Proposed classification of waste that landed on small island in Indonesia for the conservation of waterbird

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Abstract. Studies on waste in Indonesia has intensified after this country was identified as the second most plastic waste in the world. The study site was in Pulau Rambut Wildlife Sanctuary (Jakarta Bay area), where 13 rivers ended in the bay. Waste that has landed in Pulau Rambut could disturb waterbirds’s habitat. Waste was usually classified by using foreign country’s situation. Researchers usually classify waste into 6 categories: plastic, metal, glass, rubber, processed lumber/paper, and cloth/fabric. These categories are then divided in more detail, e.g. 18 types of plastic and 3 types of metal. However, some of the wastes that has been found were not classified yet. The objective of this paper was to propose classification of waste that has landed on small island in Indonesia. We identified waste that has landed in Pulau Rambut then reviewed and modified the standard classification by NOAA and UNEP. The proposed classification is organic and non-organic. This classification is to be applied for the waste that landed on small island. For household waste in urban area or along the rivers need to be developed further.

1. Introduction
Waste is defined by The United Nations Educational, Scientific and Cultural Organization (UNESCO) as a material left over after products have been made by producers and after they have been used by consumers. It is widely known that most of the wastes on the land eventually reaches the oceans. Thus, it becomes marine litter or marine debris. National Oceanic and Atmospheric Administration (NOAA) and United States Geological Survey (USGS) defined marine litter as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment [1]. There are currently 150 million tons of plastics in the world’s oceans and another 250 million will be added if current trends in urbanization, production and consumption continue. It is also estimated that by 2050, there will be more plastic than fish in the ocean and 99% of of seabirds will have ingested plastic [2].

Marine litter is a global concern due to its contribution to biodiversity loss through pollution, entanglement, ingestion, and habitat change. Many marine species become entangled in marine litter, causing drowning and death. Another serious problem affecting marine species is the ingestion of marine litter, particularly plastics. It mistook marine litter as its food. The first ingestion case that ever recorded was the ingestion of plastic items by Laysan Albatroses (Phoebastria immutabilis) on the northwest Hawaiian Islands in the late 1960s[3] and the case is still increasing. Around 90% of seabirds eat plastic annually and half of all seabird species are in decline, a higher fraction than other comparable taxa [4].
As the result of the impact of marine litter, many agencies developed standardized methodologies and classification to monitor marine litter (e.g. NOAA and UNEP). The most common methodologies and classification that researcher used are based on NOAA’s Marine Debris Monitoring and Assessment.

Studies on waste in Indonesia has intensified after this country was identified as the second most plastic waste in the world after China and before the Philippines [5]. Pulau Rambut is one of the small islands in Indonesia and a wildlife sanctuary where it is a home and an important habitat for waterbirds. Amount of litters were found in beach, beach forest, and mangrove forest. Some of them trapped in the prop roots and the beach sediments which could disturb waterbird’s habitat.

Identifying the waste is a must for further management action. Waste was usually classified by using foreign country’s situation. It is shown in the reviewed journals during the development of NOAA Marine Debris Monitoring and Assessment were studied in various places but in Indonesia [1]. Some of the wastes that has been found in Indonesia were not classified yet. Therefore, the current classification needs to be modified. The objective of this paper was to propose classification of waste that has landed on small island in Indonesia.

2. Waste Classification

Marine litter can be classified into several categories. Researchers usually classify waste into 6 categories: plastic, metal, glass, rubber, processed lumber/paper, and cloth/fabric. These categories are then broken down into more specific subcategories according to its materials.

Classification by NOAA for example, splits plastic into 18 subcategories. This makes plastic has the most subcategories (Table 1). Plastic are a diverse group of synthetic polymers. Their low density, durability, and relatively low cost make plastics ideal materials for a wide range of manufacturing and packaging applications [3]. They are used to make everything from bottles, shopping bags, pipes, automobile bumpers, carpet yarn, yoghurt cups, insulation panels, window frames, or synthetic fibres for clothing [6]. But their durability makes plastic so hard to be gone. And with the increasing of plastic production is linked to the increase of marine litter.

