic found in Jatiluhur Reservoir classified into 3 size groups, from 100 - 500 µm, 501 – 1000 µm and 1001 – 5000 µm. According the analysis, size between 1000 µm to 5000 µm were the most abundant than other sizes, accounting for 30.56 – 74.07 % of the total microplastics. Percentage of microplastics based on size is described in **Table 4**.

Table 4.
Percentage of Microplastic divided by size

Location	Size (µm)		
	100 - 500	501 - 1000	1001 - 5000
1	16.67%	52.78%	30.56%
2	4.88%	43.90%	51.22%
3	25.00%	37.50%	37.50%
4	10.00%	45.00%	45.00%
5	3.70%	22.22%	74.07%
6	10.00%	36.67%	53.33%
7	22.22%	22.22%	55.56%
Average	13.21%	37.18%	49.61%

Most of microplastics shape that found in Jatiluhur are fragmented microplastics. Microplastics in Jatiluhur Reservoir are mostly formed by fragmented plastic from daily usage plastic products. Some of micropolastic were line shaped, probably fragmented from breakdown of fishing net of fisheries industry in this Reservoir. Typical examples of microplastics shape collected from Jatiluhur Reservoir presented in **Fig. 3**.

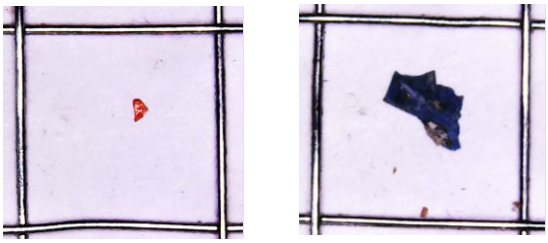


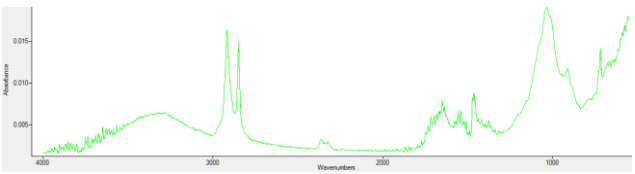
Fig 3. Microplastics Shape

3.3 Microplastic polymer type

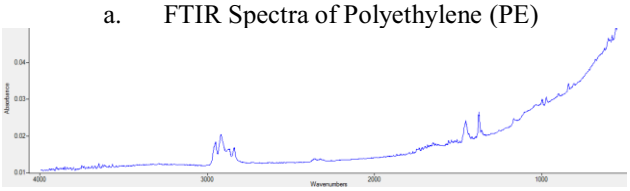
The polymer types of microplastics were identified with FT-IR to be polyethylene (PE) and polypropylene (PP) (Fig. 4). Polyehylene is the most dominant microplastics in this reservoir, which account for 54.73% (Table . PP and PE mostly found in reservoir aand/or freshwater because the density is lower than water density, (PP and PP density 0.83 – 0.85 g mL^{-1}; water density 1.0 g mL^{-1}). Other types of plastics are likely to be settled in the bottom of reservoir because other microplastics density are higher than freshwater density [13]. Percentage of microplastic polymer type presented in Table 4 and Fig. 4.

Table 4.
Percentage of Microplastic divided by polymer type

Location (Points)	PE (Polyethylene)	PP (Polyprophylene)
1	45.95%	54.05%
2	73.17%	26.83%
3	50.00%	50.00%
4	30.00%	70.00%
5	33.33%	66.67%
6	40.00%	60.00%
7	44.44%	55.56%
Average	45.27%	54.73%



a. FTIR Spectra of Polyethylene (PE)



b. FTIR Spectra of Polypropylene (PP)

Fig 4. Microplastic Polymer Spectra in FTIR

4. Conclusion

Occurrence of microplastics were observed in samples collected from Jatiluhur Reservoir. Typical microplastics shape in this area are fragmented microplastics sourced from breakdown of human activites plastics, and fisheries industries. The highest abundant is microplastic size ranging from 1000 to 5000 µm. Polymer type of microplastics in this Reservoir are PE and PP. Reservoir has potential to be the accumulation area of microplastics, because microplastics are trapped in reservoir.

5. Acknowledgment

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6. References

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