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ANALYSIS OF MICROPLASTIC ABUNDANCE IN SEAWATER ON THE NORTH GALESONG COAST OF TAKALAR REGENCY

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Abstract

North Galesong District, Takalar Regency, is located in the coastal area and is one of the contributors to plastic waste that will become microplastics. This study aims to analyze the abundance of microplastics in seawater on the North Galesong Coast of Takalar Regency. Water sampling was carried out at high tide and low tide using a dynamic method with a Neuston net. The results showed that the total average abundance of microplastics in seawater was 157.39+1.88 particles/m^3. Microplastic abundance is dominated by market areas (fish auctions), but is lowest in less populated residential areas. Microplastic abundance tends to increase in areas near the coast rather than deeper into the sea, and abundance increases in high tide conditions rather than low tide conditions. Based on this, an effort is needed to reduce and handle plastic waste to reduce pollution in seawater in North Galesong, Takalar Regency.

Keywords: Microplastics, Abundance, Tides, Seawater

1. INTRODUCTION

Every business and/or activity carried out by humans certainly produces waste that can endanger the environment if not managed properly, one of which is plastic waste, which can change size into microplastics through the weathering process due to sun exposure (Harpah et al., 2020), friction and flow speed. Nonbiodegradable plastics are among the most common types of waste found in the surrounding environment due to human activities (Rocha-Santos, 2014). This is due to the nature of plastic, which is lightweight and durable, and the fact that the price is quite cheap, so it has an important role in people's lives today (Joesidiawati, 2018).

Microplastics are sourced from the degradation and fragmentation of plastic waste measuring under 5 mm (Stanton et.al, 2019). Its small size and abundant amount make microplastics a polluter that can cause damage to seawater ecosystems with different impacts (Hiwari et al., 2019). Plastic waste deposited on the beach, including those that have been fragmented into microplastics, then enters marine waters through currents, waves, tides, or coastal erosion (Joesidawati, 2018). Generally, the types of microplastics in the ocean are polyethylene terephthalate (57.26%), polyethylene (13.52%), and polypropylene (11.24%), with a size of 2.5 mm and in the form of pellets, films, foam (Veerasingam, 2020), and fibers derived from fishermen's activities such as trawls, nets, and ropes. The large number of types of microplastics in the ocean is because the plastic is quite cheap, so it is widely used as food packaging both on an industrial scale and produced by a consumer (Jualaong, 2021).

The presence of microplastics in marine waters has been documented by several researchers, particularly in the southwest sea waters of Sumatra, Indonesia. The presence of microplastics reported by Cordova (2016) shows that microplastics were found in 8 areas out of 10 sediment sampling sites. Microplastics are more prevalent in areas of varying depths with concentrations of 0-14 particles/100 cm^3 of sediment. Microplastics were also found in 4 out of 10 digestive tracts of Silverside fish (Stolephorusheterolobus) in the form of transparent and blue colored fragments collected at Paotere Fish Market, Makassar (Tahir & Rochman, 2014).

Thus, the problem of fragmented waste degrading into microplastics in marine waters due to garbage disposal carried out on the North Galesong beach of Takalar Regency through various human activities ranging from settlements, industry, tourism, and markets (fish auctions) can threaten the survival of marine life and also have an impact on human health. In this study, we present data on the abundance of microplastics in seawater on the North Galesong coast of Takalar Regency at tidal and low tide conditions.

2. METHODOLOGY

A. Study Area

This research was carried out on the coast of North Galesong, Takalar Regency, on October 8, 15, and 22, 2022, respectively, at high tide and low tide conditions, consisting of 5 stations and 2 sampling points from the coast, including Station 1, a densely populated area located in Aeng Batu-Batu Village; Station 2, an industrial area located in Taman Pandanga Village, Aeng Batu-Batu Village; Station 3, a tourist area located in Sampulungan Beru Village of Sampulungan Village; Station 4 is an underpopulated residential area located in Bontolebang Village; and Station 5, a market area (fish auction place) located in Beba Hamlet of Tamaju Village. The location of the study is shown in Figure 1 below.

