Microplastic Observations in the Waters of Labuan Bajo-Gili Trawangan, Indonesia

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Abstract. These microplastics can be found near sources of waste or have spread to waters near remote islands, in fragment, fiber, film, or styrofoam. The 5Gyres Expedition 2018, using KLM Sea Safari VII, sailed along Nusa Tenggara, Indonesia, on 21-29 July 2018. One of the objectives of this expedition was to collect data on the abundance of microplastic marine debris (< 5 mm in size) from Labuan waters. Bajo to Lombok, which has not been recorded until now. Seawater samples were taken at the surface at 12 different locations during the expedition. The process of separating microplastics in seawater samples was carried out in the laboratory. Identifying the shape and total concentration of microplastics (microplastic particles per liter) was carried out using a microscope. As a result, microplastics were found in all seawater samples in the form of fibers and fragments. Microplastics in fiber were found in all locations (12 locations), while fragments were only found in 6 areas. In the waters near Labuan Bajo, East Nusa Tenggara, microplastic marine debris in fiber was found, as much as ten particles/liter. Meanwhile, 27 particles/liter in fragments were found near Gili Banta Island, West Nusa Tenggara. Currents around the area are thought to have contributed to the spread of microplastics.

1. Introduction

Nusa Tenggara is a group of islands to the east of Java Island, from Bali Island in the west to Timor Island in the east. Administratively, most of the Nusa Tenggara Islands are part of the territory of Indonesia, except for the eastern part of Timor Island and small islands. Surrounding areas are part of the territory of the State of Timor Leste. Nusa Tenggara has four major islands: Flores Island, Sumba Island, Timor Island, and Alor Islands, as well as 562 other islands. This archipelago is a tourist paradise for eastern Indonesia. Most of the islands in this region have a variety of fascinating natural panoramas. Apart from mountains and hills, there are also vast grassland areas known as steppes and savannas. In addition, Nusa Tenggara also has the Komodo National Park, a conservation island, and has been designated by UNESCO as one of the world heritages.

The natural charm of Nusa Tenggara is so beautiful that many tourists come to visit, but they have problems to deal with. One of them is the garbage brought by tourists. The habit of visitors to leave trash
and littering, both organic and non-organic, will undoubtedly harm the ecosystem in the area, especially the beach.

Plastic is the most commonly found waste [1,2]. Plastic waste that can affect the food cycle in coastal and marine areas is microplastic. Microplastic is a type of plastic waste smaller than 5 mm and is grouped into two types, namely primary and secondary microplastics. Primary microplastics are plastics produced in micro-forms, such as microbeads in skincare products that enter waterways. Secondary microplastics are fragments, parts, or results of fragmentation of larger plastics [3].

Microplastic is one part of ocean waste that accumulates in water areas will cause disruption of the food chain in fish. Microplastics have the potential to threaten more seriously than large plastic materials as organisms that inhabit lower trophic levels, such as plankton which have particles that are susceptible to microplastic digestion processes as a result of which they can affect higher-level tropical organisms through the bioaccumulation process. Laboratory test results show that microplastics can be digested by marine organisms when one of the microplastic particles can resemble food [4,5,6].

Several studies on microplastics in Nusa Tenggara have been carried out, including types of microplastics around Kupang, Rote [7], Sumba [8], and the path of microplastic waste in the Savu Sea [9]. Meanwhile, Nusa Tenggara is an area that has many small islands, so it is still necessary to research microplastics. Therefore, The 5Gyres Expedition 2018 has made a voyage along the waters of Nusa Tenggara, Indonesia. One of the objectives of this expedition was to collect data on the abundance of microplastic marine debris (< 5 mm in size) from the waters of Labuan Bajo to Lombok, which has not been recorded to date.

![Image](image_url)

**Figure 1.** Water sampling location. The number 1 indicates the start of the expedition, and the number 12 marks the end of the expedition.

### 2. Method

The research method involves the numerical modeling of HAMburg Shelf Ocean Model (HAMSOM) hydrodynamics, developed by Backhaus [10,11]. The hydrodynamics model simulation results' output is the current, temperature, salinity, and density data, which is a depth function. This data is used to see the characteristics of the waters. The bathymetry data input was processed directly from the world map.
obtained from the Shuttle Radar Topography Mission [12], with each horizontal size \(dx, dy\) of 6 minutes \((1/10^o)\), \(dz\) by 20 vertical layers, and \(dt\) by 180 seconds. Furthermore, tidal data are used to generate force at the model area's open boundary. This was obtained from the Oregon State University Tidal Prediction Software (OPTS) global model [13], with a horizontal resolution of \(1^o \times 1^o\). The atmospheric parameters used as input include average sea level pressure, air temperature, specific humidity, total cloud cover, wind, and precipitation levels, obtained from the National Center for Environment Prediction (NCEP). NCEP data have a resolution of \(2.5^o \times 2.5^o\) longitude/latitude, which happens to be an "ocean," not a "land" point, with data intervals of six hours [14]. Monthly temperature and salinity data with quarter-degrees (represent the world as 1440 x 720 quarter-degree longitude/latitude boxes) are obtained from the World Ocean Atlas (WOA) [15,16]. Furthermore, the atmospheric parameter, temperature, and salinity data were captured into the domain model to be used.