| Categories       | Type                                                                                           |
|------------------|------------------------------------------------------------------------------------------------|
| Plastic          | Plastic fragments, food wrappers, beverage bottles, other jugs or containers, bottle or container caps, cigar tips, cigarettes, disposable cigarette lighters, 6-pack rings, plastic bags, plastic rope/small net pieces, buoys & floats, fishing lures & line, cups (including polystyrene/foamed plastic), plastic utensils, straws, balloons, and personal care products. |
| Metal            | Aluminium/tin cans, aerosol cans, and metal fragments.                                         |
| Glass            | Beverage bottles, jars, and glass fragments.                                                   |
| Rubber           | Flip-flops, gloves, tires, and rubber fragments.                                               |
| Processed lumber | Cardboard cartons, paper and cardboard, paper bags, and lumber/building material.              |
| Cloth/fabrics    | Clothing & shoes, gloves (non-rubber), towels/rags, rope/net pieces (non-nylon), and fabric pieces. |

The other classification by UNEP is slightly different than NOAA. In classification by NOAA, processed lumber includes paper and cardboard and lumber/building material. But in UNEP version, processed lumber and paper and cardboard are different categories. But the other categories are similar. Categorizing marine litter is further complicated by the fact that many items are composed of more than one material [6]. Which is why the classification is different from one institution to another. The classification is made based on the situation of the site.
3. Proposed Classification Criteria
The location of this study was in Pulau Rambut Wildlife Sanctuary, an important habitat for various species of waterbirds. Pulau Rambut is a representation of small island in Indonesia. It is located in Jakarta Bay area where 13 rivers from Java ended up in the bay as it is shown in Figure 1. Marine litter has been a major problem in Pulau Rambut. Study of Pulau Rambut’s waste in 1992 revealed that there was an extremely variety of waste stranded along the coast and within the mangrove in the north area [7].

Figure 1. Study area

Type of waste found in 1992 was also found in today’s study. Sachet packaging, plastic cup, life jacket, styrofoam, disposable diapers, foam mattress, pillow, toys, doll, lightbulbs, bags, clay-pot, logs, bamboo, wood chips, coconut leaves, and rotten foods/fruits were found in this study. These wastes were found alongside the shoreline, primary mangrove forest, beach forest, even in the secondary mangrove forest. These wastes were trapped in the prop roots and the beach sediment. Even there are group of styrofoam found near the nest of Phalacrocorax sulcirostris or as known as little black cormorant shown in Figure 2

Figure 2. Styrofoam found near the little black cormorant's nest
Classifying this waste is important for further action of waterbird conservation. Waste classification is a tool to simplify the identification of waste management and the conservation action for managing waterbird. Study in 2007 has shown that the little black cormorant, one of the existing birds in Pulau Rambut, used waste as its nest specifically seaweed, algae, plastic, and rubber [8]. Yet some of these types (e.g. seaweed and algae) were not categorized in any general classifications and it needs to be modified.

The proposed classification consists in two big categories: organic and non-organic. Organic waste is any material that is biodegradable and comes from either a plant or an animal. Whereas non-organic is the opposite. Classifying waste based on the biodegradability is important to differentiate which waste is capable of decomposing itself or not. These categories then split into more detail subcategories which shown in Figure 3.

Separating logs and bamboo from processed lumber in NOAA classification is needed. In NOAA classification, processed lumber consists of lumber/building materials. But not all logs and bamboo found in the site is a building materials. Moreover the amount of logs and bamboo in the site is plenty. Therefore logs and bamboo needs to be classified as a new subcategory. There is no food waste in both NOAA and UNEP classification. However, rotten food/fruits were found in the site (e.g. pineapples and coconuts). It is considered as a waste, hence, food waste is a new subcategory under the organic category.

For non-organic, the subcategory is not that different from NOAA and UNEP. But the changes are only in the addition of styrofoam and mix materials as the new subcategory. Technically, styrofoam is a part of a group of synthetic polymer like plastic, but the amount of styrofoam in the site is plenteous. If styrofoam is in the same subcategory as plastic, the classification would be generic. As for mix materials, it consists on waste that made by more than one materials such as lightbulb (glass and metal) and spring mattresses (metal, fabrics, and plastic).

4. Conclusion
The general classification is not suitable in Indonesia’s condition due to various type of waste that has been found. This proposed classification is a modification from NOAA which has no organic material in its classification. By materials, there are organic and non-organic waste. These categories are to be applied for the waste that landed on small island in Indonesia.

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