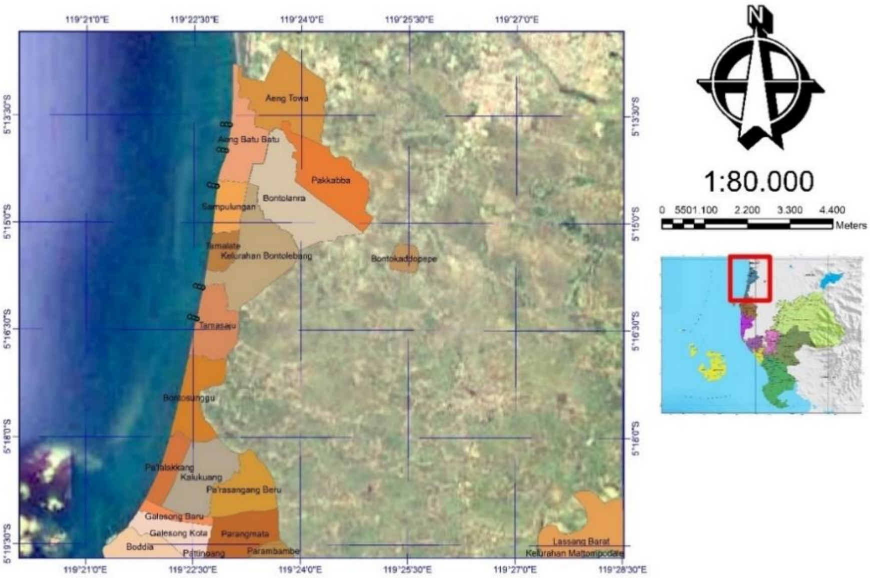

Figure 1: Sampling Location

B. Material and Sampling Approach

Sampling was carried out using a dynamic method by pulling a Neustson net tool with dimensions (0.75x0.75x1 m) with a mesh opening of 300 μm at each research station, namely at a distance of 0-100 m (point A) and a distance of 100-200 m (point B) at the high tide and low tide conditions of each coast with variations in triplo repeats every week. Seawater samples as much as 300 ml at the cod-end are stored into glass bottles and then preserved in cool boxes at 4°C.

Identification of microplastic abundance was carried out ex-situ at the Water Quality Laboratory, Department of Environmental Engineering, Faculty of Engineering, Hasanuddin University, Gowa which is guided by the Guidelines for Harmonizing Ocean Surface Microplastic Monitoring Methods (Michida et al., 2020), National Oceanic and Atmospheric Administration (NOAA) (Masura et al., 2015), Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean (GESAMP, 2019), and Microplastics in Waters (Yona et al., 2021), with several stages including wet sieving of micro and macro-sized particles using a 5 mm and 0.300 mm mess stratified stainless steel filter (Masura et al., 2015; Michida et al., 2020). The solids collected in a 0.300 mm sieve are put into a 100 mL beaker glass covered with aluminum foil and oven-roasted at 90°C for 24 hours. Then the Wet Peroxide Oxidation (WPO) stage is carried out to destroy organic material through the addition to the beaker glass as much as 20 mL of 0.05 M Fe (II) solution and 20 mL of 30% H_2O_2 solution, then heated on a hotplate at 75°C. Then, 6 gr of NaCl (5 M) per 20 mL was heated at 75°C until the salt dissolves for approximately 24 hours (GESAMP, 2019).

The addition of NaCl aims to increase the density of the solution so that it can be separated between microplastic particles and organic deposits. The sample was then transferred to Whatman GF/C Glass Filter paper (diameter 47 mm and pore size 1.2 μm) and observed in abundance using Binocular XSZ 107 BN microscope. The identification of microplastic abundance by formula (Masura et al., 2015) is as follows:

$$\text{Abundance} = \frac{\text{microplastic (particles)}}{\text{volume of filtered water } (\text{m}^3)}$$

While the volume of filtered water is calculated by the formula (Kapo et al., 2020) as follows:

$$V = p \times l \times a$$

Where:

V = Volume-filtered water (28.13 m^3)

p = Length of net opening (0.75 m)

l = 1/2 net mouth width (1/2 x 0.75 m = 0.375 m)

a = Water sampling distance (100 m)

3. RESULTS AND DISCUSSION

The results of identifying the abundance of microplastics through a microscope, namely the entire research station, were positive for microplastic contamination. The highest level of microplastic pollution is at station 5, which is a market area or fish auction place with a net withdrawal distance of 0-100 m from the sea coast, while the lowest level of microplastic pollution is at station 4, which is an underpopulated area with a Neuston net distance100-200 m from the sea coast. The average and percentage of microplastic abundance in seawater in North Galesong sub-district in terms of particles per m^3 can be seen in Table 1 below.