Sampling was carried out in July 2018 in 5GyresExpedition 2018 using the KLM Sea Safari VIII ship. The water sampling method is carried out in two ways. First, take a sample of 1 liter of water on the sea surface horizontally at each station that is passed. On this occasion, there are 12 stations, namely: waters near Labuan Bajo Harbor, Padar Island, Loh Liang-Komodo National Park, Loh Buaya-Rintja Island, Batu Bolong Island, Gili Lawa Darat, Gili Banta, Bontoh Village, Sangiang, Satonda Lake, Mayo Island, Nara Bay, and Gili Trawangan. The sampling location is shown in Figure 1. The sample was filtered using a plankton net. Second, pulling a manta trawler for 10 minutes at sea level at a speed of 2 knots. The manta trawler was rinsed with water, and all the material in the manta trawler was put into a sample bottle and tightly closed. The sample bottle is placed in a cool box. Storage of samples must be adequately observed to minimize the occurrence of microplastic contamination originating from other places [17].

The sample separation process in the laboratory is carried out to separate microplastics from plankton or metals. This process is divided into three parts. First, the filtering process uses a 100 mesh sieve. Second, destroy non-plastic samples using a 10 mg/ml solution of 0.05 M Fe (II) and 30% H2O2. The solution was put into a heat-resistant Erlenmeyer and heated to a temperature of 75°C for 30 minutes, then allowed to stand for a day in a closed condition with aluminum foil. Next, the particles were separated based on their density using 1.2 kg/l NaCl. Particles that have a low density will float. The separation process uses Whatman microfiber filter paper. Microplastic can be seen in type and shape using by a microscope [18]: counted the number and kind, then analyzed the microplastic distribution in Nusa Southeast Waters. The data analyzed were the results of the microscope examination in the form of particles (fiber, film, fragment, pellet) in each sample to be classified and quantified based on the shape of the microplastic particles. The abundance of microplastics was calculated by dividing the number of microplastics in each sample by the total volume of water g. The formula for calculating the abundance of microplastics (C) in one sample is to divide the number of microplastic particles per sample (n) by the total volume of water (V) during sampling (liters).

3. Results and Discussion

3.1. Overview and Characteristics of Oceanography
Field observations show that the sampling locations rely on their livelihoods by working as fishermen and in the tourism sector. The tourism sector is divided into several parts: port tourism, sea tourism, lake tourism, and national park tourism. Therefore, many domestic and non-domestic tourists visit.

Areas that are port tourism are Labuan Bajo and Nara Bay. Labuan Bajo is a small town on the westernmost coast of Flores Island. It has strategic functions, among others, as the center of government, education, trade (ferry dock, port, and Komodo Airport), tourism center. Nara Bay, there is a port called Nara Bay Harbor. This port is one of the entrances and exits for tourists to the tourist areas of Gili Meno, Air, and Trawangan.

Loh Liang-Komodo National Park and Loh Buaya-Rintja Island are Komodo National Park areas. Loh Liang-Komodo National Park is the largest island in the Komodo National Park area, East Nusa Tenggara, Indonesia. This National Park is home to more than 4,000 Komodo dragons (one type of
lizard, the largest on earth from about 3000 other lizard species). Likewise, with Loh Buaya-Rintja Island, a tourist area included in the ranks of the big islands in the West Manggarai district. The last tourist area is Bonto Village. Bonto Village, Sangiang is an island used by local people to make phinisi boats.

Oceanographic parameters reviewed in this study are temperature, salinity, density, and surface currents in the Flores Sea during July. The distribution of sea surface temperature (SST) in the waters of the Flores Sea is in the range of 28.25-29.25°C with an average of 28.75°C (Figure 2a). The sea surface temperature in the west of the Flores Sea is higher (29.25°C) than in the east (28.25°C). The sea surface salinity (SSS) distribution in the Flores Sea ranges from 32.25 to 33.25 psu with an average of 32.75 psu (Figure 2b). In contrast to sea surface temperatures, the salinity in the eastern Flores Sea is higher than in the western Flores Sea. Meanwhile, the density of waters in the Flores Sea shows a value of 1,020.25-1,021.25 kg m⁻³ (Figure 2c). Overall, the horizontal distribution of temperature, salinity, and density appears relatively homogeneous in all locations.

