Analysis of sources and composition of marine debris in western and southern Aceh, Indonesia

R Fitria 1, F Diana 1, E Riani 2*, G Yulianto 2 and N Najmi 3

1Department of Aquaculture, Faculty of Fisheries and Marine Science, Teuku Umar University, Meulaboh, Indonesia
2Department of Aquatic Resource Management, Faculty of Fisheries and Marine Sciences, Bogor Agricultural University (IPB University), Bogor, Indonesia
3Department of Aquatic Resources, Faculty of Fisheries and Marine Science, Teuku Umar University, Meulaboh, Indonesia

*E-mail: etty_riani_harsono@yahoo.com

Abstract. Marine debris has become an important pollution issue in recent years. Its existence has impacted to marine environment, harmed marine life, and also effected human health and lives. Marine debris study in western and southern Aceh is necessary to compare debris sources, amounts, and locations. The research outputs can provide input to the government to adopt more comprehensive policies and provide important information to targets protection in the coastal areas. Eight sites (two sites for each regency: at shoreline area and estuary stream mouth area) were selected from four regencies located in western and southern Aceh namely the regency of Aceh Jaya, west Aceh, southwestern Aceh, south Aceh. Marine debris was grouped by seven categories namely: plastic, glass, metal, rubber, cloth/fabric, processed lumber, and other/unclassifiable. The results indicated that marine debris was dominated by plastic (86.6%). The highest of debris density (0.145 items/m²) were found in southwestern Aceh and South Aceh Regency. Shoreline and recreational activities have known as the largest source of marine debris (74.8 %), followed by medical/personal hygiene activities (10.8%) dumping activities (85 items, 9.2%), smoking or related activities (4.1%) and activities related to ocean/waterway (1.1%).

Keywords: environment, litter, plastic, pollution, shoreline

1. Introduction

Plastic production has increased every year and it will impact to marine environments. Marine debris is known as marine litter has become one of the most important issues in recent years. Recently, marine debris is becoming important topics along shoreline, estuaries, coastal area, and oceans. A wide variety of negative environmental, public health, social and economic and safety impacts were caused by marine litter. Marine debris sources are classified into ocean-based sources and land-based sources with the material categories included are metal, plastic, rubber, glass, cloth/fabric, paper/processed lumber,
sewage-related debris (SRD) and other non-classifiable debris (Lipiatt et al 2013, Opfer et al 2012, FAO 2017).

Three impacts caused by marine debris: effects on human health and lives, harm to marine ecosystems and also killed and harmed marine life (UNEP 2005; Rochman et al 2015; Opfer et al 2012). Marine debris can impact the environment in several aspects: physical habitat impacts, chemical impacts, and biological impacts. Furthermore, marine debris also impact human health and safety namely degradation of the habitats and ecosystem services, disrupt commercial and fishing related to recreational, threaten health and safety, decrease leisure industry, and interfere with navigation (Pawar et al 2016). Waste production increases every year, the characteristic and total amount of waste production depends on inhabitants and increasing the consumption associated with economic growth, especially in city and developing (Jambeck et al 2015).

Shuker et al 2018 has claimed that “Indonesia is a marine rich and megadiverse country. It spreads into three geographic regions and has an excellent place for growing more than 76 percent of coral species, vast mangrove forests and seagrass meadows. However, coastal deforestation, declining water quality, pollution have had a severe impact on these ecosystems. Indonesia’s ecosystems are in great peril from the constant leakage of waste. With rapid urbanization and growth in coastal populations, the level of pollution entering and destroying these ecosystems will also increase; further exacerbating the current situation”. Furthermore Indonesia produced 17 million ton of waste per year and 1.29-million-ton matrix per year leakage of plastic debris entered the ocean.

Aceh is one of the provinces in Indonesia with the longest shoreline has serious risk on environmental problems caused by marine debris. To our knowledge, very few studies have been conducted concerning marine debris in Aceh. So, we present a study to analyse and estimate the quantity and composition of marine litter along the western and southern Aceh, Indonesia. The location sites we have chosen were near the estuary and shoreline that has the highest inhabitant density and the recreational area. The result of this study can be used as a reference for action plans and mitigation strategy of marine debris.