Table 1: Abundance of Microplastics in Seawater

Sampling Point	Average Abundance of Microplastics in Seawater (Particle/m^3)					
	High Tide+SE		Low Tide+SE		Total	
STA 1A	28,55+1,06	21,87+3,05	17,28+0,22	15,07+1,04	45,83+5,64	36,94+3,40
STA 1B	15,18+0,76		12,86+0,68		28,04+1,16	
STA 2A	24,97+0,94	19,21+2,61	11,95+1,19	10,80+0,94	36,92+6,51	30,01+4,21
STA 2B	13,45+0,17		9,65+1,29		23,10+1,90	
STA 3A	21,72+0,39	17,45+1,92	11,60+1,20	10,05+0,97	33,33+5,06	27,50+3,70
STA 3B	13,17+0,17		8,50+0,91		21,67+2,33	
STA 4A	12,79+0,23	10,51+1,03	9,88+1,03	8,55+0,86	22,67+1,45	19,06+0,98
STA 4B	8,23+0,10		7,22+0,94		15,44+0,50	
STA 5A	36,02+2,82	27,06+4,28	20,63+1,39	16,84+1,84	56,65+7,69	43,89+5,11
STA 5B	18,10+1,81		13,04+0,74		31,13+2,53	
Total	**192,18+1,54**	**96,09+1,54**	**122,61+0,76**	**61,30+0,76**	**314,79+1,66**	**157,39+1,88**

Source: Calculation result (2022)

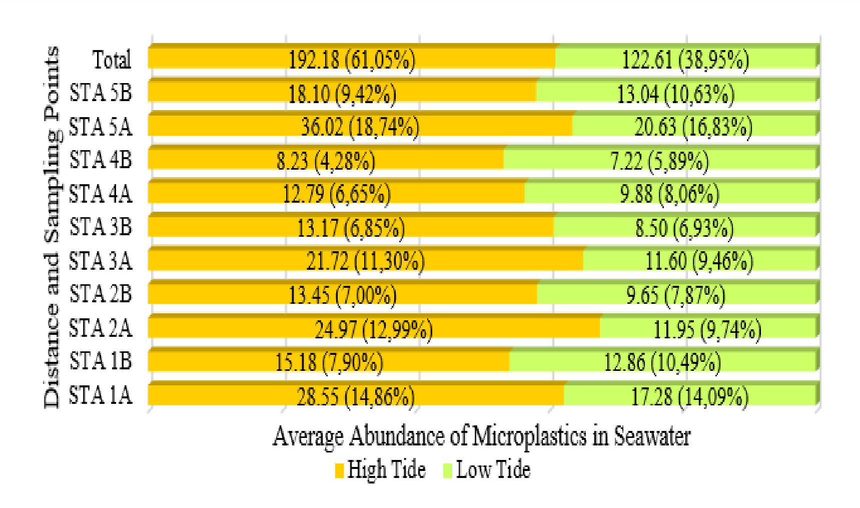

Figure 2: Graph of the Percentage Abundance of Microplastics in Seawater at High and Low Tide Conditions

Source: Processing results (2022)

Table 1 and Figure 2 show that station 5 (the market area or fish auction) is the sampling location with the highest total abundance of microplastics. The total average microplastic was 43.89+5.11 particles/m^3, while the average total abundance of microplastics was the least at station 4 (less populated residential area), at 19.06+0.98 particles/m^3. However, based on the sampling point, namely at point A (distance 0-100 m from the coast) and point B (distance 100-200 m from the coast), the most abundant microplastics were found at station 5A (market area or fish auction) at high tide conditions with a total average abundance of microplastics of 36.02+2.82 particles/m^3, or equivalent to 18.74% and station 4B (less populated area) at low tide was a sampling location with the least abundance of microplastics at 7.22+0.94 particles/m^3, or equivalently, 5.89% microplastics.

