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# The Relationship between Current Patterns and the Distribution of Surface Waste in the Waters of the City of Palopo

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**ABSTRACT**

Marine debris is a solid material that is disposed of or left in the marine environment by the public either intentionally or unintentionally. The purpose of this study is to identify the abundance and weight of waste (mega and macro) and explain the relationship between current patterns and the distribution of surface waste in the waters of Palopo City. The research was conducted in May-July 2023. Sampling data was collected using Neuston nets installed on both sides of the boat. The results showed that the marine debris found in the waters of Palopo City during high and low tide was dominated by plastic waste. The abundance of plastic waste at high tide is higher than at low tide. The accumulation of scattered surface marine debris is carried away by currents due to the intensity of wind and tides and strengthened by the location of the waters close to the mainland of Palopo City so that marine debris carried by wind and currents tends to the south.

**Keywords:** Current Sea; Inorganic; Marine Debris; Palopo City

## 1. INTRODUCTION

Marine Debris is a solid material that is disposed of, planned or accidentally, and left in the sea area. Based on research results (Jambeck et al., 2015) Indonesia is the second largest contributor of marine debris after China. Sources of marine debris found in waters usually come from coastal tourism and the processing of waste from households into waterways, boats, and industrial waste (Larasati et al., 2020). Dispersal carries garbage from one place to another because it throws garbage into rivers and ends up in the sea (Ningsih et al., 2020).

The cause of the accumulation of garbage in the waters is due to several physical oceanographic factors. This phenomenon occurs due to the influence of parameters, namely wind, currents, and tides (Asmal et al., 2021). According to research (Nadir, 2020), people throw garbage into the sea due to a lack of landfills. Garbage that is thrown into the sea is then carried from one place to another by sea currents and wind, maybe even carried away from the source (Djaguna et al., 2019). The wind blowing over the sea is the source of currents (Permadi et al., 2015). In general, the stronger the wind blows, the greater the current generated. In addition, marine debris has been shown to follow current patterns in the region. Garbage in the waters moves from one direction to another according to the direction of the ocean currents. Based on the results of research on ocean currents, it greatly influences the movement patterns of marine debris (Sari, 2019).

The community throws garbage into the river with the assumption that it can wash it away outside the residential area. Tides and river flows are not effective in carrying garbage out of settlements: some plastic waste is increasing in residential areas (Asmal et al., 2021). Marine debris will be a major threat to marine ecosystems and coastal areas and can harm marine biota, human health, marine mammals, sea birds, turtles, and fish, including the most affected organisms, with cases of ingestion and entanglement in marine debris (Purba et al., 2019). The area of Palopo City reaches 247,52 km² and includes 9 districts and 48 villages. According to information from the BPS (2021), there has been an increase in the population of Palopo City since 2017-2020. The population of Palopo City in 2020 was 184,68 thousand residents. If the population continues to grow, this is of course expected to affect the results of household waste disposal, the activity of changing people's lifestyles which can have an impact on increasing the number of waste piles (Manik et al., 2016). If the problem of marine debris in Palopo City continues to occur, it is suspected that it will affect the sustainability of the marine ecosystem.

Seeing the various kinds of problems above, it is necessary to identify the characteristics of the abundance and weight of marine debris carried by surface currents and the pattern of surface currents in Palopo City Waters which are assumed to be locations of marine pollution. The purpose of this study is to determine the relationship between the current pattern and the distribution of surface waste in the waters of Palopo City.

The difference between these studies with previous research is in the method of collecting data on marine debris. Neuston nets are installed on both sides of the ship so that the data collected is more accurate to maximize marine debris data collection

## 2. RESEARCH METHODS

### Time and Place of Research

The research was conducted in May-July 2023 in Palopo City Waters with 20 observation points (Figure 1). The determination of the starting point of the observation station is 500 m from the beach, and each observation station is ± 1 km from the next station. The total area of the observation station ranges from ±16 km². Analysis of waste samples was carried out at the Marine Laboratory of the Muhammadiyah University of Palopo.

