Marine litter distribution in Ampana Beach Tojo Una-Una Regency Central Sulawesi Province

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Abstract. Ampana City, Tojo Una-Una Regency has the potential of marine tourism and the area also faces a serious threat from the litter that can affect aesthetic value, reduce the quality of waters, intervention to normal systems in the environment. Sampling to the beach in general representative locations in Malotong Beach (area of 100 x 25 m²), and Bailo Beach (100 x 10 m²). The sampling units in the transect plots are 5 plots covering 25 m² (plot size 1 x 1 m²) randomly determined. The next procedures are the collection and classification of litter. The composition and density of the type of litter are distinguished for meso (0.5cm-2.5cm) and macro (> 2.5cm) litter. The results showed that the type and abundance of the litter that generally comes from recreational activities of beach visitors and household litter. In general, meso and macro litter were found in Malotong Beach as many as 25 types, and in Bailo Beach as many as 35 types. The presence of litter on the coast and the sea threatens life on the Coast of Ampana City. Today's public awareness is needed to change habits and give more respect to their environment.

1. Introduction
Tojo Una-Una Regency has the potential for marine tourism which can increase income in the region. Like the coastal regions in the world, Tojo Una-Una faces a serious threat from the marine litter that can affect aesthetic values, reduce the quality of waters, even intervenes in normal systems in the environment. The increasing number of tourist visits to the coastal areas has given significant results to the economic stretching of the community, also contributing to the decline in environmental quality. It is undeniable that tourist activity disrupts the presence of organisms in their habitat, changes in the patterns of types' habitats, and increased litter.

Marine litter or debris is a serious threat faced by Indonesia's coastal area. Tojo Una-Una Regency is a coastal area with islands in the waters of Tomini Bay, land with mountains and valleys. The location of the regency which stretches in the bay area has maritime economic potential. This area is very potent with the existence of the Togean Islands National Park. Based on 2019 BPS data, the number of tourist arrivals, both domestic and foreign, reached 12,995 people in 2017 [1]. The high number of tourist visits has the potential to increase litter that empties into the coastal areas of Tojo Una-Una Regency. The maritime economic potential of the Tojo Una-Una Regency will decrease as a result of litter. Litter that ends up at sea affects aesthetics, intervenes in marine ecosystems, and will significantly reduce aquatic productivity.
2. Material and methods
The sampling location at Malotong Beach has located 7.5 km to the West of the Regency Capital, Ampana Kota. Its white sandy characteristics with a wide area make Malotong Beach one of the beaches destinations for local people in Ampana Kota and its surroundings. This condition is quite influential on sanitation in the Malotong Coast region. In addition, there is also a large river which is quite close to this area, namely the Bangka River. Similar to Bailo Beach, Malotong Beach is bordered directly by Tomini Bay so that the litter shipment is also very potential to be obtained from small islands in the Togean Islands.

The sampling location on Bailo Beach is in Ampana City which is only ±2.5 km from the Regency Capital, Ampana. The distance which is relatively close to the Regency Capital makes this Region quite influenced by the urbanization of migrants due to the creation of job opportunities and business opportunities in the Ampana Kota District which naturally makes the environment around the Bailo coast more complex. One of the issues that developed in the coastal area of Ampana Kota was the inadequate condition of settlement sanitation. Generally, people still use the beach as a place to dispose of litter and rubbish. In addition, the location of Bailo Beach, which borders directly with Tomini Bay, makes this area a destination for litter shipments from ±450 small islands in the Togean Islands. Bailo Beach area is also affected by rivers such as the Kasamba River, Bailo River, and Ampana Masae River.

![Sampling Location at Malotong and Bailo Beach](image1.jpg)

2.1. Beach litter assessment
Rapid Beach survey conducted in August 2018. The determination of sample units is carried out as follows: The sampling unit was placed in the transect area with the criteria above, along the 100 m coastline to the back of the beach with an area of 100 x 25 m² on Malotong Beach and 100 x 10 m² on Bailo Beach. The sampling units in the Transect Plots are 5 plots covering 25 m² (plot size 1 x 1 m²) randomly determined [2].
Subsequent procedures after the transect area are done is litter collection and classification. Litter classification is done in situ and determined by UNEP (on the litter types required for rapid beach surveys). This classification system comprises a list of 10 different material classes and a total of 77 discrete litter types [2]. Field condition data and sampling results after classified and identified inputted in table format have been provided.