2. Materials and Methods

Samples were collected by collectors through walking using some apparatuses for instance work gloves, ruler, trash bag and etc from four regencies located in western and southern Aceh Province namely: Aceh Jaya, West Aceh, Southwestern Aceh, South Aceh Regency. Two study sites were chosen from each regency (shoreline area and estuary stream mouth area), therefore the total study site in this research are eight locations (figure 1). The sites were selected based on recreational areas and close to the residential areas. The recreational areas are a famous site for people. All of the sites are sand beach.

2.1. Materials

In order to conduct the study, we prepared the following supplies namely: digital scales, digital camera, surveyor’s measuring wheel, stakes, fiberglass measuring tape, work gloves, ruler, datasheets, clipboards for datasheets, marks, and a trash bag.

2.2. Methods

2.2.1 Survey and sampling. We conducted standing-stock surveys based on the literature (Opfer et al 2012). We measured 100-m shoreline and estuary stream mouth location and divided the 100 m into 5-m segments. Each section, left to right, has extent from 1 to 20. The segment should run from the water’s edge to the back of the shoreline for each 5-m. Then, four numbers were selected randomly from 20 segments. The local tide was checked to arrive at the site during low tide.
We classified the sample of marine debris into seven categories and 30 items and recorded it on datasheet/form. These seven groups include: (1) plastic, including plastic bags, food wrappers, bottle or container caps, beverage bottles, other jugs or containers, plastic rope/net pieces, disposable cigarette lighters, buoys and floats, fishing lures and line, cups (including polystyrene/foamed plastic), plastic utensils, straws, personal care products, and other; (2) metal, including aluminum/tin cans, aerosol cans, and metal fragments; (3) glass, including beverage glass bottles, medicine glass syrup bottles, and glass fragments; (4) rubber, including flip-flop/shoes, gloves, tires, and rubber fragment; (5) processed lumber, including cardboard cartons, paper and cardboards; (6) cloth/fabrics, including clothing, rope/net pieces (non-nylon), fabric pieces; (7) other/unclassifiable.

The sources of debris were grouped into five types, namely (1) shoreline and recreational activities; (2) smoking or related activities; (3) dumping activities; (4) medical/personal hygiene; (5) ocean/waterway activities (The Ocean Conservancy 2010). We also recorded the weight and large samples.

![Figure 1. Study sites (the map of Aceh Province).](image)

3. Results and Discussion

3.1. Density

The highest total number of marine debris was 368 items/1,200 m recorded in Southwestern Aceh Regency (figure 2). Following by 347 items/1,200 m, 174 items/1,200 m and 56 items/1,200 m in South Aceh Regency, West Aceh Regency, and Aceh Jaya Regency, respectively. From the perspective of study sites, the highest of debris density were in Southwestern Aceh Regency and South Aceh Regency with the same number namely 0.145 items/m² and the lowest was in Aceh Jaya Regency with the density number of debris was 0.024 items/m².
Figure 2. Marine debris from western and southern Aceh (a) metal, (b) medicine bottles (glasses), (c) disposable cigarette lighters, (d) bottle caps, (e) baby diapers, (f) cardboard cartons, (g) fabric pieces, (h) rubber.

There are some factors that lead the amounts, types, and sources of litter, for instance, wind track and intensity, local and regional inhabitants, human behavior and laws. The nearby debris is also contributed by coastal and nearshore recreational and industrial activities (Hardesty et al 2016). According to debris data recorded in western and southern Aceh, the highest amount of debris was found in the large urban area, nearshore recreational and near fishing port. In general, sites with a large total debris count also had a high debris density.

Figure 3. The density of debris in each location.
3.2. Composition
Plastics was the majority of the debris, with a total of 86.6 percent of total debris counted (figure 4). Rubber and unclassifiable debris (baby diapers were the majority of unclassifiable debris) the next largest category, with 4.4 percent and 3.8 percent respectively. We recorded 1.5 percent for each glass and lumber processed categories, 1.4 percent metal categories, and 0.6 percent clothes/fabrics categories. Beverage bottles, plastic bags, food wrappers, and personal care were recorded as the majority of plastic fragment category in sites location. Flip flop/shoes were the most rubber category found in this study. Unclassifiable categories including baby diapers were the most important concern on marine debris issue because it was founded almost at all study sites.