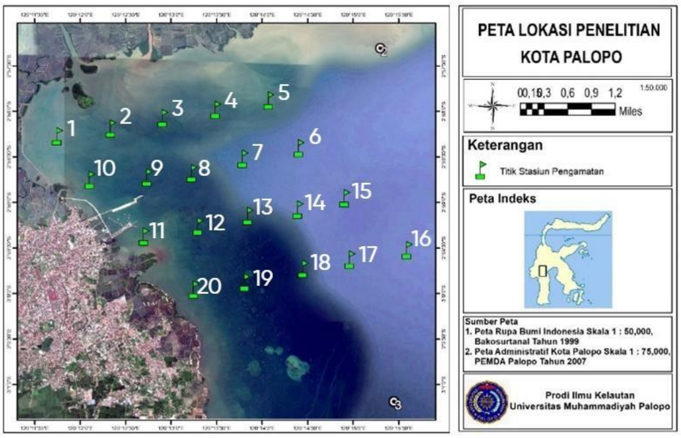


**Figure 1. Research locations around the waters of the city of Palopo**

### Procedure

The process of carrying out the research used tools and materials including boats, current kites, Neuston Net, GPS, digital scales, stationery, neat ropes, cameras, stopwatches, aiming compasses, trash, and buoys.

### Wind Data Processing

Retrieval of wind data (direction and speed) through the website *power.larc.nasa.gov*. Meanwhile, the processing of wind direction and speed data uses WRPLOT Version 8.2.0 software. In this study, wind data was used for 1 year (May 2022 – April 2023). This is because it describes wind data every year.

### Current

T Data collection on the speed and direction of the current is carried out at each point of the observation station. Speed and direction data are measured using current kites at high and low tides. Meanwhile, the current direction data is collected using an aiming compass. Retrieval of current speed and direction data refers to research (Yulisa et al., 2016). The following is an analysis of current velocity using the formula:

$$\mathbf{v} = \frac{s}{t}$$

Information:

V = current speed (m/s)

s = Length of rope track (m)

t = time (s).

### Marine Debris

Surface marine debris samples were taken using the Neuston Net. The Neuston Net used in this study measures 150 × 50 cm with a hole size of 0,5 cm. Neuston Nets are installed on both sides of the ship using neat ropes for the reason that the data collected is more accurate, to maximize the sampling of floating marine debris according to research suggestions (Asmal et al., 2021). Vessels are used when sampling waste at speeds of 1-3 knots. Furthermore, the samples that were successfully filtered by the Neuston Net were put into sample bags and then classified based on the type and weight of the waste. The types of waste samples targeted in this study are mega- and macro-sized plastic and wood. The formula for waste abundance and waste weight is based on (Lippiatt et al., 2013):

$$C = \frac{n}{P\ x L}$$

Information:

C = Abundance of waste (pieces/km²)

n = the amount of waste observed

L = width of net mouth opening (km)

P = Length of track (km)

$$M = \frac{Total\ waste\ wight\ (g/m2)}{P\ xL}$$

Information:

M = Weight of marine debris (g/m²)

p = network pull length (m)

l = width of net mouth (m)

## 3. RESULT AND DISCUSSION

### Wind

The results of wind data processing for 1-year show that the dominant wind direction comes from the north. In addition, the wind direction also comes from east to south but this is not too dominant. Wind speed and direction are unstable and changeable during this period (May 2022 – April 2023). During this period the wind pattern is always changing which causes changes in wind direction from season to season (Purba & Jaya, 2023). The average wind speed during this dominant period was around 0.50-2.10 (m/s). The results of wind data analysis can be seen in (Figure 2).

