

JURNAL SEGARA

<http://ejournal-balitbang.kkp.go.id/index.php/segara>

ISSN : 1907-0659

e-ISSN : 2461-1166

Nomor Akreditasi: 766/AU3/P2MI-LIPI/10/2016

IDENTIFICATION OF FLOATING MARINE DEBRIS IN THE BANDA ACEH ESTUARY

Koko Ondara & Ruzana Dhiauddin

Research Institute for Coastal Resources and Vulnerability, Ministry of Marine Affairs and Fisheries
Jln. Raya Padang Painan km.16, Padang – West Sumatera

Received: 3 Maret 2021; Revised: 2 September 2021; Accepted: 7 September 2021

ABSTRACT

The coastal area of Banda Aceh City have the potential to be polluted by waste from the mainland as much as 45.41 tons/day. One source of land waste is the Krueng Aceh river, the river has dense residential areas and high community activities such as ports, ship repairs, traditional markets, recreation and fishing activities. This study aims to identify floating debris in the Krueng Aceh estuary. Data collection was carried out at the mouth of the river using a debris trap mounted on the ship that moves periodically and the research time was based on tidal charts. The results showed that type of marine debris found is plastic, cloth, processed wood, rubber and metal. Plastic debris is the most common debris found by 89 % on the surface of the Krueng Aceh estuary at spring tide and neap tide. The highest amount of debris is found in the morning 09.50 AM and 03.32 PM in the evening.

Keywords: Marine debris, estuary, banda aceh, plastic.

INTRODUCTION

Marine debris is waste originating from land, rivers, and beaches that flow into the sea or waste originating from activities at sea. Meanwhile, plastic waste is waste that contains polymer compounds (PP Nomor 83, 2018). The amount of world plastic production reached 348 million tons in 2017, an increase of 10 million tons from the previous year (Plastics Europe, 2018). However, the increase in plastic production is not accompanied by good plastic waste management, so that plastic debris resulting from human activities on land is located and pollutes the waters (Agustina *et al.*, 2020). One of the cities that has the potential for marine debris from the mainland is Banda Aceh, a city on the tip of Sumatra Island which faces directly to the Indian Ocean and Andaman Waters. Land waste in Banda Aceh City has the potential to produce 56.77 tons/day of waste (Murnianti *et al.*, 2019). Referring to the results of research which states that 80% of marine debris comes from land (Allsopp *et al.*, 2006), the waters of Banda Aceh City have the potential to be polluted by waste as much as 45.41 tons/day (Agustina *et al.*, 2020). A study on zero waste that the composition of waste throughout Banda Aceh consists of 89.1% organic waste, 2.5% paper and 0.74% plastic (Nizar *et al.*, 2018b). According to the same source, waste management in Banda Aceh City is still carried out conventionally, which is collected and transported to an open landfill in the Gampong Jawa area which is directly adjacent to sea waters. The content of essential heavy metals (Zn, Cu, Fe, Co, and Mn) in small concentrations from some leachate wastewater samples taken at the Gampong Jawa TPA which still must be watched out for because it can cause toxic effects if accumulated in large quantities (Irharni *et al.*, 2017).

Research on marine debris in Aceh province on the composition of marine debris has been carried out in West Aceh (Kusumawati *et al.*, 2018; Rahmayanti *et al.*, 2020) and Banda Aceh (Agustina *et al.*, 2020; Nizar *et al.*, 2018a; Ondara & Dhiauddin, 2020), marine debris management (Kusumawati, 2019; Kusumawati & Setyowati, 2020; Nizar *et al.*, 2017), the impact of marine debris on biota (Nufus & Zuriat, 2020), microplastics in Banda Aceh (Yumni *et al.*, 2020) and analysis of debris carbon emissions (Faisal, 2015; Sofriadi *et al.*, 2017). To identify the composition of marine debris in Banda Aceh City, there is only one journal (Agustina *et al.*, 2020) whose research was conducted in river mouths. The results of the study stated that bottled drinking water was the most common floating marine debris found in the Krueng Aceh river estuary, the largest river in Banda Aceh City. The estuary of the river which directly faces open waters and faces directly to the Indian Ocean and Andaman Waters, has the potential to produce marine debris

originating from the mainland, which is then distributed to these waters and also to the Malacca Strait (Ondara *et al.*, 2021). The area around the Krueng Aceh river has dense residential areas and high community activities such as ports, ship repairs, traditional markets, recreation and fishing activities make the river waters polluted (Hadi *et al.*, 2018). Research on marine debris is still less in Aceh Province, especially in estuary area in Banda Aceh City. This study aims to identify floating waste in the estuary area of the largest river in Banda Aceh City, namely the Krueng Aceh river. The data and information on the composition and characteristics of waste in estuary, it is hoped that it can assist the handling and control of marine debris originating from land.

