Plastic Wastes Distribution Pattern in the Covid-19 Era in Kreo Sub-Watershed Basin, Semarang City

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Abstract. The COVID-19 pandemic in Indonesia has occurred since March 2020 has caused restrictions on people's mobility and forced people to adapt by changing people's consumption patterns. To reduce direct interaction, people use products that are more durable, easy to take home, and hygienic. The use of plastic packaging and single-use plastic products is increasing. Without waste management, plastic dumped into rivers will increase and ultimately increase the potential for microplastic pollution. This study aimed to analyze and compare the types and distribution of plastic wastes in the Kreo sub-watershed basin sediments. Types of plastic wastes are categorized according to the Van Emmerik classification. Research samples were taken at 17 locations. This study uses a survey method with a qualitative descriptive approach. The average abundance of plastic wastes is 6-24 n/m2. The characteristics of plastic wastes in the upstream are dominated by PO-soft (47.95%), similar to the middle (51.12%), and in the downstream, it is dominated by multilayer (65%). The area with the most significant accumulation of plastic waste is downstream (20 n/m2) due to denser settlements, extensive sedimentation and river topography. The type of plastic waste in the Kreo sub-watershed basin can be a source of microplastic pollution in the future.

1   Introduction

Coronavirus Coronavirus (COVID-19) is a contagious diseases caused by SARS-CoV-2 virus [5]. The first Covid-19 case and the first death case caused by the virus in Indonesia was occurred in March 2020 [1]. The virus spreading process occurs very quickly because it can be contagious from human to human [2], causing the COVID-19 case to occur almost all over the world, with a total of 150 million cases and a mortality rate of 3% [3]. The COVID-19 cure has not been found, so what people can do is suppress the rate of transmission by

reducing interaction with other people and the daily mobilization [4]. Due to the mobility restrictions, even strict lockdown in several regions, there is a change in people consumption patterns where there is a frequency reduction in shopping for daily necessities. [5].

Based on the Central Java Provincial Government data until May 2021, Semarang has the highest COVID-19 case in Central Java (37.991 cases), so that the community activities restrictions or '*Pembatasan Kegiatan Masyaraka*t' (PKM) are applied, that causes the people to adapt to disposable plastic equipment and plastic wrappers because it is considered more hygienic and safer from viruses [6]. People who initially shopped for a small number of groceries or daily necessities and in the form of fresh food switched to buy in large quantities and stored in preservative containers. Dining in the restaurant is reduced because people choose to take home or order through the "gofood" app, resulting in increased use of plastic during this pandemic.

Plastic is a strong material, so that the plastic waste will be in nature for an extended time [7]. The increasing use of plastic in daily life can cause plastic waste accumulation in water due to the change in current speed and hold back by macrophyte plants, so it is deposited in riverbanks and floodplains [8]. It is proven by the presence of plastic in several waterways in Indonesia, which reaches four times more than waterways in Italy, France, and the Netherlands [9].

The waste management pattern in Semarang is not yet maximized by the existence of 0,56% of people who dispose of the waste in the river, waterway, or buried in the ground [10]. Most of (67%) waste in Semarang comes from settlements [11], and 16% of them are plastic wastes. The existence of 21,28% Semarang settlements on the riverbank causes the enormous potential of river pollution in the Kreo sub-watershed by plastic waste (macroplastic and microplastic) [11]. The river is the main route for primary or secondary plastic waste into the ocean [12], so research related to plastic waste in the Kreo watershed in Semarang needs to be done to see the plastic waste character dan to identify its resources so that efforts can be made to reduce the source of disposal and the impact of plastic waste because with the Jatibarang dam Kreo sub-watershed will be one of the important water sources in Semarang [13].

2 Research Methods

This study aimed to analyze and compare the types and distribution of plastic waste during the COVID-19 era in Kreo sub-watershed basin sediments. This research is quantitative research with river populations in the Kreo Sub-watershed, Semarang City, which is categorized into 3 areas of upstream, midstream and downstream. The research data were taken from river sediments from 17 locations by purposive sampling with a sampling area of 1m2 [14]. Plastic waste floating in the river was not taken into account in this study. The classification of plastic waste in this study refers to the classification according to Van Emmerik [15]. Plastic waste samples were categorized into 7 categories, namely polystyrene (PS), expanded polystyrene (PSE), terephthalate (PET), polyethylene soft polyolefins (PO-soft; low-density polypropylene (PP) and polyethylene (PE)), hard polyolefins (PO- hard; high PP and PE), multilayer plastics (ML) and Others which cannot be categorized into other 6 types. The data analysis used in this research is the percentage descriptive analysis technique.

3 Results and Discussions

The Kreo sub watershed in Semarang reaches 3.846,39 Ha and covers three sub-districts, namely Gunungpati, Mijen, and Ngaliyan. The length of the main river is ±30.60 km, with an average width is 14.6 m [16]. In the upstream area, the topography was dominated by hilly areas dominated by volcanic breccia rocks [17] with an area of approximately 40.61 km2 and a slope of 10->20%. In contrast, the downstream area has a more ramps slope and is formed from sedimentary rocks with an area of approximately 22.71% [18].

Geophysical land prone to erosion [19] and land-use changes in Kreo watershed in the form of increased settlements and plantations area increase the surface runoff [20] and landslides that can be the bearer of land material including plastic waste to the river system. Teh distribution of plastic waste from land to the river is also affected by river flow, wind, rainfall, river discharge, and hydraulic infrastructure [21].

3.1. Plastic Wastes Distribution

The distribution of plastic wastes in the sediment of Kreo sub-watershed varies by the total amount of plastic wastes found are 243 particles (n) from 17 sampling sites, and none of the locations is free of plastic wastes. The average abundance of plastic wastes is 6-24 n/m2, with the tendency to increase the number of plastic wastes from upstream to downstream. Figure **1** shows the land use in the upstream area of Kreo sub-watershed dominated by rice fields and settlements. In the upstream area, the average amount of plastic wastes is 12 n/m2, with the highest accumulation found in sites 5 and 6, which reaches 20 n/m2. Site 5 is located in Purwosari, sub-district Mijen is an orde 2 river and passes through 11 settlements. In contrast, site 6 is located in Cepoko, Gunungpasti is an orde 1 river and passes through 7 settlements before the sampling location. Although the amount of plastic wastes found is relatively the same as site 5, which is 20 n/m2, the dominant type of plastic wastes found is different. The least plastic waste in the upstream area is found in site 1, an orde 1 river and passes through 4 settlements.
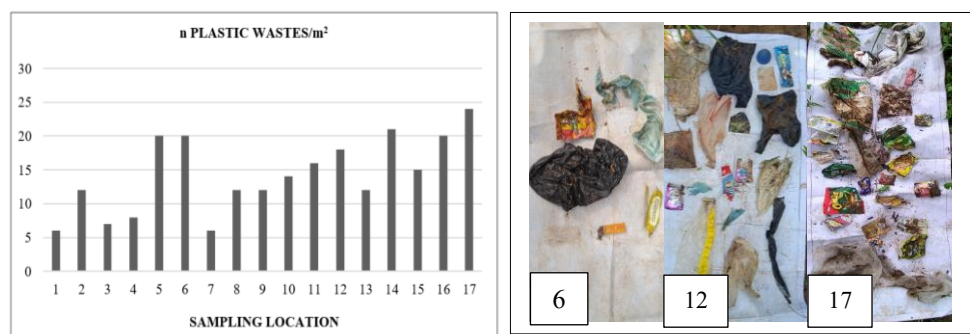

Fig 1. The plastic wastes ammount (n/m^2) obtained in 17 sampling site in Kreo sub watershed.

In the midstream, the average amount of plastic wastes found is 12.8 n/m2 or slightly higher than the upstream area. The closer to the downstream area, the number of plastic wastes is found in the midstream increases. Although it is not in the settlement area, the amount of plastic waste in site 11 that is located in Kedungpane, Mijen, reaches 16 n/m2 and site 12 that is located in Kandri, Gunungpati, reaches 18 n/m2 so that it became the highest

in the midstream area. Because the river in both locations is the river that becomes the water source for the Jatibarang dam so that the plastic wastes from this location will be accumulated in the Jatibarang dam, which serves as one of the water sources for PDAM (municipal drinking water company).

The Downstream area in the Kreo sub-watershed developed into a settlement, industrial, and agricultural area. The number of plastic wastes found in this area is 15–24 n/m2 with an average of 20 n/m2, higher than the upstream or midstream area. The highest plastic wastes amount was obtained in sites 17 (24 n/m2) and 14 (24 n/m2), which is orde 3 river and located in a densely populated area in Sanding, Gunungpati.

3.2. Identification and Classification of Plastic Waste Types

Based on the sampling data, plastic waste found in the upstream part was mostly plastic bags (5.67 n/m2) and was followed by plastic food wrappers (4.17 n/m2), drinking bottles, drink cups, foam, straps/sealing and some unidentifiable plastic. In the midstream, the plastic wastes which dominate almost the same as the upstream but are found in a larger quantity such as plastic bags (6.14 n/m2) and plastic food wrappers (5.43 n/m2), however in the midstream are found more varied plastic wastes with the discovery of straw, cap/lid, cutlery and isolation strips which were not found in the upstream part. At the downstream, the highest number of plastic wastes are found. Most plastic wastes found is different from the upstream and midstream because the downstream is dominated by food wrapping (13 n/m2) and then plastic bags (10 n /m2). Unlike the upstream and midstream of the downstream part, there are container fragments, as shown in Figure 2 below.

Most of the food wrapping found at the research location was in the form of spices, cooking oil, instant noodles, milk, instant coffee and children's snacks. Meanwhile, non-food packages are in the form of plastic bags, laundry soap, liquid soap, shampoo, pampers, and clothes deodorizers (**Figure. 1**).
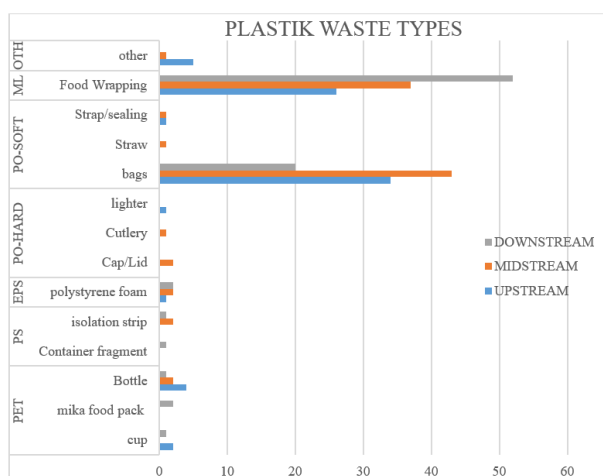

Fig. 2 Identification of plastic waste and classification based on Van Emmerik.

The types of plastic waste in this study were classified according to Van Emmerik into 7 types [15]. In the upstream part, the types of plastic wastes found were dominated by PO-soft types (47.95%) followed by multilayer (34.25%), PET (8.21%), other (6.85%) and EPS and PO-Hard with the same amount (1.37%). In the upstream, polystyrene (PS), which is generally in food container fragments and polystyrene foam, was not found. In the midstream, the most significant type of plastic was PO-soft (51.12%), then multilayer (41.11%), PET, EPS and PO-Hard, respectively 2.22%, and the smallest was PS (1.11%).

The dominant types of plastic wastes found in the research location were PO-soft and Multilayer. PO-soft consists of PP and PE and multilayer plastics which are multilayer flexible packaging materials, primarily based on PE and PP [9]. The most common microplastic polymers found in various studies that have been carried out are Polystyrene (PS), Polyethylene (PE) and Polypropylene (PP) [22], so that the type of plastic waste in the Kreo Sub-watershed can be a source of microplastic pollution in the future.
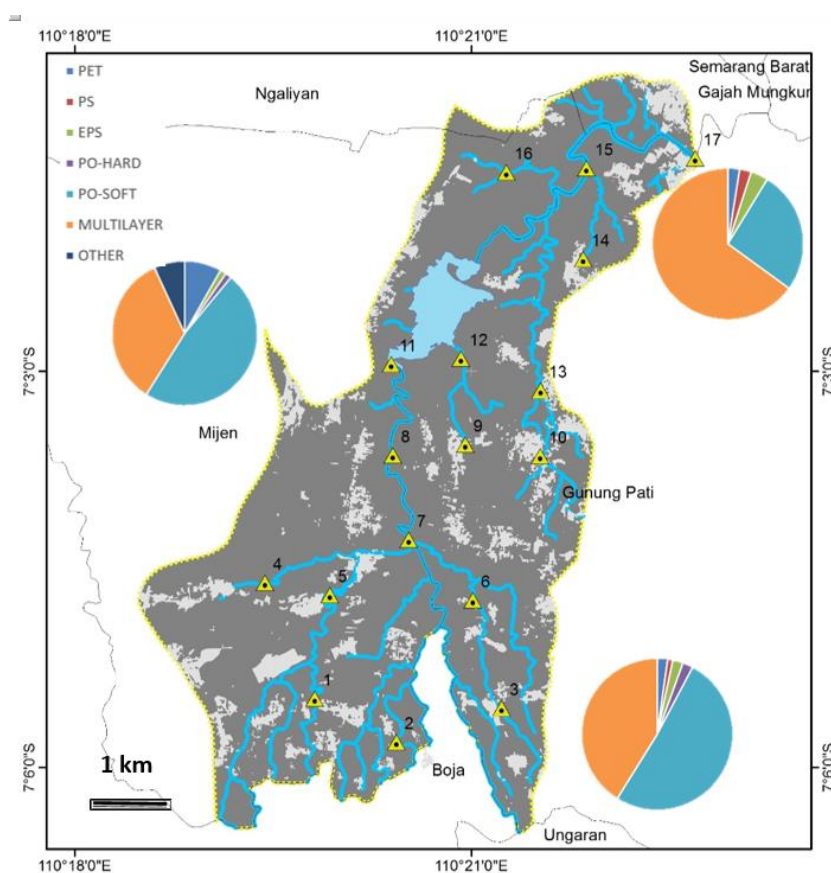

Fig. 3 Types of plastic wastes in the upstream, midstream and downstream of the Kreo Sub-watershed.

4 Conclusion

The distribution of plastic wastes in the sediments of the Kreo Sub-watershed tends to be higher from upstream to downstream, where the highest amount is found in rivers that pass through many residential areas. So even though the location is not in a residential location, the amount of plastic waste found can be high, especially the type of plastic waste that is light and easily carried away by river currents.

Most of the food wrapping this research was wrapping for daily food items and wrapping for hygiene materials and plastic bags. Based on the identification of plastic wastes, it indicates that most plastic wastes comes from household activities from settlements along the river and can indicate that many people buy daily necessities wrapped in plastic packaging from food producers/factories and still use plastic bags for their daily activities indicated by the presence of plastic bags at all sampling locations. With sediment discharge reaching 1,394.36 tons/day [16] and the average plastic waste found in this study reaching 14.29 n m-2, the content of plastic wastes passing through the river in the Kreo Sub-watershed is quite large.

If the plastic wastes in the Kreo watershed are not handled thoughtfully, especially those from PS, PP and PE, it will become a source of microplastic pollution in the future. It will cause danger because it will affect the quality of Semarang City raw water sources taken from the Jatibarang Dam.

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