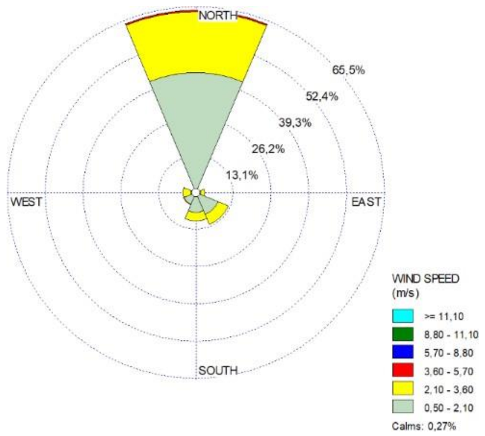


**Figure 2. The results of wind data analysis at the study site**

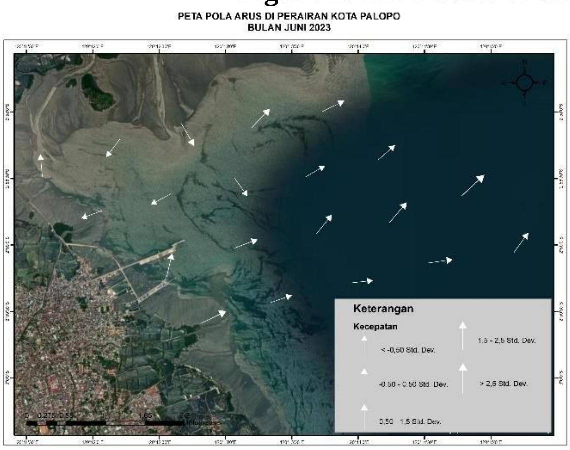


**Figure 3. Current pattern map at high tide in the waters of the city of Palopo**

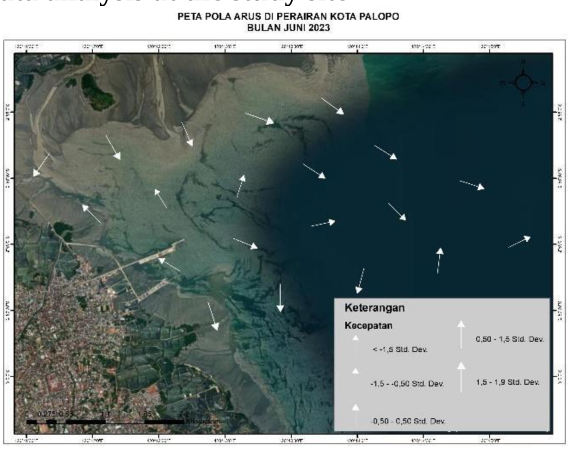


**Figure 4. Map of current patterns at low tide in the waters of the city of Palopo**

### Current Speed and Direction

At high tide, the current at the study site moves from north to east. In contrast to low tide, the current moves from east to south before diverting to the northwest due to the location of the beach at the research location. At high tide conditions, the current speed is much slower than at low tide. The current speed at high tide ranges from 0.17 – 0.25 m/s at low tide. The current speed during high and low tide is included in the slow current category. This is by research that says that current speeds of 0 – 0.25 m/s are classified as slow currents (Bibin et al., 2021).

**Abundance and specific gravity of surface waste**

The amount of waste found at all points of the observation station during high and low tide was 106 pieces of plastic and wood waste. Plastic waste is the most common type of waste found at each observation point during high and low tide. The highest amount of plastic waste was found at station 13 during high tide. Meanwhile, at low tide, plastic waste can be found at station 11. 47 pieces of plastic waste were found while 25 pieces of wood waste were found during high tide (Figure 5). According to research (Priliantini et al., 2020) plastic waste is more often found in marine waters because the material is light and easily floats.

The abundance of garbage is found at high tide compared to low tide. The highest abundance of waste is plastic waste, 141 pieces/km² at high tide. In addition, an abundance of plastic waste was also found at low tide, 66 pieces/km². The abundance of waste found could be due to several factors. Palopo City Waters is a busy location and a tourist spot around Palopo Waters. Household waste disposal is thought to be the source of the large amount of marine debris found at that location, this was also explained in research in the waters of Tanjungpinang City (Nursyahnita et al., 2023).

