THE SPATIAL COMPOSITION OF BEACH LITTER IN NORTH CENTRAL TIMOR REGENCY, EAST NUSA TENGGARA PROVINCE, INDONESIA

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ABSTRACT

Marine litter is currently an environmental problem that has become a global issue and attracts everyone's attention because it has a significant negative impact on the marine and coastal environment. One of the concerns at this time is the amount of marine litter in coastal areas. The purpose of this study is to determine the type and composition of litter on the beach. This study was conducted on nine coastal beaches of the North Central Timor Regency in August 2020. The sampling technique was used by adapting the Guidelines on Survey and Monitoring of Litter method. Sampling was carried out by drawing a line 100 m long parallel to the coast and a transect width of 10 m from land to sea with sampling boundaries, namely dunes, vegetation and anthropogenic activities. The results of the study show that the composition of plastic litter is 79,7%, paper and cardboard 3,5%, foam and cork 2,7%, cloth 1,8%, glass and ceramics 1,6%, rubber 2,6%, wood 1,9%, metal 1%, and others 5,3%. The category of litter that dominates the entire study beach is plastic.

INTRODUCTION

Any persistent, manufactured or processed solid material that is disposed of or left in the marine and coastal environment is marine litter (marine debris) (NOAA, 2013). Plastic is one type of waste with a significant and growing component, comprising between 60 and 80% of global marine litter. During the second half of the 20th century, the proportion of plastics in municipal waste increased by an order of magnitude from 1% in the 1960s to at least 10% in 61 of the 105 countries surveyed in 2005 (Hoornweg *et al.,* 2013). The proportion of total plastic waste that enters marine ecosystems ranges from 1.7 to 4.6% (Jambeck *et al.,* 2015) up to 10% (Avio *et al.,* 2017).

Marine litter is a global issue this century. Especially in Indonesia, marine litter is a serious problem for coastal areas and small islands, because this area is a habitat for marine biota (Purba *et al.,* 2017). Most of this waste comes from human activities, which are transported by ocean currents to all areas depending on the oceanographic system. The distribution of marine litter in Indonesia, as the largest archipelago country in the world, is very complex because it is transported by the current system, which is local and shifts (Purba *et al.,* 2014). Various coastal areas and islands have been studied on marine litter. It was found that marine litter from various continents was washed away by ocean currents, as happened on Amami Island, Japan (Kei, 2005). Marine litter is scattered on the beach when the tide ends (Attamimi *et al.,* 2015).

Since Indonesia was declared the largest contributor of waste after China (Jambeck *et al.,* 2015), the Indonesian government through the Presidential Regulation of the Republic of Indonesia Number 83/2018 concerning Marine Waste Management has determined marine litter to be a special concern, to reduce marine litter, through the Action Plan. The Indonesian government's National Action Plan is committed to reducing marine waste, especially plastic waste by 70% by 2025. Of course, there is a need for cooperation from all parties, including the government, relevant agencies, research institutions, and the

community through strategic, measurable strategies, programmes, and activities.

North Central Timor/NCT Regency (Kabupaten Timor Tengah Utara / TTU) is one of the regencies in East Nusa Tenggara Province (Provinsi Nusa Tenggara Timur), which has a coastline of 50 km stretching from North Insana District to Biboki Anleu District, which includes three sub-districts (BPS Timor Tengah Utara Regency, 2021) bordering the sea and there are nine coastal villages. It is feared that many human activities in the coastal area of NCT Regency will result in piles of litter in the coastal area. The negative impacts caused by marine litter affect people's livelihoods and welfare, and also have an impact on marine and coastal ecosystems (Oosterhuis *et al.,* 2014). As the population grows in the area, therefore, littering in coastal areas is one of the complex problems faced by cities located right on or adjacent to the coast or coastline (Citrasari *et al.,* 2012).

To support the commitment of the National Action Plan (Rencana Aksi Nasional/RAN) and the importance of preserving coastal areas, it is necessary to conduct a study to determine the distribution and types of litter on the coast. This study will inform the government about the state of litter on the coast of the NCT Regency. This study aims to determine the type and composition of litter that is washed up on each beach on the coast of NCT.