METHODOLOGY

The study was conducted at the Krueng Aceh river estuary in Banda Aceh City for 3 days from March 2-4 2019. Debris items should only be recorded if they are at least 2.5 cm in size the longest dimension (Lippiatt *et al.*, 2013). This size approximately the diameter of typical beverage bottle cap was chosen to ensure that the same size items are counted across surveys and to maintain consistency in survey results.

Marine debris data collection conducted at the river mouth is carried out to see the discharge data of marine debris entering and leaving estuary. Marine debris data retrieval is carried out using waste catchers mounted on the front and side of the ship. The waste trap used is made of nets with a density of 2x2 mm and has dimensions of 2x2 meters. Debris taken is on the surface (maximum depth of 1 meter from the surface). The ship moves back and forth 4 times horizontally between equal rivers. Debris that has been collected is then washed to remove adhering particles, then dried in the sun to weigh the mass of the object. The types of debris observed were plastic waste, metal, glass, rubber, processed wood, ceramics and clothing (Opfer *et al.*, 2012). The debris data obtained was then made in graphical form to facilitate analysis of the composition of the debris and also the characteristics of the debris at each time of observation.

RESULTS AND DISCUSSION

River Condition

The results of observations during the data collection process showed that there were many community activities around the river border. This activity has the potential to increase the amount of waste in the river which will lead to the open sea. In addition to marine debris, these activities will affect the quality of river and sea water and affect the life of coastal biota.



Figure 1. Research location at Krueng Aceh river estuari, Banda Aceh.

Estuary Marine Debris

In the process of collecting samples at the estuary, it is seen that the plastic waste category is more dominant than other types of debris. The results obtained are in accordance with research that has been carried out in Surabaya (Kurniawan & Imron, 2019), Bangka Belitung (Riskiana *et al.*, 2020), Jakarta (Rahmad *et al.*, 2019), Palembang (Maherlsa, 2018), Kutai Kratanegara (Sari Dewi *et al.*, 2015), Citarum (Pamungkas *et al.*, 2021). The types of debris found in

the estuary area can be seen in Figure 3.

Debris from capture fisheries activities such as fishing nets (Figure 3c) and plastic (Figure 3a) is harmful to marine biota because it can trap marine life, cover mangrove roots, seagrasses, coral reefs and if degraded to a smaller size, it will become microplastic debris (Brandon *et al.*, 2016; Khoironi *et al.*, 2020; Zhang *et al.*, 2021). Ceramic debris (Figure 3b) in the waters can be arbitrarily shaped and have sharp edges.



Figure 2. Activities of (a) boat docking, (b) capture fisheries, (c) traditional markets and (d) residential areas and public transportation routes around the Krueng Aceh river estuary.



Figure 3. Types of debris found in the Krueng Aceh estuary (a) plastic (b) ceramics (c) fishing nets and (d) baby diapers.

These ceramic debris can injure marine life as well as humans (Katsanevakis & Katsarou, 2004; Lasut *et al.*, 2021).

Marine debris with the plastic category still dominates the amount of waste found at river mouths (Table 1). The plastic debris found was 89.7% with the majority being plastic packaging and bottled drinking water. In addition, 5.59% of cloth, 4.03% of processed

wood, 0.4% of rubber and 0.22% of metal.

The maximum amount of marine debris found on March 3, 2019 at 09.50 AM and 03.32 PM was 22% and 11% of the total amount of debris. In the morning and evening, it is the time for human activities especially in areas commensurate with the river such as loading and unloading ship activities, traditional markets and household activities in residential areas.