2.2. Data analysis
The litter composition is calculated as a percentage, i.e., the weight of litter per type per overall litter in the survey area.

\[
\%_i = \frac{x_i}{\sum_i x_i}
\]

\(x_i\) = litter weight per type

The litter density \(D\) is calculated from the amount types of litter per \(m^2\).

\[
D = \frac{\sum_{type} x_{type} \times width}{Length \times width}
\]

Length and width are measured in meters

The calculations are differentiated for meso size (0.5cm-2.5cm) and macro size (> 2.5cm).
Classification of litter types is carried out in situ and determined based on UNEP (regarding the Marine Litter Characterization) [2].

3. Results and discussion
The results of marine litter at the Malotong Beach location were not found large litter, while at Bailo Beach there was a fallen tree. The profile of coastal and marine litter in the form of litter composition and density

3.1. Litter composition
Malotong Beach is located in Malotong Village, Ampana Kota District, which has a strategic position for fishermen. Observations in the coastal area found a lot of residents' activities that utilize coastal areas such as settlements and canoe/boat moorings.

The results of the meso size litter composition analysis in the Malotong Beach coastal area are presented in Figure 5. Litter composition found in this area includes; wood, other materials, glass and
ceramics, rubber, metal, and plastic. The highest composition is wood (90%), other materials (7.89%),
glass and ceramics (1.03%), rubber, (0.84%) metal (0.39%), and plastic (0.11%).

The high litter composition of the wood in the Malotong Beach area is caused by the condition of
the coastal land area in the eastern region, with shrubs and trees. Also, the mainland area of the west
and south is a residential area and a fishing boat moorings. This condition strongly supports the
composition of wood meso litter which is high in this area either directly or indirectly. It can directly
occur by breaking a fallen wooden stick and occupying the beach area then undergoing the weathering
process. Indirectly, there is the activity of the population that has the potential to produce a wood litter
or the fragments of plant branches from the surrounding area which are bottomed by rainwater or tide
and waves to occupy the Malotong Beach area.

The second highest composition is another material (diaper material, cotton bud, and electronic
equipment). The source of this litter, especially diaper and cotton bud materials, can come from
settlements in the Malotong Beach area that are deliberately discharged into the sea and subject to
decomposition. Also, this litter types can also be sourced from settlements from outside the Malotong
Beach area, which is carried by currents to the beach. While the type of electronic equipment litter is
sourced from local settlements that are disposed of to the beach area either intentionally or not. The
same thing happened for glass, ceramic and metal litter.

The lowest composition is plastic litter. The low composition of plastic litter in this area is closely
related to the function and condition of the beach. Based on the results of surveys and interviews in the
field obtained information that the Malotong Beach area is not the main destination for recreation so
there is little plastic litter. Besides, the condition of the coastal currents is calm with movement at low
tide from west to east and vice versa at high tide and gently sloping beach topography leading to
Tomini Bay (about 200 m). This condition affects on the low level of litter shipment from outside to
the Malotong Beach area.

The results of the meso size litter composition analysis in the Bailo Beach area are shown in Figure
6. Litter composition found in this area includes; glass and ceramics (49.59%), plastics (29.61%),
wood (10.58%), other materials (6.62%), rubber (3.52%), cardboard (0.42%) and metals (0.38%). The
highest composition is glass and ceramics while the lowest is metal. The composition of glass and
ceramics is higher due to higher human activities in the Bailo Beach area. This is confirmed by the
results of interviews that every weekend Bailo Beach will be crowded with visitors. The most common
activity carried out by visitors is to eat together on the beach, wherein the event often bring bottled
drinks and eating utensils. The source of the ceramic fragments allegedly came from the rest of the
construction of Bailo Park. Drinking litter (bottles) are left behind, and ceramic flakes, as well as
rocky beach conditions, provide a great opportunity for the breakage of these objects. Bailo Beach area
is also affected by rivers such as the Kasamba River, Bailo River and Ampana Masae River [3].

The second high meso litter composition is a type of plastic. As is the case with ceramic and glass
litter, the high composition of plastic litter in Bailo Beach is caused by the activity of visitors who
come every weekend. Habits of visitors who come are throwing plastic trash around the beach and
sometimes burn it. The activity contributed to the increase in the composition of plastic-type meso
litter in the Bailo Beach area. Also, there is a composition of litter for other types of material, rubber,
cardboard, and metal which is also thought to be caused by visitors' activities on the beach. This is
supported by steep coastal conditions (16.7%; 2018 field survey results), as well as an average current
velocity of 0.11 m/s and direction of current at high tide and ebb respectively from east to west and
vice versa. The physical condition of such a coastal area does not allow rubbish carried by the currents
to stranded on Bailo Beach. The accumulation of marine trash on the coast is higher in the built coastal
areas and the coastal areas which are dominated by rivers so that the area gets a high accumulation of
organic matter [4].