The high total abundance of microplastics in seawater at Station 5 is due to the location being a fish auction site. At the station, various activities were also carried out, namely as a place for sales of marine products and a place for fishing boats to rest, so that with several activities at station 5 and based on field studies, a lot of plastic waste was found scattered, and some fishing boat equipment had the potential to be plastic waste, such as ropes, fishing gear and nets, so that it was very possible for the degradation process or fragmentation of plastic into microplastics. Not only that, the estuary of the Campagaya river south of Station 5 also causes a lot of plastic waste carried by water flows from the river body to sea waters, which allows a total increase in microplastics at the station. This is in accordance with Kapo's statement (2020) which states that fish market areas and river estuaries can contribute to the entry of microplastics due to run-off into sea waters. While the least amount of microplastics is found at station 4, which is an underpopulated residential area that is not directly adjacent to the waters, this is because at the station, although there are domestic activities, there is agricultural land and vegetation that are barriers to the distribution of microplastics to the waters.

The presence of microplastics in several other stations, also caused by various activities, namely domestic activities from household waste, shops or stalls, and located south of the runoff of the Jeneberang river estuary (Makassar City), found as much as 36.94+3.40 particles/m^3 of microplastics at Station 1, effluent runoff WWTP that flows to the sea coast, operational processes and packaging/packaging of flying fish eggs that are thrown on the beach and carried by tidal currents to the sea, fishing boat activities that fill fuel, and several household activities, obtained as many as 30.01+4.21 particles/m^3 of microplastics at Station 2, due to the activities of visitors, hotels, baths, restaurants that throw domestic waste directly to the beach, and outlet runoff from WWTP, 27.50+0.98 particles/m^3 of microplastics were obtained at Station 3. The total average abundance of microplastics in seawater is 157.39+1.88 particles/m^3. Tidal conditions are also very supportive of the amount of microplastics at Station 5A. This is because the sea level rises above normal, so plastic waste on land is carried into seawater. This is also supported by Andrady's (2011) research, which states that land-based microplastics are a substantial source of microplastics, so they can cause a lot of microplastics at point A (distance 0-100 m) compared to point B (distance 100-200 m). Sadri & Thompson (2014) also stated that more microplastics were found in Muara Tamar, southwest England, at high tide conditions than at low tide due to the influence of turbulent mixing, where tidal conditions greatly affect the residence time and transport of floating objects in the waters.

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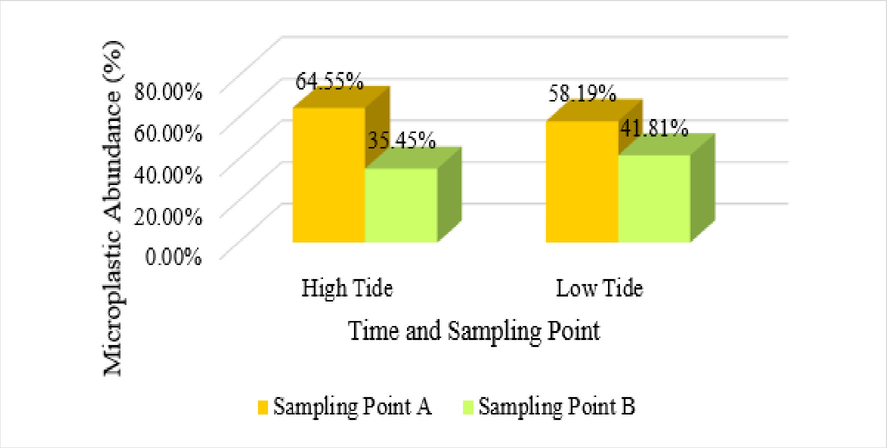

Figure 3: Graph of the Percentage of Microplastic Abundance in Seawater at Tide and Low Tide Conditions at Points A and B

Source: Processing results (2022)

Wilson et al. (2021) also stated that tides are a secondary factor affecting the abundance of microplastics on the shores of the Bristol Strait, England. In addition, the distribution and abundance of microplastics in sediments in the Persian Gulf, Iran, at high tide is higher than at low tide (Naji, Esmaili, Mason, et al., 2017). Thus, the percentage of seawater microplastic abundance at tidal and low tide conditions at points A and B of the five study stations can be seen in Figure 3.