![Figure 4. Composition of categories.](image)

According to the observations, plastic debris is the most common waste found on the shoreline and estuary stream mouth area. The types of plastic debris in this study dominated by food wrappers, personal care products, plastic bags, beverage bottles, and others. In other studies, they found plastic bottles, plastic fragments, bottle caps and plastic drinking glass with the highest occurrence (Poeta et al 2014). Thompson (2006) said that the highest contribution to marine debris worldwide come from plastic-type.

3.3 Sources
Debris sources were primarily shoreline and recreational activities (688 items, 74.8 %), followed by medical/personal hygiene activities 99 items, 10.8% dumping activities (85 items, 9.2%), smoking-related activities (38 items, 4.1%) and ocean/waterway activities (10 items, 1.1%) (figure 5). Based on Zhou et al (2011) in South China Sea also showed that 95% of marine debris were land-based sourced (recreational activities). Aceh Jaya as one of regency in western and southern Aceh with small population, we obtained a small number of marine debris. That was means, population density affects the presence of marine debris due to many recreational activities and human activities.
4. Conclusion

This study has been conducted to get an overview and information about the amounts, characteristics, and sources of marine debris in Aceh’s shoreline. We found that the types of debris are dominated by plastic fragments in all locations, with shoreline and recreational activities hold the biggest role in produced the debris. The highest debris density was found in Southwestern Aceh and South Aceh Regency and the lowest in Aceh Jaya Regency. The number of waste density was influenced by local resident population density and the number of visitors. Strengthen the government policies and action plans are needed to resolve the problem of marine debris in Aceh.

References
FAO 2017 Microplastics In Fisheries and Aquaculture: Status of Knowledge on Their Occurrence And Implications for Aquatic Organisms and Food Safety (Rome: FAO)
Hardesty B D, Lawson T J, Tonya van der V, Matt L and Chris W 2016 Frontiers in ecology and the environment Estimating quantities and sources of marine debris at a continental scale. *Frontiers in Ecology and the Environment* 15 18-25
Jambeck J R, Roland G, Chris W, Theodore R S, Miriam P, Anthony A, Ramani N and Kara LL 2015 Plastic waste inputs from land into the ocean *Mar. Pollut. Bull.* 347 768-771
Lippiatt S, Opfer S, and Arthur C *Marine Debris 2013 Monitoring and Assessment: Recommendations for Monitoring Debris Trends in the Marine Environment* (USA: Silver Spring)
Opfer S, Courtney A and Sherry L 2012 *NOAA Marine Debris Shoreline Survey Field Guide* NOAA Marine Debris Program (USA: Silver Spring)
Pawar P R, Sanket S S and Rahul B P 2016 Plastic marine debris: Sources, distribution and impacts on coastal and ocean biodiversity *Proc. Biol. Sci.* 3 54-40
Poeta G, Battisti C, Acosta A T R 2014 Marine litter in Mediterranean sandy littorals: spatial distribution patterns along central Italy coastal dunes *Mar. Pollut. Bull.* 89 168-173
Rochman C M, Akbar T, Susan L W, Dolores V B, Rosalyn L, Jeffrey T M, Foo-Ching T, Shinta W and Swee J T 2015 Anthropogenic debris in seafood: plastic debris and fibers from textiles in fish and bivalves sold for human consumption *Sci. Report* 5 1-10
Shuker, Iain G, Cadman, Anne C 2018 *Indonesia-Marine debris hotspot rapid assessment: synthesis report (English)* Marine Debris Hotspot Rapid Assessment (Synthesis Report). (Washington: World Bank Group)
The Ocean Conservancy 2010 *Trash Travell From Our Hands to the Sea, Around the Globe, and Through Time* (Washington: Conservation International)

Thompson R C 2006 Plastic debris in the marine environment: consequences and solutions *Marine Nature Conservation in Europe 2006, Proceeding of the Symposium* ed Krause J C, Nordheim H, Bräger S (Germany: Federal Agency for Nature Conservation Stralsund Germany)

Zhou 2011 The abundance, composition and sources of marine debris in coastal seawaters or beaches around the northern South China Sea (China) *Mar. Pollut. Bull.* 1998-2007