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Composition of Microplastic on Coastal Sediments at Kupang and Rote Islands, East Nusa Tenggara

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ABSTRACT

This research was conducted at the Kupang dan Rote Islands, East Nusa Tenggara in June until November 2018. The aim of this work was to obtain data on microplastics distribution that accumulates in coastal sediments in Kupang and Rote Islands. This research using wet peroxide oxidation method. Results showed that Ndana Beach had the lowest abundance of microplastic (5 particles/400gr) and Pasir Panjang had the highest microplastics abundance of 23 particles/400gr. The types of microplastics obtained in all stations were fragment and fiber. In addition, film was also found in two stations, Oenggae Beach and Pasir Panjang Beach. The microplastics obtained were in black, blue, yellow, red, green and white colors. Small size of microplastics was dominant in all stations.

Keywords: *Kupang, Rote Island, Microplastic, Coastal Sediments, Wet Peroxide Oxdation*

ABSTRAK

Penelitian ini dilakukan di Pulau Kupang dan Kepulauan Rote, Nusa Tenggara Timur pada bulan Juni hingga November 2018. Tujuan dari penelitian ini adalah untuk mendapatkan data tentang distribusi plastik mikro yang terakumulasi dalam sedimen pantai di Kupang dan Kepulauan Rote. Penelitian ini menggunakan metode *wet peroxide oxidation*. Hasil penelitian menunjukkan bahwa Pantai Ndana memiliki kelimpahan mikroplastik terendah (5 partikel / 400gr) dan Pasir Panjang memiliki kelimpahan mikroplastik tertinggi yaitu 23 partikel / 400gr. Jenis mikroplastik yang diperoleh di semua stasiun adalah fragmen dan serat. Selain itu, film juga ditemukan di dua stasiun, Pantai Oenggae dan Pantai Pasir Panjang. Mikroplastik yang diperoleh berwarna hitam, biru, kuning, merah, hijau dan putih. Mikroplastik ukuran kecil dominan di semua stasiun.

Kata kunci: Kupang, Pulau Rote, Mikroplastik, Sedimen Pesisir, wet peroxide oxidation

1. Introduction

Sawu Sea waters are one of the waters with coral reef biodiversity and are a high catchment migration location. These waters are influenced by Cross-Indonesian Flow originating from the Pacific Ocean and the Indian Ocean (Wyrtki, 1987) besides these waters there are core zones and utilization zones (Ministry of Maritime Affairs and Fisheries, 2009).

The coastal area is a very important area as a source of food, transportation and recreation that can improve the economy of a region. But coastal areas also have the potential to become sources of environmental pollutants in a water due to human activities. One of the causes of a decrease in the quality of a waters is caused by the presence of waste which is a microplastic origin due to human activities (Hetherington et al., 2005)

According to Dehaut et al., 2016, microplastic was first identified in the 1970s found in sediments even in microplastic fish.

Microplastic is divided into 2 types namely primary microplastic and secondary microplastic. Primary microplastic itself is a plastic that enters waters accidentally or due to negligence while secondary microplastic is a large plastic when entering the waters and degrades into micro-sized particles (Moore, 2008).

Microplastic can also accumulate in sediments, this is caused by oceanic physics processes such as tides, waves and currents and affects the process of microplastic accumulation in coastal sediments (Carlo, 2016).

This study aims to obtain composition data and microplastic distribution data on coastal sediments in Kupang and Rote Island, East Nusa Tenggara.

2. Materials and Method

2.1. Place and Time

This research was conducted from June to November 2018 in Kupang and Rote Island, East Nusa Tenggara. Sediment processing was carried out at the Marine Research Laboratory (MEAL) located in Building 3 of the Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor, Sumedang. The map of the research location in Kupang and Rote Island East Nusa Tenggara is shown in Figure 1.

The picture above is the location point for coastal sediment data collection to be carried out in Kupang and Rote Island, East Nusa Tenggara with in-situ data collection methods or direct data retrieval. Data collection was carried out at 8 location points by dividing 3 locations in Kupang and 5 other locations on Rote Island, East Nusa Tenggara.

2.2. Drying Sediments Sampling

The sediments that have been taken, then dried in the hot sun to dry. Then the sediment weight measurements were carried out using analytical scales.

2.3. Sieving Sediments

Sediments were sieved using a *shieve* shaker for ± 10 minutes so that the sediments were perfectly sieved with 7 mesh sizes namely 2.00 mm, 850 μm, 425 μm, 250 μm, 150 μm, 75 μm, 0 μm (Purnawan, 2012). The weight of the sediment is processed in *kummod* cells to determine the type of sediment.

