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Marine Debris Composition and Abundance: A Case Study of Selected Coastlines in Ujong Karang, Meulaboh, West Aceh

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ABSTRACT

Marine debris has become an increasing environmental threat in the world. West Aceh's coast is designated for tourism and fishing activities. This study determines the composition, characteristics, and abundance of waste on two selected beaches with economic activities for fishing (daily activities of coastal communities) and tourism activities. Garbage collection was carried out on two beaches on the coast of Johan Pahlawan District, West Aceh Regency, namely Pasar Baro Beach and Ujung Karang Beach. Pasar Baro Beach and Ujung Karang Beach were chosen because they are near fish market activities and recreational beaches, respectively. Determination of the sampling area by distance, from the low tide line to the first vegetation or concrete on the beach. The sampling length was measured using a 100 m roll meter parallel to the coastline. The results showed that the total weight (%) and frequency of waste per category were highest in the household category at Pasar Baro Beach. While at Ujung Karang Beach, the highest frequency of garbage is found in the variety of plastic drink bottles. The difference in abundance at the two stations is due to differences in visits and activities of the surrounding community. In addition, due to the lack of local cleaning efforts and facilities that could be more optimal, piles of garbage are still found along the coast.

Keywords: Abundance, Composition, Marine Litter, West Aceh

1. INTRODUCTION

Marine debris is an increasing environmental threat in the world. This debris includes diverse forms of plastic sources originating from land and ocean and is estimated to account for 85% of marine debris worldwide (Wang et al., 2019). Plastic pollution has become a significant concern in Indonesia's coastal and marine environments. This is because 14% of the solid waste component in the country is plastic, and its waste management infrastructure and services are still limited, so urgent solutions are still needed regarding its management (Lestari and Trihandiningrum, 2019). Most plastic waste is generated on land, eventually reaching the marine environment, which is considered a significant landfill for plastic waste. The distribution of waste on the coast is related to the surrounding economic activities.

Garbage in the marine environment can come from several sources, including activities at sea or along the coast (e.g., fishing, aquaculture, and tourism) or household, industrial, and agricultural activities in the coastal environment (Thiel et al., 2013). Beaches close to river mouths or cities and beaches with barriers have a more significant accumulation of garbage. Plastic materials are the largest contributor to marine debris, up to 93% (Jang et al., 2018). Jambeck et al. (2015) found about 275 million tons of plastic waste generated in 192 coastal countries in 2010, of which 4.8-12.7 million tons were wasted into the sea and can pollute the ocean with Indonesia's status as the most significant contributor of marine plastic waste in the world.

The increasing human population also has implications for the increasing use of plastic for daily purposes. Not only that, but the use of the beach as a place of tourism and the

start of fishing activities also causes the beach to be aesthetically unattractive because of the many piles and deposits of garbage. This anthropogenic waste reduction can be started with local solutions that can be applied to each city (Thiel et al., 2013). Local solutions can be used in each region with initial information or data about waste. Research on waste in the marine environment has been widely conducted, including analysis of composition, abundance of marine debris, sources of waste, and management of marine and coastal debris (Fruergaard et al., 2023; Jang et al., 2018; Mishra et al., 2023; Setiawan and Nugroho, 2022). However, few have researched the coast of West Aceh, so there is no picture of the waste's distribution, composition, or characteristics. One of the studies Kusumawati et al. (2018) conducted on the composition of marine debris in four coastal districts of West Aceh found that Johan Pahlawan District was in second place in the number of marine debris dominated by the glass plastic category.

West Aceh Coast has been designated as a place of tourism and fishing activities for fishermen, one of which is in Johan Pahlawan District. Pesisir Pantai Kecamatan Johan Pahlawan is one of the most visited locations by local tourists because of its strategic location close to the city center in West Aceh. So, this dramatically affects the contribution of garbage accumulation on the coast. Although there has been a Regional Regulation (Qanun) that regulates waste management in West Aceh Regency, this is considered still not optimal due to the lack of government efforts and management in managing waste in the community, such as the lack of facilities and infrastructure in waste management so that there are still many piles of garbage, especially in specific locations such as the coast. This study determined the composition, characteristics, and abundance of waste in two selected beaches with economic activities for fishing (daily activities of coastal communities) and tourism activities. Therefore, the results of this study can be used as a basic and additional reference regarding appropriate waste management steps (Azwar, 2017; Yulianita et al., 2021).

2. RESEARCH METHODS

Time and Place

Garbage collection was carried out on two beaches on the coast of Johan Pahlawan District, West Aceh Regency, namely Pasar Baro Beach and Ujung Karang Beach. These two beaches were chosen because of the high intensity of activities on the beach compared to other beaches in Johan Pahlawan District. Pasar Baro Beach and Ujung Karang Beach were selected because they are beaches close to fish market activities (community activities) and recreational beaches, respectively. The comparison was made based on the composition, possible sources, and distribution of marine debris resulting from two different activities. Sampling on two separate beaches will take place in March 2023.

Method

The garbage sampling area for each beach is adjusted to the actual width and length. Determination of the sampling area by distance, from the low tide line to the first vegetation or concrete on the beach. The sampling length was measured using a 100 m roll meter parallel to the coastline, with each sampling width at 1 m to the right and left of the roll meter. Garbage that enters the designated area is taken as a whole, provided that only waste above the sand is collected, while waste below/ in the sand is ignored. Sampling is carried out at low tide. The data collected is garbage found on the beach, excluding garbage collected in the trash can provided. This measures the amount of waste likely to be carried into the sea or impact the ecosystem.

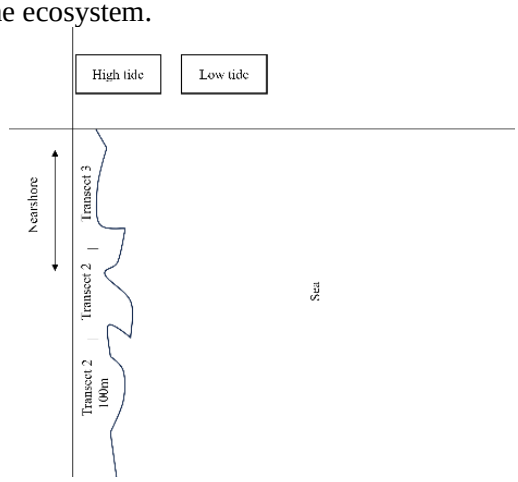

Figure 1. Three sample points per Beach location with a length of each repeat 100 m.

Procedure

These anthropogenic wastes are then sorted and categorized based on the following

classification (Duhec et al., 2015).

Data Analysis

Each beach's total weight and frequency of marine debris is calculated using Microsoft Excel 2023. The characteristics of each category of waste are visually analyzed and described descriptively.

Table 1. Categorization and classification of anthropogenic waste

No	Category	Classification
1.	Beach sandals	Flip-flops or shoes
2.	Plastic beverage bottles	
3.	Glass bottle	Drinks and food
4.	Lightbulb	
5.	Household items	Lighters, toothbrushes, toys, hangers, cotton buds, plastic food bottles and cleaning bottles
6.	Fishing items	Bait, fishing line, buoys (including handmade buoys made from flip-flops or plastic bottles), fishing rod buoys, ropes and pieces of net
7.	Foam sheet	Includes sheets cut to resemble the shape of flip-flops
8.	Hard plastic	Includes hard plastic macro pieces
9.	Soft plastic	Includes pieces of plastic bags, food packaging, large pieces of plastic sheeting
10.	Plastic cap	Beverage bottles, pens, oil containers, plastic bottles, etc.
11.	Small plastic fragments (pieces)	Decomposed plastic measures <2cm, including pieces of polystyrene, foam, and hard plastic
12.	Other	Includes car wheels, fuel jerry cans, barrels, and wood

3. RESULT AND DISCUSSION

The total weight of waste collected at the research sites, Pasar Baro and Ujung Karang, was 15.5 kg and 5.9 kg, respectively. Marine debris is concentrated at the top of the beach at the highest tide of seawater. The density and abundance of garbage collected respectively at the Baro Market with a total weight of 15.5 kg to 272 trash, and the total weight at Ujung Karang is 5.9 kg with a full item of 132 garbage.

Household goods contributed the most, with a total weight of 10.8 kg, followed by the soft plastic category of 6.95 kg. In descending order, the total weight of each item is a plastic beverage bottle (2 kg), another (1.4 kg), small plastic fragments (pieces) (0.2 kg), and a plastic cap (0.1 kg). The total weight (%) of waste per category (presented in the following graph (Figure 1).

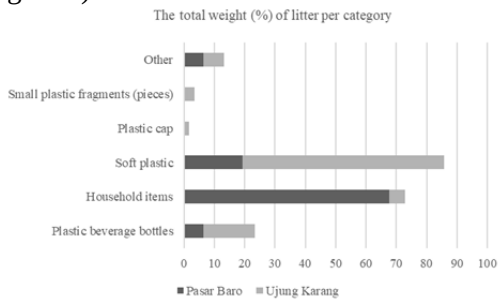

Figure 2. Total weight of litter per category

The total weight of each category is different when assessed in terms of frequency (Figure 2). The category "household goods" has a higher frequency of occurrence, reaching up to 92% of all objects collected in the Baro Market. The household goods category has more items and is scattered compared to other types. The different categories were found to have the lowest frequency values found. Unlike Ujung Karang, the highest frequency of marine debris by category is in the "plastic drink bottles" category.

The density of garbage washed up on Pasar Baro Beach and Ujung Karang is estimated at 2.7 items per linear meter on the beach. This number is much smaller when compared to the study results, which obtained a mark of 18.48 items per meter. Microplastics are the most common plastic waste in household and soft plastic categories (Kusumawati et al., 2018).

The total frequency per category based on the location of the study was found to be most diverse in Ujung Karang (Figure 3). There were categories of plastic drink bottles, household items, soft plastic, plastic caps, small plastic fragments (pieces), and others. While in the Baro Market, only four of the other six categories are found.

The high abundance of plastic waste, in

terms of amount and weight observed in this study, shows that the waste accumulation period is more extended with Beach cleaning efforts that have not been maximized. Plastic objects, including plastic drink bottles, soft plastics, and household items, were the most common types of waste found in this study for the two observation sites. Based on visual observations, the garbage found on Ujong Baru Beach is a pile of garbage that has been in the area for a long time. This can be seen from the wood-type household garbage that has begun to grow with moss and barnacles. Regular cleaning and adequate facilities should be done in the Beach tourist area.

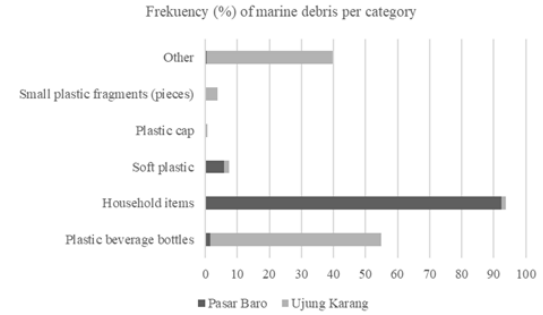

Figure 3. Frequency of marine debris per category

However, this was not done at the two observation sites. Garbage disposal and the abundance of garbage piles depend on the locals' initiative to implement good waste management (Duhec et al., 2015; Khairunnisa et al., 2012). Another thing that may contribute to the high frequency of waste found is due to differences in the number of visits and activities of local communities. This aligns with research (Thiel et al., 2013) that reveals that marine debris is the most waste produced by anthropogenic activities on sandy beaches.

Average length and width per category were also performed at each location. The results showed that the highest average height and width were found in the "soft plastic" category in the Baro Market, while in Ujung Karang, the most increased average length was found in the "Small plastic fragments" category, with the largest width in the "soft plastic" category.