Figure 3 shows that based on the distance of seawater to the coast, the closer the seawater is from the coast, the higher the percentage of microplastics in marine waters, and the farther the seawater is from the coast, the percentage of microplastics in marine waters is also lower. This also applies at high tide and low tide times. At point A, the abundance of microplastics at high tide is greater than at low tide, but at point B, the abundance of microplastics at low tide is higher than at high tide. This is because there is more waste on the surface of the coastline due to various activities such as fishing, damaged old ships, and various other activities that can cause microplastics (Aliabad et al, 2019). Panida Prarat and Hongsawat (2022) stated that the contributing factors to microplastics are waste disposal from residential activities, industry, hotels, restaurants, fisheries, beachgoers, and other marine activities. The highest percentage of microplastic abundance was at high tide with a Neuston net withdrawal distance (point A, distance 0-100 m from the coast) of as much as 64.55%, while the least percentage of microplastic abundance was at high tide with a Neuston net withdrawal distance (point B, distance 100-200 m from the coast) of as much as 34.45%. So it can be concluded that the abundance of microplastics tends to increase in areas near the coast rather than deeper into the sea, and abundance increases in tidal conditions rather than low tide conditions. Tidal currents are the main drivers that can affect the dispersion, transportation, and landing of microplastics in coastal and nearshore waters (Forsberg et al, 2020) and also due to tidal currents (Kim et al, 2015).

4. CONCLUSIONS

This study explained that the abundance of microplastics varied at each research station on the North Galesong Coast of Takalar Regency. The total average abundance of microplastics in seawater is 157.39+1.88 particles/m^3. The abundance of microplastics is dominated by market areas (fish auctions), but the lowest is in sparsely populated residential areas The abundance of microplastic tends to increase in areas near the coast compared to areas deeper into the sea, and the abundance increases during high tide conditions rather than low tide conditions. Based on this, an effort is needed to reduce and handle plastic waste to reduce pollution in sea water in North Galesong, Takalar Regency.

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Declaration of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Aliabad, M. K., Nassiri, M., & Kor, K. (2019). Microplastics in the surface seawaters of Chabahar Bay, Gulf of Oman (Makran Coasts). Marine Pollution Bulletin, 143(November 2018), 125–133. https://doi.org/10.1016/j.marpolbul.2019.04.037
2. Andrady, A. L. (2011). Microplastics in the marine environment. Marine Pollution Bulletin, 62(8), 1596–1605. https://doi.org/10.1016/j.marpolbul.2011.05.030
3. Cordova, M. R., & Wahyudi, A. J. (2016). Microplastic in the deep-sea sediment of Southwestern Sumatran Waters. Marine Research in Indonesia, 41(1), 27. https://doi.org/10.14203/mri.v41i1.99
4. Forsberg, P. L., Sous, D., Stocchino, A., & Chemin, R. (2020). Behaviour of Plastic Litter in Nearshore Waters: First Insights from Wind and Wave Laboratory Experiments. Marine Pollution Bulletin, 153(October 2019), 111023. https://doi.org/10.1016/j.marpolbul.2020.111023
5. GESAMP. (2019). Guidelines for the monitoring and assessment of plastic Litter in the Ocean. In Rep. Stud. GESAMP (Vol. 99). http://www.gesamp.org/publications/guidelines-for-the-monitoring-and-assessment-of-plastic-litter-in-the-ocean
6. H. Hiwari, N. P. Purba, Y. N. Ihsan, L. P. S. Yuliadi, and P. G. Mulyani. (2019). Condition of microplastic garbage in sea surface water at around Kupang and Rote, East Nusa Tenggara Province. vol. 5, pp. 165–171. doi: 10.13057/psnmbi/m050204
7. Joesidawati, M. I. (2018). Microplastic pollution along the coast of Tuban Regency. Proceedings of the National Seminar on Research Results and Community Service III, September, 7–15
8. Jualaong S., Pransilpa M., Pradit Siriporn., Towata P. 2021. Type and distribution of microplastics in beach sediment along the coast of the Eastern Gulf of Thailand. Journal of Marine Science and Engineering. 1-10. https.//doi.org/10.3390/jmse9121405
9. Kapo, F. A., Toruan, L. N. L., & Paulus, C. A. (2020). The types and abundance of microplastics in surface water at Kupang Bay. Papadak Maritime Journal, 1(1), 10–21.