2.4. Separation of Microplastics

WPO (Wet Peroxide Oxidation) method (Masura, J. et al. 2015) where the sediment is put into 1000 ml beaker glass then NaCl solution is added until there is a distance of about 3 - 5 centimeters above the sediment. After that, the upper part of the NaCl solution is transferred to another glass beaker without following the sediment, then a solution of Fe (II) of 20 ml is added and a solution of 30% H_2O_2 is 6 ml then heated ± 30 minutes after which it is left for 24 hours.

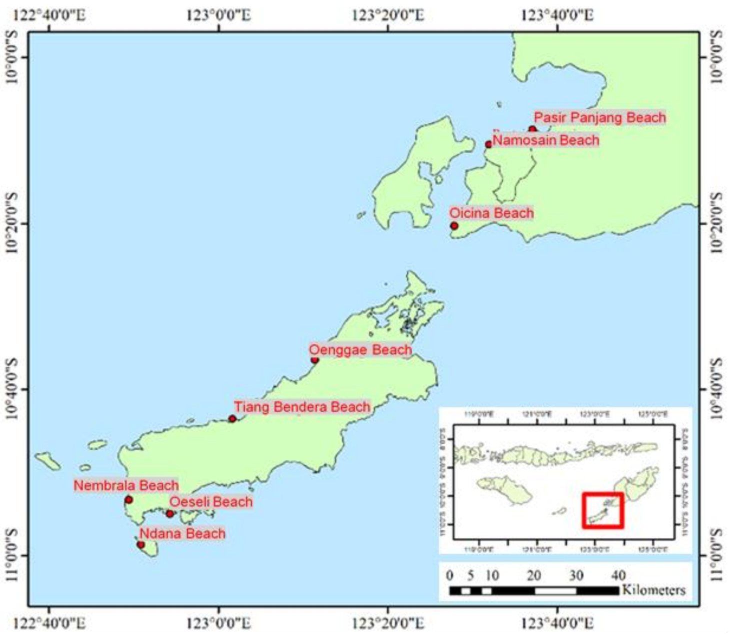


Figure 1. Coastal Sediment Data Collection Sites in Kupang and Rote Islands

2.5. Filtering

The sediment samples were then filtered using 0.47 nm filter paper so that the microplastic did not pass through the filter paper.

2.6. Microscope observation

Then filter paper was observed using a microscope to see the number and type of microplastic visually then using the ZEN application measured the size of each microplastic. The data obtained is processed using statistical data in Microsoft Excel and compared descriptively.

2.7. Parameters observed

Sediment type

Sediment test using granulometry using analysis of Wenworth grain size (Rifardi, 2008).

$$\%\ sediment\ weight = \frac{weight\ of\ faction}{weight\ of\ total\ samples} \times 100\ \%$$

Information:
Weight fraction is the weight of each mesh size on shieve shakers

Microplastics

The obtained microscopy is then described in the form of statistical diagrams using Excel software (Dewi, 2015).

$$\%\ Type, Color, and\ Size = \frac{Number\ of\ Particles}{Total\ Particles} \times 100\ \%$$

Current

The current data used is sourced from the Hybrid Coordinate Ocean Model (HYCOM), with the website address www.hycom.org. The data are data from May - June 2018, with a spatial resolution of 1/12 ° and monthly temporal resolution. The current data that has been downloaded consists of a description of the coordinates, as well as the components of the current u and v with a monthly temporal resolution May - June 2018. Data visualization is done using the Matlab R2013b software. In making a visualization of the current pattern, the current data that is downloaded is displayed using coastline data obtained from the GSSHS Coastline Database using the m_map toolbox.

3. Results and Discussion

3.1. Current

Current itself is a factor in the physical, biological and chemical processes that occur in the oceans (Latief, 2002). The aspects assessed only use the current movement pattern because the current velocity data in East Nusa Tenggara is still very limited. The following is a visualization map of current movement patterns in Kupang and Rote Island.

Based on the Figure 2, it can be seen that the current moves to the south due to the strong push from Arlindo (Indonesian Cross Flow), which is the mass of water moving from the Pacific Ocean to the Indian Ocean due to differences in sea level between the Pacific Ocean and Indian Ocean (Wyrtki, 1987).