Currents in the Flores Sea tend to move in the same direction in July (east monsoon), i.e., from east to west (Figure 2d). The current velocity at latitude 6° 00' 00" - 7° 00' 00" S is slower than at latitude 7° 30' 00" - 8° 15' 00" S. Some of the currents turn into the Sape Strait towards the Indian Ocean at a speed of 0.5-0.6 m s⁻¹, and some move towards the west with currents that tend to weaken (± 0.5 m s⁻¹). In the north of West Nusa Tenggara, some currents continue to move westward, some enter the Alas Strait and Lombok Strait, joining currents that leave the Sape Strait to the Indian Ocean. When entering the Alas Strait, the current speed weakens (± 0.1 m s⁻¹), while the current velocity in the Lombok Strait remains in the range of ± 0.5 m s⁻¹. The current simulation result is the same as the result of Wyrtki (1987), Gordon et al. (2010), and Sprintall and Revelard (2014) [19,20,21].

**Figure 2.** Characteristics of oceanography: a. temperature, b. salinity, d. density, and e. current speed in the waters of Labuan Bajo-Gili Trawangan.
3.2. Abundance of Microplastics

Laboratory results showed that two types of microplastics were found: fragments and fibers, while films and pellets were not found (Figure 3). Microplastic fragments were found in Gili Banta (27 particles/liter or 60% of the total fragments), Gili Trawangan (7 particles/liter or 16% of the total fragments), Labuan Bajo Harbor (6 particles/liter or 13% of the total fragments), Pulau Rintja (3 particles/liter or 7% of the total fragments). Meanwhile, almost no microplastic fragments were found (0-1 particle/liter or 0-2% of the total fragment). Types of fiber were found in all sampling locations. However, Labuan Bajo Harbor had the most fiber type microplastics (10 particles/liter or 19% of total fiber), while Gili Banta only found one particle/liter (2% of total fiber).

![Figure 3](image)

**Figure 3.** The results of microplastic identification show that two types of microplastic: (a) fiber (green color), and (b) fragments (blue color)

![Figure 4](image)

**Figure 4.** The results of (a) microplastic and (b) percentage

During the observation, plastic factories were not found in the vicinity of the research site, so that microplastic pellets or films were not found. Meanwhile, the types of fragments and fiber indicate that the sampling location is purely a tourism and fishing area. The number of tourists visiting the beach with bad habits (little littering or buying or food/drinks in single-use plastic packaging) strongly supports the discovery of these microplastics. Furthermore, most studies have found the dominance of fibers and fragments in the coastal environment [22,23,24,25,26]. This is related to the source of plastic types of fiber and fragments that mostly come from fishing activities such as nets and fishing gear, domestic activities such as washing clothes waste, and tourism activities [26,27,28,29].

The figure 5 explains the distribution of microplastic regardless of its type in 12 sampling locations. Microplastics are more concentrated in Gili Banta (28 particles/liter or 29% of the total microplastic),
Labuan Bajo Harbor (16 particles/liter or 16% of the total microplastic), and Gili Trawangan (11 particles/liter or 11% of the total microplastic). The microparticles in the Labuan Bajo Port are estimated to come from loading and unloading activities at the port, which are disposed of intentionally or unintentionally, and the waste is degraded. On the other hand, Komodo National Park has the fewest microplastics (2 particles/liter or 2% of the total microplastic). For comparison, microplastic calculations using manta trawls in 5GyresExpedition2018 Final Report + Highlights [30] showed that 42 microplastics were collected from ocean surface waters in 14 different locations (the location was not explained).

Figure 5. The distribution of microplastic regardless of its type in 12 sampling locations

The concentration of microplastics on Gili Banta is thought to be due to a reasonably strong current (0.5-0.6 m s⁻¹) moving microplastics in the north of Nusa Tenggara into the Sape Strait (Gili Banta is located in the Sape Strait). The same thing also happened in Gili Trawangan. Therefore, the microplastic is thought to have come from areas north of Nusa Tenggara, which were carried away by the current and entered the Lombok Strait with a strong current velocity (± 0.5 m s⁻¹).

4. Conclusion
This study found that microplastics have polluted coastal waters on small islands in Nusa Tenggara. The microplastics found were dominated by the types of fragments and fibers. The high use of plastic as wrapping, fishing activities, and tourism are the reasons for microplastics in the research area. Microplastics were found to be higher in Gili Banta, Labuan Bajo, and Gili Trawangan. Furthermore, the dynamics of currents around the site play an essential role in discovering microplastic in small islands. Therefore, plastic waste management is necessary so that plastic pollution in the aquatic environment in small islands in Nusa Tenggara. The results of this study are expected to be used as educational materials for the surrounding community about the distribution of microplastics so that the biodiversity in Nusa Tenggara can be maintained and the contamination of microplastic waste will be minimized.

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