MATERIAL AND METHODS
Time and locations

The research was carried out in August 2020 on a beach located in the NCT Regency. August is the eastern season in which the East Nusa Tenggara Province is in dry climatic conditions. Based on the initial survey of coastal locations on the coast of NCT Regency, this study was conducted at nine locations which were divided into four activities, a) beaches with tourist activities, such as Tanjung Bastian Beach and Faularan Beach; b) beaches with residential activities and ship ports, such as Marpari Beach and Kolnai Beach; c) beaches with fishing activities, such as Oepuah Beach and Amtasi Beach; and d) beaches with mixed activities between settlements, boat berths, and fishing activities, such as Temkuna Beach, Kolamtuak Beach, and Oebubun Beach. (Figure 1). Marpari Beach is located on the border with the Democratic Republic of Timor-Leste which is separated by a river. Determination of the research location is done by using the purposive sampling method, which determines

the research location with certain criteria or considerations. The considerations seen in determining the location are tourism places, ship anchoring areas, and settlements with a minimum beach length of 100 m and a beach slope of 15^0-45^0.

Tools and materials

During the research, the tools and materials used were transects using pipes and ropes; a smartphone equipped with a camera for retrieval of research documentation, as well as the GPS Map Camera application version 1.0.4 to record the coordinates of each transect; gloves and masks to protect hands and nose; plastic bags for storing litter; sacks to store plastic bags filled with litter; stationery to record the types of waste and the number of pieces of waste for each type; as well as a laptop as a data processing tool.

Sampling Method

Observation of litter is carried out by referring to Cheshire *et al.* (2009) at each research location. There was no sampling repetition in every location. Several important things must be prepared before conducting observations of waste stranded in coastal areas, such as the selection of observation sites, the materials needed for observation, and the duration of the observations. Determination of waste research locations can be done as follows:

Research Site Selection

- Accessible (for continuous monitoring)
- Sandy or gravel.
- No breakwaters, jetties, piers or other structures.
- Minimum length of 100 m parallel to the water's edge
- Slope-moderate (low-moderate 15^0-45^0).
- There was no beach clean-up activities close to the sampling time.
- There is no waste management at this location.

Observation

- At each sampling transect, location recording was carried out using GPS Map Camera version 1.0.4.
- The observation method was using a quadrant transect parallel to the coast (Figure 2).
- The transect line was installed parallel to the coastline, 100 m long and 10 m wide from land to sea, bordering anthropogenic

activities, dunes, and vegetation. To ensure the accuracy of data collection, at a width of 10 m, the litter was taken at intervals of one meter (Toruan *et al.,* 2021).

- An observer walking along the transect line.
- All litter seen in the transect was collected and cleaned of sand/mud.
- Waste was classified based on the existing categories and then the amount is calculated.
- The results of sorting and counting the amount of litter are then recorded in the observation notebook according to the prepared data sheet.

Data analysis

Samples of marine litter were grouped into nine categories, 1) plastic, 2) cork/styrofoam, 3) cloth, 4) glass and ceramics, 5) metal, 6) paper and cardboard, 7) rubber, 8) wood, and 9) others (Cheshire *et al.,* 2009). Others category is comprised of organic and mixed inorganic types of litter other than the first eight categories. Furthermore, each type was calculated in the number of pieces of waste and then analysed descriptively using graphs to get the composition of litter by category and location. Data analysis using the application MS Excel.
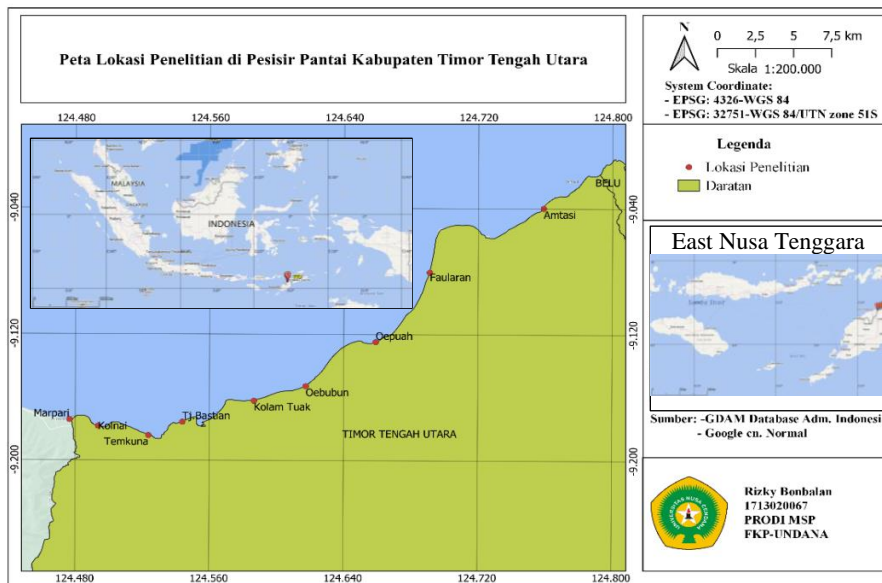