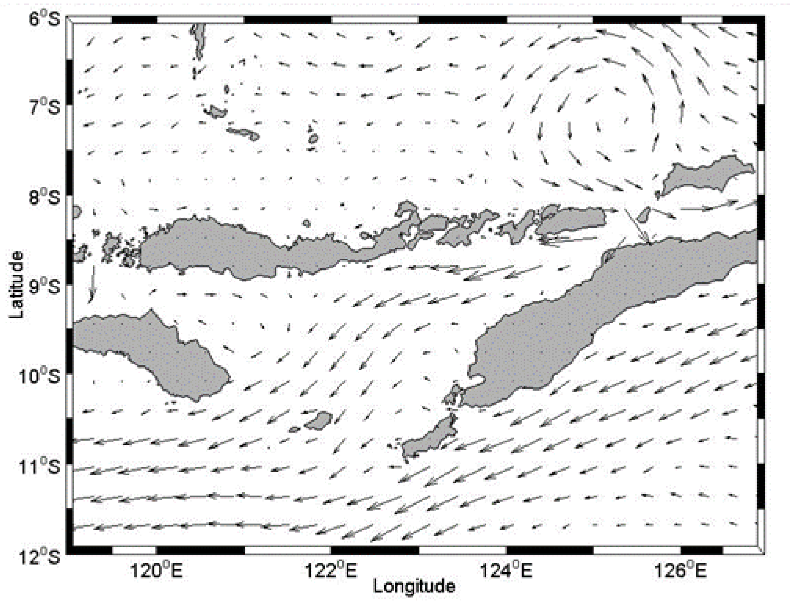


Figure 2. Visualization of Kupang Flow and Rote Island May - June 2018

3.2. Microplastics

Based on the sample processing that has been done and observations through a microscope, there are 3 types of microplastic found, namely fragments, fibers and films, but not found in microplastic pellet types (Figure 3). The following microplastic obtained during observation.

Based on the results of the research that has been carried out, it is found that the types of microplastic dominating in Kupang and Rote Island are fragments and fibers, whereas for films only found on Oenggae Beach and Pasir Panjang Beach because microplastic films have low density and are easily transported (Hastuti, 2014).

3.3. Microplastic abundance

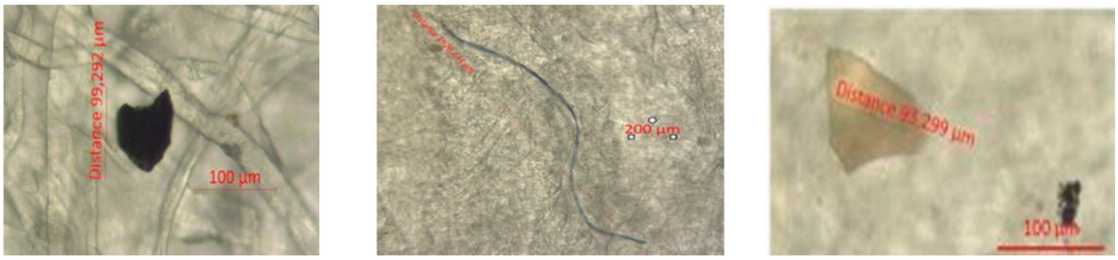
Based on the Table 1, the highest number of micropalstics is found at station-7, which is a long sand beach with 36 particles / kg because the long sand beach is the closest beach to Kupang and many hotels so that the activity of tourists and fishermen is high. The lowest abundance is in station-3 of Ndana island, which is as much as 5 particles/400gr because Ndana island is the southernmost island of Indonesia so it is uninhabited. The number of microplastic in a location depends on the activity and population density in that location (Browne et. Al., 2010).

3.4. Type of Microplastics

Microplastic found on the entire coast is dominated by fragments, fibers and films (Table 2). But the microplastic found on the entire coast is dominated by fragments, fibers and films. Oicina Beach is a beach directly adjacent to residential areas so that it can be assumed that with the highest fragment percentage of 93% compared to all beaches, this is influenced by activities around the coast this is supported by the statement of Cole et al. (2011) where plastic waste those in marine waters come from tourism activities, population activities and industrial activities.

Fragments can come from the degradation of food wrapping plastics and bottles originating from the type of waste that is often found around the coast which is degraded to very small. Beaches in Kupang and Rote are generally tourist beaches where microplastic fragments are thought to originate from products such as plastic bags, bottles and possibly derived from macroplastic fragments through physical and chemical processes, or heat and light aids that produce irregular fragments (Browne et al., 2010).