10. Kim, I. S., Chae, D. H., Kim, S. K., Choi, S. B., & Woo, S. B. (2015). Factors Influencing the Spatial Variation of Microplastics on High-Tidal Coastal Beaches in Korea. Archives of Environmental Contamination and Toxicology, 69(3). https://doi.org/10.1007/s00244-015-0155-6

11. Masura, J., Baker, J., Foster, G., & Arthur, C. (2015). Laboratory methods for the analysis of microplastics in the marine environment: Recommendations for quantifying synthetic particles in waters and sediments (Issue July).

12. Michida, Y., Chavanich, S., Chiba, S., Cordova, M. R., Cozsar Cabanas, A., Glagani, F., Hagmann, P., Hinata, H., Isobe, A., Kershaw, P., Kozlovskii, N., Li, D., Lusher, A. L., Marti, E., Mason, S. A., Mu, J., Saito, H., Shim, W. J., Syakti, A. D., … Wang, J. (2020). Guidelines for harmonizing ocean surface microplastic monitoring methods. In Ministry of the Environment Japan (Issue June). https://repository.oceanbestpractices.org/handle/11329/1361

13. N. Harpah, I. Suryati, R. Leonardo, A. Risky, P. Ageng, and R. Addauwiyah. (2020). Analysis of types, forms and abundance of microplastics in the Sei Sikambing River, Medan. J. Sci. Technol. J. Sci. Ind. Technol. Appl. vol. 20, no. 2, p. 108. doi: 10.36275/stsp.v20i2.270

14. Naji, A., Esmaili, Z., Mason, S. A., & Dick Vethaak, A. (2017). The occurrence of microplastic contamination in littoral sediments of the Persian Gulf, Iran. Environmental Science and Pollution Research, 24(25), 20459–20468. https://doi.org/10.1007/s11356-017-9587-z

15. Prarat, P., & Hongsawat, P. (2022). Microplastic pollution in surface seawater and beach sand from the shore of Rayong Province, Thailand: Distribution, characterization, and ecological risk assessment. Marine Pollution Bulletin, 174(December 2021), 113200. https://doi.org/10.1016/j.marpolbul.2021.113200

16. Rocha-Santos, T., & Duarte, A. C. (2014). A critical overview of the analytical approaches to the occurrence, the fate and the behavior of microplastics in the environment trends in analytical chemistry, 65(December), 47-53. Https://Doi.Org/10.1016/J.Trac.2014.10.011

17. Sadri, S. S., & Thompson, R. C. (2014). On the quantity and composition of floating plastic debris entering and leaving the Tamar Estuary, Southwest England. Marine Pollution Bulletin, 81(1), 55–60. https://doi.org/10.1016/j.marpolbul.2014.02.020

18. Stanton, T., Johnson, M., Nathanail, P., Gomes, R. L., Needham, T., & Burson, A. (2019). Exploring the efficacy of nile red in microplastic quantification: A costaining approach. Environmental Science and Technology, 6. Https://Doi.Org/10.1021/Acs.Estlett.9b00499

19. Tahir, A., & Rochman, C. M. (2014). Plastic particles in silverside (stolephorusheterolobus) collected at Paotere Fish Market, Makassar. International Journal of Agriculture System (IJAS), 2(2), 163–168. https://doi.org/http://dx.doi.org/10.20956/ijas.v2i2.32

20. Wilson, D. R., Godley, B. J., Haggar, G. L., Santillo, D., & Sheen, K. L. (2021). The Influence of depositional environment on the abundance of microplastic pollution on beaches in the Bristol Channel, UK. Marine Pollution Bulletin, 164. https://doi.org/10.1016/j.marpolbul.2021.111997

21. Yona, D., Zahran, M. F., Fuad, M. A. Z., Prananto, Y. P., & Harlyan, L. I. (2021). Microplastics in Water.