Figure 1. Map of Research Locations for North Central Timor Regency

Figure 2. Visual Litter Collection Method

RESULTS AND DISCUSSION
Results

There were 13.901 pieces of litter found on nine beaches off the coast of the NCT Regency. When referring to Cheshire *et al.* (2009), then on the coast of NCT Regency there were nine categories of waste which include 75 types of beach litter where two types of litter were not found, namely plastic resin and paraffin or wax (Figure 3). Different amounts of litter were found at each study location. The composition of the litter categories at each beach on the coast of NCT Regency can be seen in Figure 4, while the composition of the total litter at each location is presented in Figure 5.

a. Plastic

b. cork/styrofoam

c. paper and cardboard

d. Rubber

e. glass and ceramics

f. Other waste (organic)

Figure 3. Several Categories of Litter Found on the Beach in the North Central Timor District

At each study location, the nine categories of litter were found with different percentages. The plastic category dominates in the amount of litter on each beach with a total percentage of 79,7% (Figure 4). The next category that dominates is the other category of litter with a percentage of 5,3% of total waste. Litter categories of cork or foam, cloth, glass and ceramics, metal, paper and cardboard, rubber, and wood were found less than 5% each in each study location with a percentage of 2,7% (cork or foam), 1,8% (cloth), 1,6% (glass and ceramics), 1% (metal), 3,5% (paper and cardboard), 2,6% (rubber), and 1,9% (wood).

The composition of litter based on the amount of waste at each study location on the coast of NCT Regency is different (Figure 5). Temkuna Beach is the beach with the highest litter composition with a total percentage of the amount of litter found at 20,6%, while the lowest was found at Marpari Beach (4,4%). A large amount of plastic waste at the nine study sites on the coast of NCT Regency is inseparable from numerous other types of litter in the plastic category. Based on *Cheshire et al.* (2009) Plastic litter is divided into 23 types. However, 26 types were found at the nine study sites on the coast of NCT Regency. The increase in the number of types of plastic litter found means that there were additional three other types of plastic in the category of plastic found on the nine beaches of the study location on the coast of NCT Regency. The three types of litter were ice packs, bottle pieces, and toiletries.
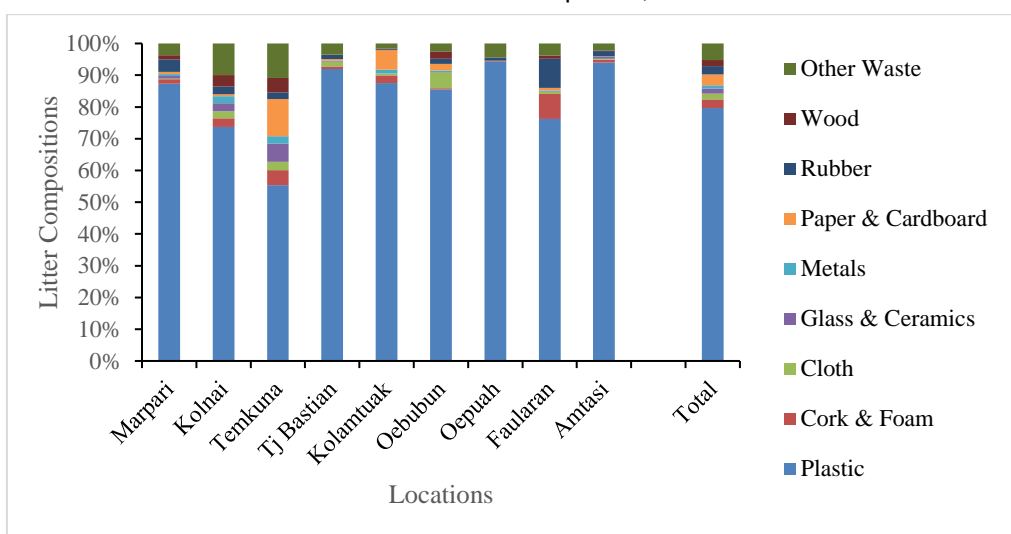