Oicina Beach is a beach directly adjacent to residential areas so that it can be assumed that with the highest fragment percentage of 93%, this is supported by the statement of Cole et al. (2011) where plastic waste in marine waters comes from tourism activities, population activities and industrial activities. Nembrala Beach is the largest beach with microplastic fiber presentations of 64%, fiber found on many beaches is because fiber is a type of microplastic originating from



(A) (B) (C)

Figure 3. Microplastics (A) Fragmen, (B) Fiber and (C) Film

Table 1. Abundance of Microplastics in Coastal Sediments

No	Station	Location	Lat	Lon	Abundance (particles/400gr)
1	Oenggae Beach	Rote	-10.60663	123.19001	17
2	Namosain Beach	Kupang	-10.17258	123.56126	18
3	Ndana Beach	Ndana	-10.97809	122.84745	5
4	Nembrala Beach	Rote	-10.88792	122.8234	15
5	Oicina Beach	Kupang	-10.33796	123.46457	21
6	Oseli Beach	Rote	-10.9162	122.90469	17
7	Pasir Panjang Beach	Kupang	-10.15122	123.60164	23
8	Tiang Bendera Beach	Rote	-10.72577	123.02805	20

Table 2. Percentage of Type of Microplastic in Each Station

No	Station	Percentage (%)		
		Fragment	Fiber	Film
1	Oenggae Beach	52	47	1
2	Namosain Beach	46	54	0
3	Ndana Beach	42	58	0
4	Nembrala Beach	36	64	0
5	Oicina Beach	93	7	0
6	Oseli Beach	43	57	0
7	Pasir Panjang Beach	65	30	4
8	Tiang Bendera Beach	51	49	0

fragmentation of fishing nets, ropes and synthetic fabrics.

3.5. Colour of Microplastics

The microplastics found in this work were generally in black and blue colors (Table 3). There were also other colors such as red, yellow, green and white. The black microplastics might be originally generated from garbage bags and plastic containers (GESAMP, 2015).

According to Hastuti (2014) said black microplastic is the result of fragmentation from macro waste plastic bags, blue microplastic itself generally comes from ship ropes or fishing nets while for yellow and green microplastic comes from clothes that are washed then the thread goes into the water. Based on microplastic observations in yellow and green, it was found on Oenggae, Namosain, Ndana, Nembrala, Pasir Panjang and Flagpoles while for white microplastic it was thought that they had undergone a photochemical process which caused the loss of color pigments in these microplastic.

Red mycroplastic itself is found in Oenggae, Namosain, Ndana, Nembrala, Oeseli and Flagpoles where red microplastic is generally produced from anthropogenic activities (Dekiff, 2014). Oicina Beach is the highest black beach, this can be caused by its location close to the mouth of the river so that household waste accumulates in the sediment of Oicina Beach. Whereas the highest percentage of blue microplastic is found on Flagpole Beach, this can be caused by quite dense activity on the beach.

3.6. Size of Microplastics

Microplastic itself is divided into 2 size categories namely large microplastic (1-5 mm) and small microplastic (<1 mm) (Storck, et al., 2015). According to Browne et., Al., (2011) the results of washing one garment can produce microplastic which will enter into the waters as many as 1900 small microplastic particles. In

Table 3. Percentage of Colour Microplastics at Each Station

No	Station	Percentage (%)					
		Black	Blue	Yellow	Red	Green	White
1	Oenggae Beach	50	35	8	7	0	1
2	Namosain Beach	59	30	3	7	0	1
3	Ndana Beach	33	33	25	8	0	0
4	Nembrala Beach	49	43	1	6	0	1
5	Oicina Beach	73	27	0	0	0	0
6	Oseli Beach	48	30	0	22	0	0
7	Pasir Panjang Beach	61	35	4	0	0	0
8	Tiang Bendera Beach	42	53	1	4	0	0

Table 4. Percentage of Size of Microscopes in Each Station

No	Station	Percentage (%)	
		Large (1-5 mm)	Small (<1 mm)
1	Oenggae Beach	17	83
2	Namosain Beach	25	75
3	Ndana Beach	42	58
4	Nembrala Beach	16	84
5	Oicina Beach	0	100
6	Oseli Beach	26	74
7	Pasir Panjang Beach	4	96
8	Tiang Bendera Beach	13	87

all stations it was found that small microplastic dominated more than large microplastic (Table 4). On one of the beaches, Oicina Beach, it was found that all small microplastics were not found with large microplastic matter. It is suspected that plastic waste has been damaged into smaller microplastic particles with the help of chemicals, waves, heat, sunlight and sea water density. (Barnes et al. 2009).

3.7. Microplastic Distribution

Microplastic distribution can not be separated from the influence of ocean currents and the characteristics of the region itself. Because generally microplastic carried by the current from one place to another due to its very light weight. Based on this, the following is a map of the distribution of micropalstic colors in coastal sediments in Kupang and Rote Island, East Nusa Tenggara (Figure 4).