Table 1. The amount of marine debris at the Krueng Aceh estuary

Time	Water Elevation (meter)	Tides	Plastic	Metal	Rubber	Wood	Cloth	Total item
02/03/2019 02.08.00	1.85	neap	32			12		44
02/03/2019 12.32.00	2.00	spring	31				1	32
02/03/2019 15.20.00	1.91	neap	7					7
02/03/2019 19.57.00	1.17	neap	52					52
02/03/2019 22.10.00	1.39	spring	20					20
03/03/2019 03.15.00	1.83	neap	0					0
03/03/2019 07.47.00	1.16	neap	13					13
03/03/2019 09.50.00	1.35	spring	91		2	2	3	98
03/03/2019 13.44.00	2.11	spring	35				10	45
03/03/2019 15.32.00	2.01	neap	52	1				53
03/03/2019 20.15.00	1.05	neap	32			2	7	41
03/03/2019 22.15.00	1.22	spring	31			2	4	37
04/03/2019 01.46.00	1.95	spring	5					5
Total			401	1	2	18	25	447



Figure 4. The amount of marine debris in the estuary at spring and neap tide.

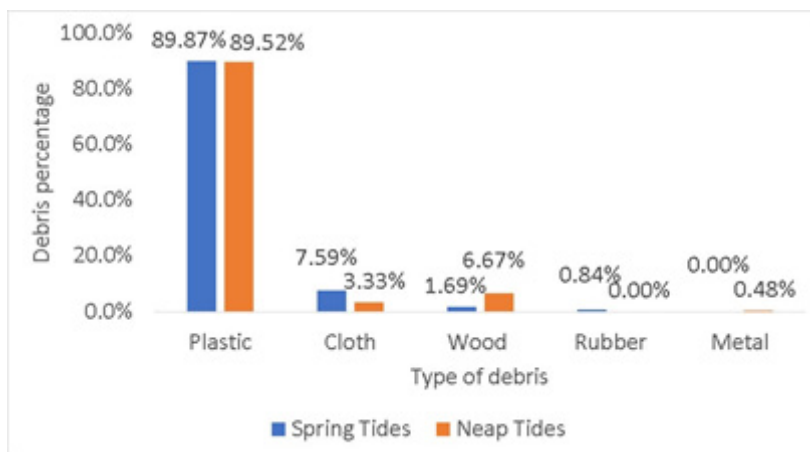


Figure 5. Percentage of marine debris in the estuary at spring and neap tide.

The least amount of waste was found on March 3 at 03.15 AM and on March 4, 2019 at 01.46 AM at 0% and 1%, respectively. The least amount of debris found occurred at a time when there was minimal human activity because it occurred between 00.00 AM and 04.00 AM.

When spring and neap tide, plastic debris found is 89.87% at spring tide and 89.52% at neap tide. Meanwhile, fabric/cloth debris at spring tide is 7.59% and at neap tide is 3.33 %, processed wood debris at spring tide is 1.69% and at neap tide is 6.67 %, rubber debris is at spring tide 0.84% and no rubber debris is found at neap tide. For the amount of metal debris found at spring tide and neap tide, very little was found, namely 0% and 0.48%, this is because metal waste has a heavier mass than other types of debris in unit form. Because the data what is observed is surface area (maximum depth of 1 meter), there is a possibility that metal waste is at the bottom of the river.

CONCLUSION

The types of marine debris found were plastic, cloth, processed wood, rubber and metal. Meanwhile, ceramic waste was not found during the data collection

process. Plastic waste is the most common debris found on the surface of the Krueng Aceh estuary at spring and neap tide. The most amount of debris is found in the morning and evening when human activities are quite high at that time

ACKNOWLEDGEMENTS

First of all, I would like to say Alhamdulillah to Almighty Allah to enabling me to complete this report. Thanks for help and encouragement to the Ministry of Maritime Affairs and Fisheries for funding this research for the 2019 fiscal year, Maritime Science Department at Syiah Kuala University, Banda Aceh LHK3, Banda Aceh PPKP Office and all those who assisted with this research.

