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Preliminary study on microplastic pollution in water and sediment at the Beaches of Pariaman City, West Sumatra, Indonesia

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Abstract. Advances in science and technology as well as population growth have increased the discharge of microplastics (MPs) into the marine environment, including the waters off the west coast of Sumatra in Pariaman City, West Sumatra, Indonesia. Therefore, this study aims to determine the abundance of MPs and to identify the form as well as types of polymers in seawater and sediment from the coastal waters of Kota Pariaman. Samples were taken from 8 points at the sampling locations on Gandoriah and Cermin beaches. Seawater and sediment samples were extracted to obtain MPs which were then identified based on morphology (shape) and numbered according to their abundance. Additionally, MPs polymer was determined using Fourier Transform Infra-Red (FTIR). The results showed that the number of MPs was 1.140 particles in the water sample and 1.379 in the sediment. The average abundance in surface water ranged from 6.62 – 15.86 particles m^{-3} while in the sediment, it was 10,825 – 17,675 particles kg^{-1}. The most dominant form of MPs in surface water were fragments at 58.37% > film, 36.34% > fiber, 5.29% and for sediment, the order was fragment 58.59% > film, 38.27% > fiber, 3.14%. MPs in the Pariaman coastal waters were dominated by the size of 101-300 µm at 49.53%, while the size < 100 µm was the lowest percentage of 0.44 %. Furthermore, the percentage of MPs categories measuring 301– 500 µm, 501– 1,000 µm and >1,000 µm were 26.76, 19.72 and 3.55%, respectively. The types of polymers detected in the samples were polyethylene, polyamide, polyvinyl chloride, polyurethane, and polytetrafluoroethylene indicating that various types of microplastics can pollute the aquatic environment. These results provide useful information on which parts of the coastal waters of Kota Pariaman should be prioritized in terms of MPs management.

Key Words: Gandoriah and Cermin beaches, FTIR, water and sediment sample.

Introduction. Marine debris pollutes the ocean from the water column to the seabed (Eriksen et al 2014; Galafassi et al 2019) which is detrimental to marine ecosystems (López-López et al 2018; Taylor et al 2016) and the economy (Lee & Sanders 2015; Watkins et al 2015). Currently, about 7,000–250,000 tons of plastic waste is in the world's oceans (Cózar et al 2014; Galafassi et al 2019), and 80% comes from human activities on land. Plastic waste from coastal areas varies widely, depending on the population, the amount of waste generated, and unmanaged waste (Jambeck et al 2015), as well as the rivers that carry waste into the sea (Jang et al 2014; Lebreton et al 2018). They can be categorized into several sizes, namely mega plastic > 50 cm, macroplastic 5 – 50 cm, mesoplastic 0.5 – 5 cm, microplastic 0.0001–0.5 cm (Cordova et al 2019; Lebreton et al 2018; van Emmerik et al 2018), and nano plastics 1–1,000 nm (Gigault et al 2018; Ter Halle et al 2017). The presence of microplastics (MPs) in water and sediment stems from the release of materials containing plastic by humans.

MPs of various types and abundances are scattered and found in the water column and sediments. Several studies have reported MPs pollution in marine waters in Indonesia, such as in Muara Jeneberang, South Sulawesi (Wicaksono et al 2023), coastal areas of Nusa Penida, Bali, