Plastic debris in sediments from the east coast of Surabaya

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Abstract. Surabaya is the capital city of East Java and it has a coastal area. This coastal area has lot of communities and tourism activities. As a result, this will have an impact of increasing plastic waste in the environment. This circumstance will have an impact on increasing plastic waste in the environment. The accumulation of plastic waste on the east coast of Surabaya is due to human activities. The present study has identified the polymer of plastic debris collected from the east coast of Surabaya. Bulak was the major district having high plastic debris (89.41%). The highest of three polymer types were identified viz. polypropylene (PP), high-density polyethylene (HDPE), and low-density polyethylene (LDPE). Polypropylene was the most polymer plastic found on the east coast of Surabaya (67.86%), particularly in Bulak followed by Kenjeran, Gunung Anyar, and Rungkut.

Keywords: coastal area, plastic debris, sediments, Surabaya

1. Introduction

Production of plastics has risen significantly since the improvement of synthetic polymers in the intermediate of the 20th century in the world [1]. In 2014, the global production of plastics estimated at approximately 311 million tonnes and still probability to rising [2]. Plastics are largely used because they are simple, light, durable and cheap [3]. The highest of a plastic polymer was polypropylene (19.2%) for packaging [2]. The accumulation of plastics in the environment caused by poor management rates and inappropriate exile of plastic waste. This base probability leads to rising levels of plastic debris worldwide, especially in the marine environment.

Currently, accumulation and fragmentation of plastic debris in terrestrial environments, in the ocean, on shorelines of even the most secluded islands and in the deep sea. Furthermore, the marine debris has attributed to land-based and ocean-based sources such as tourism activities, fishing activities, and human activities around coastal areas [4]. The marine environments are acknowledged to be useful to the fragmentation of plastic debris [5]. Previous studies on plastic debris accumulation in the marine environments [1, 3-6]. A lot of plastic marine debris accumulating in coastal areas before moving to expanses of the ocean [3].

Indonesia has more than 100 cities that are located in coastal areas. The amount is growing because of a tendency of urbanization rate in the urban region. Therefore, the human population living around coastal areas will consequently develop [7]. Indonesia produces 187.2 million tonnes of plastic waste each year, it means Indonesia is the second highest marine polluter in the world following China [8]. In fact, 43.4% of plastic in Indonesia is used as packaging [9]. Surabaya City as the second largest city

has been developing rapidly. Surabaya is a large city that has the coastal area like Jakarta as the capital city of Indonesia. Surabaya city has been produced 400 tonnes of plastic waste [9].

The east coast of Surabaya is susceptible to plastic waste accumulation on the coastline from terrestrial source owing to human activities around coastal areas, marine sources owing to fishing and tourism activities, as well as river discharges. The aim of the present study is to identify the type of plastic debris in sediments on the east coast of Surabaya.

2. Material and methods

2.1 Study area and sampling location

The east coast of Surabaya was chosen because of its accessibility and the huge number of living communities. Samples were collected at four districts on the east coast of Surabaya viz. Rungkut district, Gunung Anyar district, Bulak district, Kenjeran district. The sediments sampling was conducted using a random station in each district. Subsequently, each district has four stations. The detail of the station is shown in Table 1. Sampling at each station performed was occurred repetitions by using Global Positioning System (GPS).

2.2 Sample processing and analysis

The focus of items in the present study was plastic debris in sediments viz. mesoplastic (> 5-20 mm) and macroplastics (> 20 mm). The sediments were taken by *Ekman grab*. The sediments sample were placed directly in a plastic bag. The sediments sample was dried at room temperature overnight. Subsequently, sediments were dried at 60^{o}C in an oven for 24 hours.

The visible plastic debris were separated from sediments with tweezers. In addition, the plastic debris were sorted from non-plastic materials based on the physical and morphological characteristics. Furthermore, the sediments were sieved using commercial mesh with distinct mesh sizes to separate plastic items with distinct sizes and other particles. Most of the plastic debris were identified with the naked eye.

Figure 1. (a) station location in mangrove area (b) Sediments sampling using an Ekman grab.

3. Results and discussions

The sites of data collection located on the east coast of Surabaya. The sampling sites divided two areas viz. mangrove areas (Rungkut district and Gunung Anyar district) and urban areas (Bulak district and Kenjeran district) (Table.1). The plastic debris in sediments was taken when the east monsoon in Surabaya with the sea temperature approximately 28-29^{o}C.

Table 1. Sampling location study

District	Characteristics area	Characteristics Sediment	Stations	Coordinates
Rungkut	Mangrove area	Clay	1	S 07° 19' 07.38" E 112° 50' 03.99"
		Clay	2	S 07° 19' 15.73" E 112° 50' 12.00"
		Clay	3	S 07° 18' 30.20" E 112° 50' 46.41"
		Clay	4	S 07° 19' 16.85" E 112° 50' 25.18"
Gunung Anyar	Mangrove area	Clay	1	S 07° 20' 05.12" E 112° 49' 49.39"
		Clay	2	S 07° 20' 06.71" E 112° 49' 48.50"
		Clay	3	S 07° 20' 01.26" E 112° 49' 42.27"
		Clay	4	S 07° 19' 56.79" E 112° 49' 35.67"
Bulak	Urban area	Clay	1	S 07° 13' 33.43" E 112° 47' 23.00"
		Clay and Silt	2	S 07° 13' 28.32" E 112° 47' 18.88"
		Silt and Sand	3	S 07° 13' 02.56" E 112° 47' 06.20'
		Silt and Sand	4	S 07° 13' 11.89" E 112° 47' 15.14"
Kenjeran	Urban area	Clay	1	S 07° 14' 11.42" E 112° 47' 49.28"
		Clay	2	S 07° 14' 17.66" E112° 47' 51.81"
		Clay and Silt	3	S 07° 13' 57.94" E 112° 47' 42.10"
		Silt and Sand	4	S 07° 13' 49.43" E 112° 47' 38.20"

3.1 The quantities of plastic debris

The total of 529 plastic debris was taken successfully in four districts along the east coast of Surabaya (Table 2). The high percentages of plastic debris have obtained in Bulak District was 89.41% followed by Kenjeran 9.07%, Gunung Anyar 0.95% Rungkut 0.57%. This result indicates that Bulak district (urban area) was the highest district have a source of plastic waste. Bulak district has the majority of human activities. In addition, Bulak district has the fishing settlement that very close with the coastal areas, domestic activities, traditional markets [10, 11]. Therefore, allows if scraps of human activities directly discard to marine or carried away the wave currents to marine.

Table 2. The number of plastic debris collected from east coast of Surabaya

District	Plastic number
Gunung Anyar	5
Rungkut	3
Bulak	473
Kenjeran	48

The plastic debris was inputted in the sediments due to activities from ocean-based sources. Fishing activities include nets, lines, ropes, gillnet or trawl floats has contributed plastic debris in marine areas [12, 13]. As far as the present study, Bulak district was the fishing settlement. Therefore, a huge of fishing boats leaning on the shore areas. These conditions will contribute plastic scraps for the marine environment.

3.2 The composition of plastic debris

The composition of plastic debris refers to a polymer of plastic debris. The amount of plastic debris based on polymer observed at the distinct station in the east coast of Surabaya is shown in Figure 1. In total 529 plastic debris items were found in the following viz. Polypropylene (67.86%), High Density Polyethylene (11.53%), Low Density Polyethylene (11.15%), Polyethylene terephthalate (5.1%), Polyvinyl Chloride (3.21%), other (1%) and Polystyrene (0.19%).

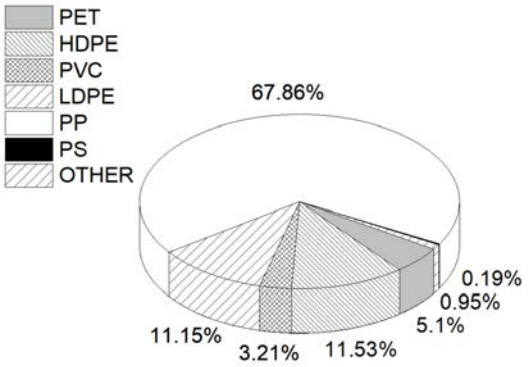
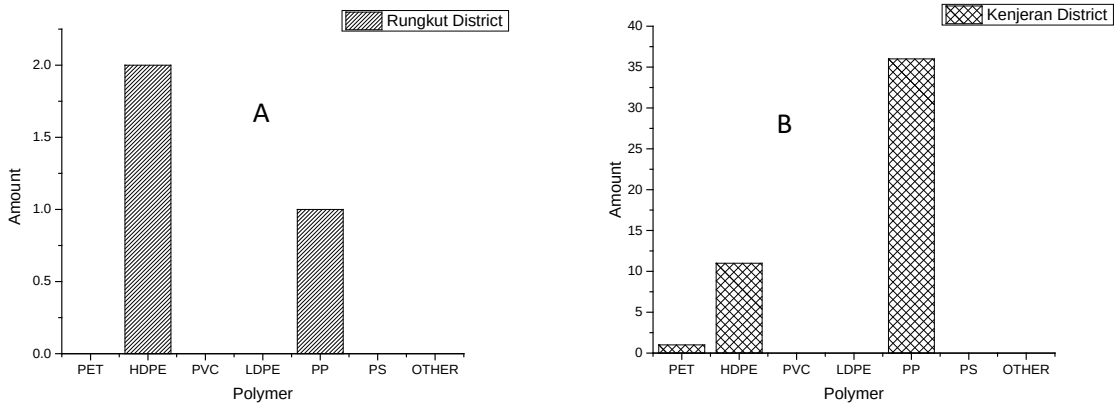