REFERENCE

Agustina, S., Nuraini, S. P., Purnawan, S., & Siregar, E.E.W. (2020, In Indonesian). Preliminary Identification Of Floating Inorganic Debris At The Estuary Of Krueng Aceh River, Banda Aceh City. *DEPIK Jurnal Ilmu-Ilmu Perairan, Pesisir Dan Perikanan*, 9(1), 131-140. <https://doi.org/10.13170/depik.9.1.15237>

- Brandon, J., Goldstein, M., & Ohman, M.D. (2016). Long-term Aging and Degradation of Microplastic Particles: Comparing In Situ Oceanic and Experimental Weathering Patterns. *Marine Pollution Bulletin*, 110(1), 299–308. <https://doi.org/10.1016/j.marpolbul.2016.06.048>
- Dewi, I.S., Budiarsa, A.A., & Ritonga, I.R. (2015, In Indonesian). Distribution of microplastic at sediment in the Muara Badak Subdistrict, Kutai Kartanegara Regency. *DEPIK*, 4(3), 121-131. <https://doi.org/10.13170/depik.4.3.2888>
- Hadi, I., Suhendrayatna, S., & Muchlisin, Z. A. (2018, in Indonesian). Water Quality Status and Heavy Metal Content in Water and Sediment at The Estuary of Krueng Aceh. *Depik*, 7(2), 91–99. <https://doi.org/10.13170/depik.7.2.8606>
- Irharni, Pandia, S., Purba, E., & Hasan, W. (2017, in Indonesian). Heavy Metal Content in the Leachate Water at the Banda Aceh City Waste Disposal Site. *Prosiding Seminar Nasional Pascasarjana*, A19–A22.
- Katsanevakis, S., & Katsarou, A. (2004). Influences on The Distribution of Marine Debris on The Seafloor of Shallow Coastal Areas in Greece (Eastern Mediterranean). *Water, Air, and Soil Pollution*, 159(1), 325–337. <https://doi.org/10.1023/B:WATE.0000049183.17150.df>
- Khoironi, A., Hadiyanto, H., Anggoro, S., & Sudarno, S. (2020). Evaluation of Polypropylene Plastic Degradation and Microplastic Identification in Sediments at Tambak Lorok Coastal Area, Semarang, Indonesia. *Marine Pollution Bulletin*, 151. <https://doi.org/10.1016/j.marpolbul.2019.110868>
- Kurniawan, S.B., & Imron, M.F. (2019). Seasonal Variation of Plastic Debris Accumulation in The Estuary of Wonorejo River, Surabaya, Indonesia. *Environmental Technology and Innovation*, 16. <https://doi.org/10.1016/j.eti.2019.100490>
- Kusumawati, I. (2019, in Indonesian). Who's Responsibility is Marine Debris? Aceh Barat Regency Case Study. *Jurnal Perikanan Tropis*, 6(2), 69-75. <https://doi.org/10.35308/jpt.v6i2.2183>
- Kusumawati, I., & Setyowati, M. (2020, in Indonesian). Analysis of the Marine Debris Accumulation Factors in Southwest Aceh District. *Journal of Aceh Aquatic Science*, 2(1).
- Kusumawati, I., Setyowati, M., & Salena, I.Y. (2018, In Indonesian). Composition Identification Of The Marine Debris In The Coastal Of West Aceh. *Jurnal Perikanan Tropis*. 5(1), 59-69. <https://doi.org/10.35308/jpt.v5i1.1026>
- Lasut, M.T., Pane, L.R., Doda, D.V.D., Kumurur, V.A., Warouw, V., & Mamuja, J.M. (2021). Seasonal Variation of Marine Debris at Manado Bay (North Sulawesi, Indonesia). *IOP Conference Series: Earth and Environmental Science*. <https://doi.org/10.1088/1755-1315/744/1/012038>
- Lippiatt, S., Opfer, S., & Arthur, C. (2013). Marine Debris Monitoring and Assessment: Recommendations for Monitoring Debris Trends in the Marine Environment. In NOAA Technical Memorandum.
- M. Faisal. (2015, In Indonesian). Analysis of Waste Flow Rate and Carbon Emissions Produced by Banda Aceh City. *Jurnal Teknik Kimia USU*, 3(4), 6–11. <https://doi.org/10.32734/jtk.v3i4.1646>
- Maherlsa, R. (2018, in Indonesian). *Identification of Surface Macro Debris in Musi River Streams and Estuaries*, South Sumatra Province. Universitas Sriwijaya.
- Murnianti, M., Syamsidik, S., & Zaki, M. (2019, in Indonesian). Analysis of Waste Transportation Performance in Zone III Banda Aceh City (Lueng Bata, Kuta Raja and Baiturrahman Subdistricts). *Jurnal Arsip Rekayasa Sipil Dan Perencanaan*, 2(4), 314–323. <https://doi.org/10.24815/jarsp.v2i4.14948>
- Nizar, M., Munir, E., Irvan, & Waller, V. (2018). The Integrating of Zero Waste Principles from National to Local Regulations: Case Study of Banda Aceh, Indonesia. *IOP Conference Series: Earth and Environmental Science*. <https://doi.org/10.1088/1755-1315/216/1/012043>
- Nizar, M., Munir, E., & Munawar, E. (2017, In Indonesian). *Municipal Waste Management Based on Zero Waste Concept: Literature Study of Municipal Waste Management Based on Zero Waste Concept : Studi of Literature*. Doctoral Program, Natural Resources and Environmental Management Study Program, Universitas Sumatera Utara USU.
- Nizar, M., Munir, E., Munawar, E., & Irvan. (2018). Implementation Of Zero Waste Concept In Waste Management Of Banda Aceh City. *Journal of Physics: Conference Series*, 1116(5), 052045 <https://doi.org/10.1088/1742-6596/1116/5/052045>
- Nufus, H., & Zuriat, Z. (2019, In Indonesian). The Socialization Of The Impact Plastic Pollution To