The distribution of microplastic colors in coastal sediments in Kupang and Rote Island can be seen in Figure 4. It can be seen from the picture above that the Pasir Panjang and Namosain Beaches are two beaches that are adjacent and semi-cape shaped. This results in the possibility of similar microplastic colors on both beaches. It is seen that on both beaches there are microplastic black, blue and green. Based on the image of current movement it can be seen that the current in the area is not too strong, this can lead to microplastic sinks and eventually accumulate in coastal sediments. It is seen that on both beaches there are microplastic black, blue and green.

Whereas at Oicina Beach has a microplastic abundance of 21 particles / 400gr which is quite high where the beach is not included as a tourist beach. However, based on the character of the region and flow, this is supported because Oicinia Beach is close to the mouth of the river and the currents in these waters are quite calm. This results in microplastic originating from other regions likely to sink and accumulate in the coastal sediments, this is also supported by the microplastic size found which is small and not large-sized microplastic.

Furthermore, microplastic compositions on the Flagpole Beach and Oenggae Beach are not much different because the two beaches have parallel coastlines. It can be seen from the microplastic colors on both beaches that the same color is black, blue, yellow and red. In addition, the microplastic size on the two beaches is the same - the majority are small. This is possible because the currents originating from the Flagpole Beach move towards Oenggae Beach and carry microplastic which eventually accumulates on the coastal sediments.

Nembrala Beach itself has a microplastic colour composition that is almost the same as Flagpole Beach and Oenggae Beach where colors are found black, blue, yellow, red and white. This is possible due to strong currents from north to south which result in microplastic accumulation. But for the type that dominates

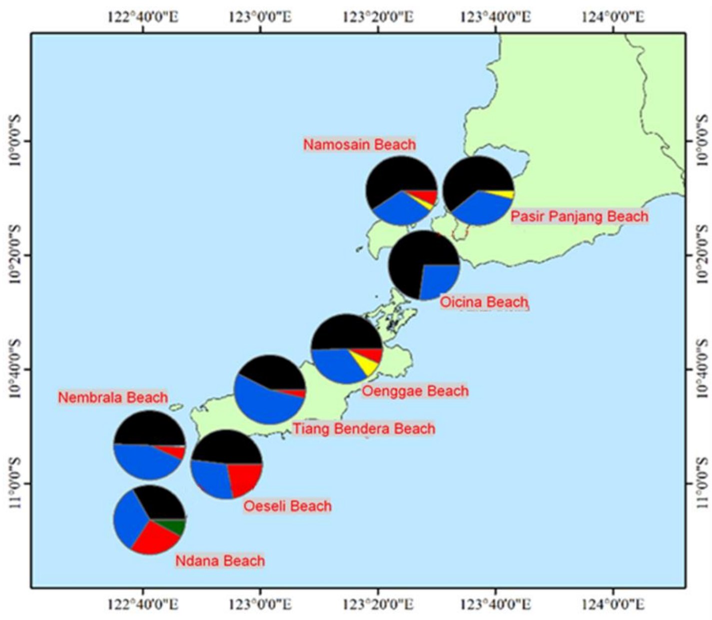


Figure 4. Distribution of Microplastics Based on Colors Microplastics in Coastal Sediments in Kupang and Rote Islands

is fiber, this is because the beach is used as a place for ships to use for surfing.

Oeseli Beach and Ndana Beach are quite close beaches. The microplastic found on Ndana Beach probably originated from another place carried by the currents around the coast because Ndana Island is an uninhabited island. It is supported that the most common type is fiber and for almost the same color composition, black, blue and red, but on the Beach of Ndana microplastic is found in green, the green color probably comes from other places that accumulate in coastal sediments. Microplastic on both beaches are also generally small because they have been destroyed by ocean currents.

4. Conclusion

Microplastic abundance accumulated in coastal sediments found that the lowest abundance on Ndana Beach was 5 particles / 400gr and the highest was at Pasir Panjang Beach at 23 particles / 400gr. The types of microplastic found in Kupang beach and Rote Island sediments are fragments, fibers and films. The fragment type is dominant in Oicina Beach, the dominant fiber on Nembrala Beach while the type of film itself is only found on Oenggae Beach and Pasir Panjang Beach. The color of microscopes found on all beaches is black, blue, red, yellow, green and white. While the dominant microplastic size is small at all locations. Based on the microplastic distribution map, it was concluded that the current affected the microplastic distribution. This is shown on the coast that is quite close together has the same micropastic color.

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