Figure 2. The total of plastic debris on the east coast of Surabaya

This study found that the majority of plastic debris on the east coast of Surabaya derives from terrestrial-based sources followed by ocean-based sources. The majority of plastic debris polymer was from polypropylene (67.86%). Based on the field observation, most of plastic debris were fragments from fishing activities and disposal from domestic activities. The source of fragments can be from fishing tools such as line fibres and nets [6, 13]. Based on our investigation, the source of HDPE plastic debris is fragmentation of plastic bottles and plastic bags. Fragmentation in the environment is mainly compelled by photo-oxidative degradation, followed by thermal and biodegradation [14]. Polypropylene fragments are more slowly and more point to mechanical degradation [15].



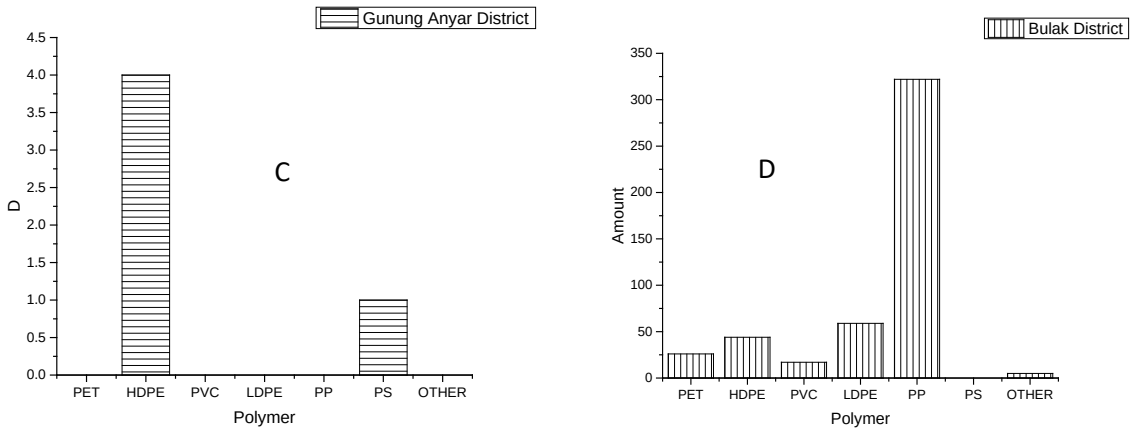


Figure 3. Summary of plastic debris based on its polymer in a) Rungkut district b) Kenjeran district c) Gunung Anyar district d) Bulak district

The amount of plastic debris in sediments based on the polymer in four districts was shown in figure 2. The highest number of plastic debris was obtained in Bulak district followed by Kenjeran district. On the other hand, Polypropylene (PP) was the dominant polymer plastic debris on the east coast of Surabaya. Bulak and Kenjeran were the districts with huge polypropylene. The previous paper reported fishing nets and line fibers include polypropylene strands [11]. Based on the observation, most of the plastic debris originated from a fishing net followed by plastic bottles scraps, and scraps of crackle bag. This indicates that plastic debris is from land-based and ocean-based sources.

The plastic debris found originated from fishing activities viz. line fibers and nets especially in Bulak district. Bulak and Kenjeran are districts whose majority population's livelihood depends on fishing. In addition, a lot of fishing boats were moored on the Bulak district. The present study has similar information to the previous report that Bulak district produces huge waste especially plastics, diapers and various other types of waste in the marine environment [16]. The present study showed Gunung Anyar and Rungkut districts have plastic debris from HDPE plastics originated from bottles of mineral water and crackle bags. This indicates that the plastic debris are from communities' activities discarded by the people into the marine environment. The finding of present result similar to previous studies of plastic debris in which polypropylene and HDPE were the among the most of polymer types found in marine environments

4. Conclusions

The plastic debris found at all the four districts sampled in the east coast of Surabaya. The plastic debris in sediments mainly consisted of polypropylene, where Bulak district had a majority of plastic debris. Overall, it can be concluded that plastic debris is commonplace in the east coast of Surabaya. Surabaya requires a strength and good management related to plastic waste to reduce the amount of plastic debris in the environment. The present study is a beginning for further study related to marine debris or plastic debris in the marine environment, especially in Surabaya.

5. References

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