- Coastal Community At Lhok Bubon Beach West Aceh. *Jurnal Marine Kreatif*, 3(2), 7-13. <https://doi.org/10.35308/jmk.v3i2.2286>
- Ondara, K., & Dhiuddin, R. (2020). Indonesia Marine Debris: Banda Aceh Coastal Environment Identification. *Jurnal Kelautan Tropis*, 23(1) 117-126. <https://doi.org/10.14710/jkt.v23i1.6238>
- Ondara, K., Rahmawan, G.A., & Purnawan, S. (2021). Particle Tracking Simulation of Marine Debris Using Lagrangian Discrete and Mesh Spatial Discretization in Banda Aceh Waters. *Depik*, 10(1) 80-85. <https://doi.org/10.13170/depik.10.1.18722>
- Opfer, S., Arthur, C., & Lippiatt, S. (2012). NOAA Marine Debris Shoreline Survey Field Guide.
- Pamungkas, B., Taryono, Kurnia, R., & Riani, E. (2021). Potential Plastic Waste input From Citarum River, Indonesia. *AACL Bioflux*, 14(1), 103–110.
- Plastics Europe. (2018). The Facts 2018. In PlasticsEurope.
- PP Nomor 83. (2018). Peraturan Presiden.
- Rahmad, S., Purba, N., Agung, M., & Yuliadi, L. (2019, In Indonesian). Characteristic Of Microplastic Debris At Estuary Of DKI Jakarta. *DEPIK*, 8(1) 9-17. <https://doi.org/10.13170/depik.8.1.12156>
- Rahmayanti, F., Diana, F., Najmi, N., Riani, E., Yulianto, G., & Munandar, M. (2020, In Indonesian). The Analysis Of Marine Debris Abundance, Composition And Sources: A Case Study In Kuala Batu Beach, Pulau Kayu Village, Aceh Barat Daya Regency. *Jurnal Laot Ilmu Kelautan*, 2(1), 49-59. <https://doi.org/10.35308/jlaot.v2i1.2361>
- Riskiana, R., Effendi, H., & Wardiatno, Y. (2020, In Indonesian). Abundance And Composition Of Plastic Waste In Baturusa Watershed Of Bangka Belitung Islands Province. *Jurnal Pengelolaan Sumberdaya Alam Dan Lingkungan (Journal of Natural Resources and Environmental Management)*, 10(4), 650-659. <https://doi.org/10.29244/jpsl.10.4.650-659>
- Sofriadi, D., Suhendrayatna, & Fatimah, E. (2017, In Indonesian). Estimating carbon emissions from residential waste using the IPCC method in Ulee Kareng District, Banda Aceh. *Jurnal Teknik Sipil*, 1(2), 339–348.
- Yumni, Z., Yunita, D., & Sulaiman, M. I. (2020, In Indonesian). Identification of Microplastic Contamination of Tuna and Dencis fish in TPI Lampulo, Banda Aceh. *Jurnal Ilmiah Mahasiswa Pertanian*, 5(1), 316–320.
- Zhang, K., Hamidian, A. H., Tubić, A., Zhang, Y., Fang, J. K. H., Wu, C., & Lam, P. K. S. (2021). Understanding Plastic Degradation And Microplastic Formation In The Environment: A Review. *Environmental Pollution*, 274(2021), 116554. <https://doi.org/10.1016/j.envpol.2021.116554>