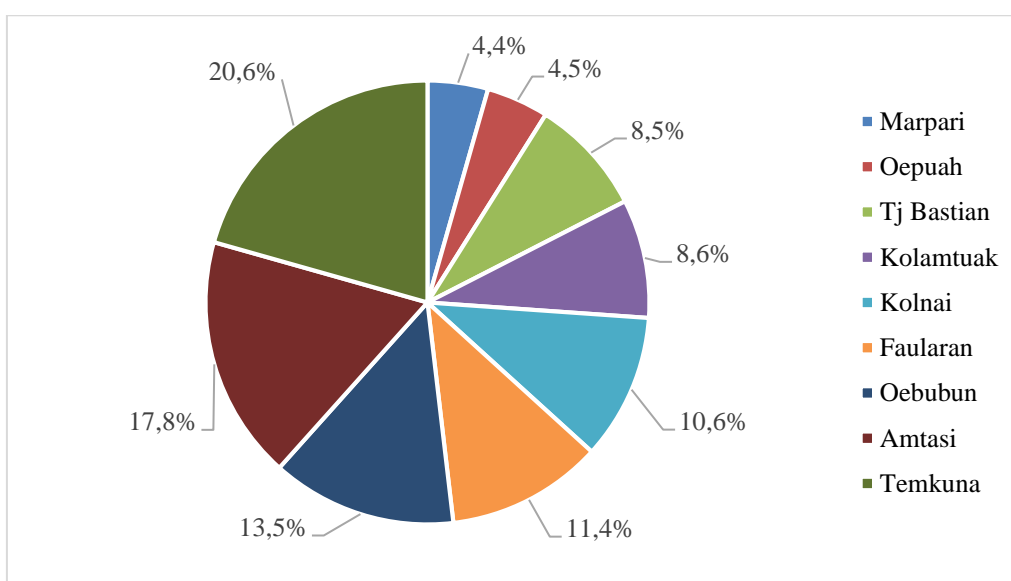**Figure 4.** Litter Composition by Category on Each Beach

Figure 5. Percent Composition of Litter All Over the Beach

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Discussion

Litter found on the coast of NCT Regency is inseparable from human activities as waste producers. The high amount of litter certainly has a bad impact on polluted beaches. Human activities in coastal areas produce a lot of waste and the amount globally continues to increase from time to time (Topçu *et al.,* 2013). For example, beaches with tourism activities are generally dominated by plastic waste such as plastic food packaging and plastic beverage packaging, while beaches with fishing activities, for example, will have different characteristics of plastic litter such as ropes, nets, nylon, and buoys. Then the type of litter from settlements has different characteristics where the type of litter from residential activities is plastic such as plastic bags, plastic detergents, and so on. Two categories of litter dominate the number of pieces against the distribution of litter, with a fairly high amount compared to other categories of litter on the nine beaches of the study on the coastline of NCT Regency, namely plastic and other category. Plastic is one of the litters that are often found in various regions with a high distribution, both on land and in the sea. The total litter accumulated along the coastline, seabed, and surface is a type of plastic with a percentage of 95% (Pham *et al.,* 2014). According to Elias (2018), almost all ocean plastic litter comes from coastal areas, mostly through rainwater flows and is carried away by river water or dumped into coastal waters. About 50% of plastic is buoyant and 60%-64% of the amount of plastic floating in the ocean is estimated to be carried from coastal waters to the high seas (Cózar *et al.,* 2014). Rahmayanti *et al.* (2020) found a high amount of plastic waste with a percentage of 79% at Kuala Batu Beach, West Aceh Regency. The same thing happened along the coastline of NCT Regency, plastic dominated the amount of litter with a percentage of 79,7%. Studies conducted by researchers in various regions explain that the most common type of litter found is plastic, such as on the coast of Kuala Pesisir District, Nagan Raya Regency with a percentage of 63% (Kusumawati *et al.,* 2019), Tongkaina Beach and Talawan Bajo Beach with a percentage of 58,41% (Djaguna *et al.,* 2013). The most common types of plastic litter found in this study were food wrappers, mineral drink glasses, ice packs, ropes (mine, nylon, raffia), crackles, cigarette butts, drink bottles, and other plastics (flakes).