The source of plastic waste mainly came from household activities on the coast and tourism, which contributed around 10.8 kg in this study. The results showed that the characteristics of garbage mainly come from sources on land. It comes from activities on land, and research (Suaria et al., 2015) finds that plastic waste is the most common type of waste floating in the waters and will later empty into the coast. Microplastic contamination of the marine environment has become a growing problem. Microplastics are abundant and widespread in marine environments, found in the highest concentrations along coastlines and in mid-ocean troughs that marine organisms will directly consume (Cole et al., 2011).

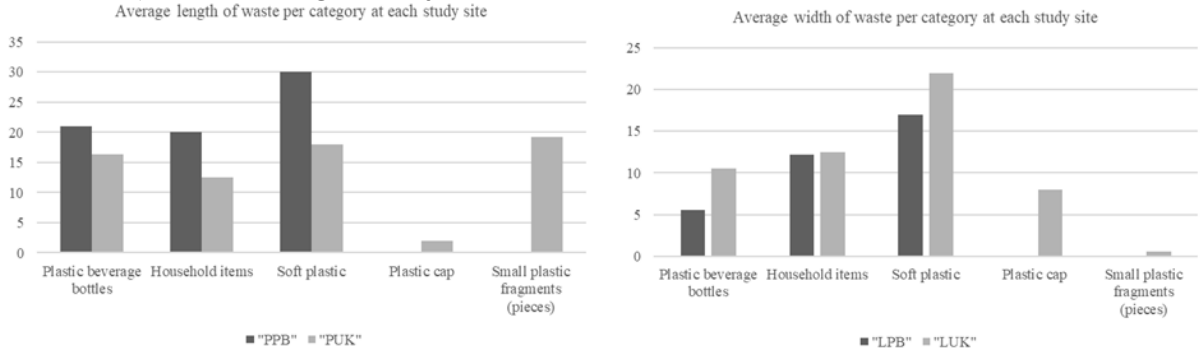

Figure 4. Average length (A) and width (B) of waste per category at each study site

Marine debris is identified based on the size range and distribution, often associated with preventive measures to fix the waste problem. Although observations were made at two different locations, the average length and width had the same result: the most significant size was in the soft plastic category (with subcategories including pieces of plastic bags, food packaging, and large pieces of plastic sheeting) (Figures 2 and 3). However, this value is inversely proportional to the results obtained on the percentage of total weight per category (Figure 1). When associated with the characteristics of waste, plastic waste is the type of waste that has the most problematic material. Currently known are four types of plastics: PVC, polystyrene, polyurethane, and polycarbonate (Lithner et al., 2011). Plastic

with such materials is tough to recycle and is made from potentially toxic materials (Rochman et al., 2013).

The length and width of garbage per category relate to the possibility of being buried by sediment piles or the flight of waste due to the influence of wind. Garbage that is left scattered and piled up on the coast, especially those made of plastic, can spread far from the source area or into the waters. Small objects with a high ratio of surface area and volume can sink into water faster than objects of larger size (Ryan, 2015). The high and diverse accumulation of waste at the Baro Market research location (Figure 2), in addition to the high activity of the surrounding community, is also caused by locations that tend to form like bays, and this path is a path used for access in and out of fishing boats. The same is revealed by Barnes et al. (2009) that the accumulation of waste (mega or macro) is found to be with the highest density because it is close to urban centers, closed seas, and because of the confluence of water (fronts).

4. CONCLUSION

The results showed that the dominating characteristic of marine debris was plastic waste, with the highest total weight (%) of the waste category being the household goods category, with a percentage of 67.7% in Pasar Baru Beach and Ujung Karang of 66.38% in the soft plastic category. In comparison, the average length and width of the two highest locations were found in the soft plastic category.

REFERENCES

Azwar, S.M.S. (2017). *Pengelolaan sampah di Kabupaten Aceh Barat Provinsi Aceh*. Universitas Gadjah Mada.

Barnes, D.K.A., Galgani, F., Thompson, R.C., Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. *Biological Sciences*, 364(1526): 1985–1998.