The results of the macro-size litter composition analysis in the Malotong Beach area are presented
in Figure 7. Litter composition found in this area includes; wood, cloth, other materials (diapers,
batteries, electronic and other equipment), glass and ceramics, rubber, metal, and plastic. The highest
composition is rubber (37%), fabric (29%), wood (26%), other materials (10%), glass and ceramics (3%), metals (3%), and plastics (2%).

The high composition of rubber litter comes from tires, while the high wood in this area is still higher than in the Palu Bay area which reaches 13.39% [2]. The high macro composition of wood litter in the Malotong Beach area is influenced by existing plants and the presence of settlements around the Malotong Beach area. The second highest composition is cloth and other materials (diapers, batteries, electronic equipment, and others). All of this litter composition comes from residential areas in the Malotong Beach area. The lowest composition is plastic litter. The low composition illustrates that this area is not entirely a place of recreation.

The rubbish found in Malotong Beach originates from the activities of residents who live along the Ampana Beach, including in Malotong. This beach is categorized in sloping type, has a flat beach contour. Sediment mass can accumulate in this area due to tidal currents that move from east to west so that the sediment is trapped into the area around Malotong Beach. Sediment build-up indicates current movement from the east coast which drifts sediment in the water column and transports trash from the surrounding coast.

The results of the analysis of macro-size litter composition in the Bailo Beach area from high to low are; Fabrics (35%), wood (27%), other materials (diapers, batteries, electronic equipment and others) (15%), plastics (12%), rubber (4%), glass and ceramics (3%), paper and cardboard (3%) and metal (1%). The composition of fabric type macro litter originates from community activities or visitors who deliberately discard clothing after swimming. In addition, the presence of fabric type macro litter is also influenced by currents and waves, reinforced by the presence of pieces of cloth in receding areas. Furthermore, the low metal composition in the Bailo Beach area indicates that visitors generally do not use metal-based products. Bailo Beach is administratively located in Bailo Village, Ampana Kota District. Bailo Village is bordered by Labiabae Village in the east, and Bailo Baru Village in the west. Bailo Beach has tourism potential, the people in Ampana Kota District utilize Bailo beach as a place of recreation. Bailo Beach has a type of steep beach, there are indications of abrasion that extend along the coast which can be caused by waves in certain seasons (December-March), the direction of current flowing to the bay area in the east along the coast (longshore current) to Tanjung Api, then the influence tidal current (tidal current) is thought to cause siltation to the west of the Bailo coast causing sediment transport to some Bailo areas. The dynamic movement of water on this beach results in a relatively diverse composition of litter compared to the west coast including Malotong Beach. The rubbish found at Bailo Beach comes from the activities of residents who live along the Ampana Beach, which is carried by the tides and ebb. Besides that, the visit of domestic tourists to the beach area is thought to contribute to new rubbish in the region. Marine waste originates from activities at sea and can be distributed away from its source by wind and currents [5].

3.2. Litter density

The meso litter density in the Malotong Beach area is 0.68 types/m², other materials (diaper material, cotton buds and electronic equipment) are 0.12 types/m², glass and ceramics are 0.04 types/m², rubber is 0.04 types/m², metals and plastic respectively 0.08 types/m² and 0.12 types/m². The highest meso litter density is wood and the lowest is glass and ceramic, and rubber. The meso litter density for wood is influenced by the presence of plant types (ketapang trees, coconut trees, and other coastal plants) and the activities of residents in the coastal area that contribute to the litter existence. In addition, wood rubbish carried by water to the beach is also taking part in the increased meso litter density of wood type.

The meso litter density of other material types (diaper material, cotton bud, and electronic equipment), and plastic shows a high value after wood litter. The density of plastic types (0.12 types/m²) in this area is still relatively low compared to the Palu Bay area which reaches 0.96 types/m². The same is true for glass and ceramic litter in the Malotong Beach area (0.04 types/m²) and the Baiya Beach area in the Palu Bay (0.28 types/m²) [2].
Meso litter density for glass and ceramic types is 1.96 types/m², plastic 1.52 types/m², wood 0.60 types/m², other materials 0.52 types/m², rubber 0.08 types/m², paper and cardboard 0.12 types/m², and metals as much 0.08 types/m² (Figure 12). The meso litter density from high to low in the Bailo Beach area is a type of glass and ceramic, plastic, wood, other materials, rubber, paper and cardboard as well as metal. The high density of this type of glass and ceramic litter is related to its higher composition. This illustrates that glass and ceramic meso litter in this area has long been accumulated at the bottom of the beach sourced from visitor activity. The same thing is suspected to occur for plastic types, other materials, rubber, and paper and cardboard, all of which are directly caused by visitor activities in the Bailo Beach area.