The number of plastic litters are high compared to other types of litter on the NCT's beach. Plastic bags, food and drink containers, and fishing gear are the most common materials and more than 80% end up on the beach (Thiel *et al.,* 2013). The characteristics of plastics that are economical, flexible, and easy to use are the reasons people use them today. Single-use plastics are commonly used in food and beverage services and community activities in the market, so this type of plastic is easy to find. Plastic litter is generally found in areas close to residential areas, where most of the plastic waste produced come from buying and selling activities. Proximity to urban areas as well as industrial and recreational areas is the most important parameter that can affect the type, abundance, and distribution of waste in marine areas (Duckett & Repaci, 2015; Moriarty *et al.,* 2016). The average amount of plastic litter is the highest compared to the average amount of litter in other categories. The high amount of plastic litter harms the environment and the community's economy. Temkuna Beach is the beach with the highest amount of litter. The high amount of litter on the beach is thought to be due to overlapping activities on the beach, such as tourist attractions and ship docking areas. Rahmayanti *et al.* (2020) found at Kuala Batu Beach, Pulau Kayu Village, Southwest Aceh Regency that most of the marine litter found in this location comes from recreational activities and beach activities. In the South China Sea, it shows that 95% of marine litter found in the area comes from land (land-based sources) through recreational activities and coastal activities as a result of human activities (Zhou *et al.,* 2011). Food wrappers, cigarette butts, plastic wrappers, ropes (nylon, raffia, mines), other types of plastic, ice packs, and bottle pieces were the most common types of plastic waste. Plastic litter such as drinking glasses, food wrappers, cigarette butts, and straws are generally often found in tourism activities (Ultimate *et al.,* 2021). Tourism activities are commonplace for many people, but the lack of concern for the environment often makes tourism actors leave food scraps on the beach so that the amount of garbage on tourist beaches is very high. The ropes (nylon, raffia, mine) and ice packs were found to indicate a contribution from fishing activities to marine litter on the coast. According to Purba *et al.,* (2017) rope is a type of litter that is often found on the coast because it is used by fishermen for fishing activities. The ice packs found are a special feature of fishermen's habits as a preservative for catching fish.

In addition to plastic, which dominates the amount of litter on each beach in the study

location, other categories are also the most abundant litter found. Among the nine study locations where other categories were found are types of human land plant litter, including seeds, midribs, leaves, weeds, and nutshells. The amount of land plant litter from human activities (other than wood-type waste) shows the activities of coastal communities who use materials from nature, such as midribs used to make huts or houses from tree trunks which are still commonly found on the coast of NCT Regency, where these materials can no longer be used, then thrown away and left alone on the beach. In addition to the midrib, many corncobs, peanut shells, and coconut shells are also found in nine study locations, causing the other categories of waste to be quite dominant compared to the number of other pieces of waste. Coconut shells, corn cobs, and peanut shells are found on almost all beaches where there are overlapping activities such as settlements and tourist beaches. This happens as a result of the habits of the community or tourists who consume them. After that the leftover food is dumped on the beach, causing a pile of litter. Categories of cork and foam, cloth, glass and ceramics, paper and cardboard, metal, rubber, and wood are litter with a small composition of waste, but this shows that human activities from local communities and tourist objects have an impact on the accumulation of waste on the coast. Although these seven categories of litter were found in small quantities, they harmed the aesthetic value of the beach and the health of the coastal environment. Therefore, there needs to be awareness and attention to the presence of litter on the beach, so that environmental sustainability is maintained and the community's economy can be improved.

CONCLUSION and SUGGESTION

The results of this study conclude that plastic waste is the type that dominates litter on every beach on the coast of the North Central Timor Regency.

This study was carried out spatially in the east monsoon, so it is necessary to conduct studies in other seasons, such as in the transition period and the west season to get a complete picture of the pattern of litter distribution on the coast in North Central Timor Regency.

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