Cole, M., Lindeque, P., Halsband, C., Galloway, T.S. (2011). Microplastics as contaminants in the marine environment: A review. *Marine Pollution Bulletin*, 62(12): 2588–2597.

Duhec, A.V., Jeanne, R.F., Maximenko, N., Hafner, J. (2015). Composition and potential origin of marine debris stranded in the Western Indian Ocean on remote Alphonse Island, Seychelles. *Marine Pollution Bulletin*, 96(1–2): 76–86.

Fruergaard, M., Laursen, S.N., Larsen, M.N., Posth, N.R., Niebe, K.B., Bentzon-Tarp, A., Svenningsen, S.K., Acevedo, N.L.I., Trinh, B.S., Tran-Thi, P.T., Doan-Nhu, H., Nguyen-Ngoc, L., Andersen, T.J. (2023). Abundance and sources of plastic debris on beaches in a plastic hotspot, Nha Trang, Vietnam. *Marine Pollution Bulletin*, 186: 114394.

Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R., Law, K.L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223): 768–771.

Jang, Y.C., Ranatunga, R.R.M.K.P., Mok, J.Y., Kim, K.S., Hong, S.Y., Choi, Y.R., Gunasekara, A.J.M. (2018). Composition and abundance of marine debris stranded on the beaches of Sri Lanka, Results from the first island-wide survey. *Marine Pollution Bulletin*, 128: 126–131.

Khairunnisa, A. K., Fauziah, S.H., Agamuthu, P. (2012). Marine debris composition and abundance: A case study of selected beaches in Port Dickson, Malaysia. *Aquatic Ecosystem Health & Management*, 15(3): 279–286.

Kusumawati, I., Mita, S., Inseun, S.Y. (2018). Identifikasi komposisi sampah laut di Pesisir Aceh Barat. *Jurnal Perikanan Tropis*, *5*(1).

Lestari, P., Trihadiningrum, Y. (2019). The impact of improper solid waste management on plastic pollution in the Indonesian coast and marine environment. *Marine Pollution Bulletin*, 149: 110505.

Lithner, D., Larsson, A., Dave, G. (2011). Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. *Science of The Total Environment*, 409(18): 3309–3324.

Mishra, P., Kaviarasan, T., Sambandam, M., Dhineka, K., Murthy, M.V.R., Iyengar, G., Singh, J.,

Ravichandran, M. (2023). Assessment of national beach litter composition, sources, and management along the Indian coast: a citizen science approach. *Marine Pollution Bulletin*, 186: 114405.

Rochman, C.M., Browne, M.A., Halpern, B.S., Hentschel, B.T., Hoh, E., Karapanagioti, H.K., Rios-Mendoza, L.M., Takada, H., Teh, S., Thompson, R.C. (2013). Classify plastic waste as hazardous. *Nature*, 494(7436): 169–171.

Ryan, P.G. (2015). Does size and buoyancy affect the long-distance transport of floating debris? *Environmental Research Letters*, 10(8): 084019.

Setiawan, A.D.C.D.S., Nugroho, S. (2022). Kecamatan Muara Badak dihubungkan dengan tingkat. *Teknik Lingkungan*, 6(1): 53–57.

Suaria, G., Melinte-Dobrinescu, M.C., Ion, G., Aliani, S. (2015). First observations on the abundance and composition of floating debris in the North-western Black Sea. *Marine Environmental Research*, 107: 45–49.

Thiel, M., Hinojosa, I.A., Miranda, L., Pantoja, J.F., Rivadeneira, M.M., Vásquez, N. (2013). Anthropogenic marine debris in the coastal environment: A multi-year comparison between coastal waters and local shores. *Marine Pollution Bulletin*, 71(1–2): 307–316.

Wang, M.H., He, Y., Sen, B. (2019). Research and management of plastic pollution in coastal environments of China. *Environmental Pollution*, 248: 898–905

Yulianita, Y., Mursyidin, M., Siregar, W.M. (2021). Analisis pelaksanaan pengelolaan sampah di Kabupaten Aceh Barat. *Journal of Social and Policy Issues*, 22–27.