The macro litter density from the largest to the smallest in the Malotong Beach area, namely, wood at 3.00 types/m², plastic at 0.84 types/m², glass and ceramics at 0.68 types/m², other materials (diapers, batteries, electronic equipment and others) of 0.52 types/m², rubber 0.20 types/m² and metals 0.08 types/m². The high macro litter density of wood type in the Malotong Beach area is caused by residents’ activities related to woodwork such as house repairs, boats, and tree felling. The low metal density in the Malotong Beach area is caused by the lack of intensity of community visits. In general, sources of metals come from metal-based products such as beverage cans and other equipment.

Plastic is the second-highest macro litter density in the Malotong Beach area. The density of types of plastic litter (0.84 types/m²) in this area is still relatively low compared to the Palu Bay area which reaches 6.4 types/m². However, glass and ceramic litter (0.68 types/m²) in the Malotong Beach area are relatively the same as in the Palu Bay Beach area (0.56 types/m²) [3].

The macro litter density from high to low are types of plastic (4.20 types/m²), wood (1.64 types/m²), glass and ceramics (1.28 types/m²), other materials (1.08 types/m²), paper and cardboard
(0.40 types/m²), rubber (0.28 types/m²), metal (0.12 types/m²), and fabric (0.12 type/m²). A high macro litter density of plastic-type originates from visitor activities in the Bailo Beach area. Generally, visitors throw away plastic litter (such as eating and drinking utensils, plastic bags, children's toys, cigarette butts filters, etc.) after recreation. the level of fragmented plastic in seawater depends on the density of the plastic (low density causes the plastic to float easily and is more exposed to sunlight and air) and the chemical structure added to the plastic (some additives increase the stability of plastic polymers in the environment) [6].

Figure 13. Meso and Macro litter found on Malotong Beach and Bailo Beach

In general, meso and macro litter were found in Malotong Beach as many as 25 types, and in Bailo Beach as many as 35 types, while in Palu Bay for meso and macro litter were only found as many as 25 types. This value indicates that the types of litter in Bailo Beach are more diverse. The dominance of meso litter at Malotong Beach was WD 06 type and a little was found in ME 02 type. Macro litter was dominated by RB 04 type, which was found in PL 21, and ME 06 type. Domination in meso litter in Bailo Beach type GC 07, which was found in OT 04 type. and PC 03. The macro litter Bailo beach was CL 01 and the least found PL 21 type.

Many of the plastic, glass and ceramic litter, metals that are not thrown into landfills and not yet recycled. Therefore, to reduce the amount of litter, proper litter management, handling and management are needed. The lack of awareness of recreational beach visitors and the clean and healthy lifestyle behavior of the people who live around the area of Bailo Beach and Malotong Beach is thought to be one of the main factors for the abundant amount of litter found along the coast of Tojo Una-Una Regency. This can be seen from the type and abundance of litter that generally comes from recreational activities and household litter.

Marine litter has an impact on life through five mechanisms, i.e. (i) through the digestive system and trapping of biota, (ii) accumulates and spreads to other regions, is toxic, bioavailability, and impacts through the food chain, (iii) as an invasive species vector, (iv) impacts on habitats and seabed life, and (v) impacts economically [7]. Plastics are vectors in the spread of microalgae that cause blooming [8] and heavy metals such as Cd, Co, Cr, Cu, Ni, and Pb [9]. Plastics are made from hydrophobic materials so that pollutants are concentrated on their surface and microplastics act as reservoirs of toxic chemicals in the environment [10]. Plastics contain organic contaminants, including polychlorinated biphenyl (PCBs), polycyclic aromatic hydrocarbons (PAHs), petroleum hydrocarbons, organochlorine pesticides, polybrominated diphenyl ethers, alkylphenols, and bisphenols which cause chronic effects such as endocrine disruption in aquatic biota [6].
With a population of Ampana Kota Subdistrict of 19,025 people in 2018 [1] contributing as a contributor to coastal waste. Reducing the potential for waste input due to the community's habit of throwing garbage into the river. Knowledge about waste management must be promoted through school education. Waste processing can be done by every industry and household by sorting waste so that it has resale value. Mitigation efforts can be carried out with routine cleaning activities along the coast by the community.

4. Conclusions
The Meso litter material at Malotong Beach is dominated by WD06 (other wood) type, while the least found is ME02 type (Bottle Cap), while the macro litter material is dominated by RB 04 type (tires), while the least is PL 21 (Strapping) and ME 06 (Foil Wrappers). The Meso Litter material at Bailo Beach is dominated by GC 07 (Glass and Ceramics fragments) types, with at least OT 04 (batteries) and PC 03 (cigarette packs), macro litter material dominated by CL 01 type (Clothing), while the least type is PL21 (Strapping). The types and abundance of the litter generally originating from recreational activities of beach visitors and household waste.

5. References
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