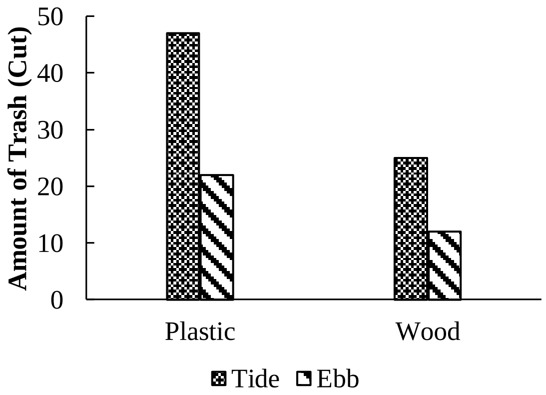


**Figure 5. The amount of marine debris at the study site**

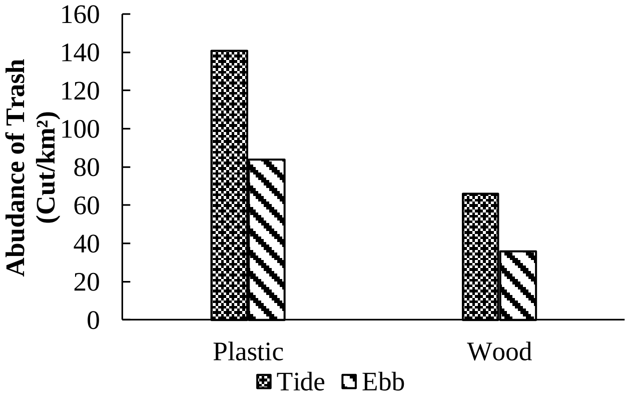


**Figure 6. Abundance of surface waste in the study site**

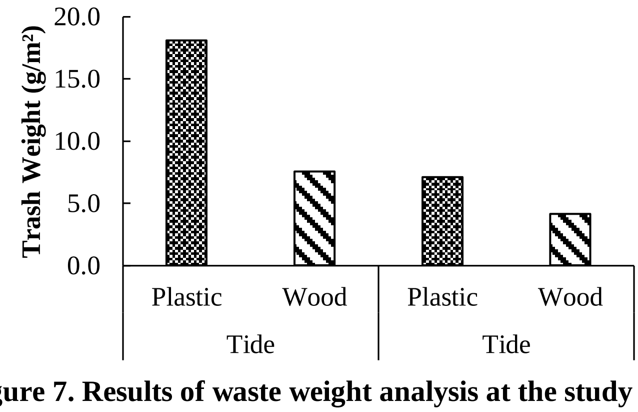


**Figure 7. Results of waste weight analysis at the study site**

The results of the weight of marine debris in the research location are known at high tide to have the highest marine debris weight compared to low tide. The high weight of plastic waste is caused by the amount of waste found during high tide. The weight of plastic waste found was highest at station 14. The type of plastic waste at tide is the type of waste with the highest weight, namely 18,0 gram/m² and wood waste at 7,5 gram/m². Meanwhile, during low tide, the weight of plastic waste is 7,1 gr/m² and 4,1 gram/m² of wood waste can be seen in (Figure 7). This is by research (Ribic et al., 2012) that the waste that has the highest weight thrown into the sea is plastic waste.

**The current pattern on the distribution of surface waste**

The results of the identification of the type and amount of marine debris in the study area revealed that the highest density of marine debris was found during high tide. Currents at high tide carry trash from the open sea to the beach. This is evident at station 2 closest to the beach, stations 13 and 14 which are not far from the Port of Tanjung Ringgit Palopo. The density of locations and activities in coastal areas is thought to have caused the density of marine debris to increase and possibly constitute waste from the mainland (Johan et al., 2020).

When the sea is receding, currents move from the beach to the open sea so that marine debris gets caught and left on the beach. This is evidenced by the amount of waste at stations 9, 11 and 18. The current velocity range at low tide is usually much lower than at high tide. The weak current speed during low tide causes marine debris to be left behind because the current speed is smaller than most of the marine debris that accumulates on the beach (Nursyahnita et al., 2023).

Based on the results of the description above, it is known that the current pattern has a relationship to the distribution of waste. In general, the movement of marine debris follows the direction of movement or patterns of ocean currents. The current speed of the current affects the process of disposal of marine debris. The faster the ocean currents, the faster the accumulation of garbage occurs. According to (Mandala, 2016) coastal areas are the places where most marine surface debris is found which is dominated by plastic waste with strong buoyancy and high durability. According to a study conducted on the west coast of Bali Island during the west season, more marine debris was found at stations close to the shoreline (500 m from the coast) compared to stations farther from the coast (Husrin et al., 2017).

## 4. CONCLUSIONS

The results showed that the current pattern at the study site was strongly influenced by tidal conditions. Current circulation in the research location is thought to affect the distribution of marine debris in the waters and on the coast of the research location. In high tide conditions, currents moving from the sea to the coast carrying marine debris whose mass is lighter than the current speed will be carried away and accumulate around the coast. At low tide, the current speed is weaker than the tide. The weak current speed at low tide can cause marine debris to be left on the beach because the current speed is smaller than the amount of marine debris piled up on the coast.

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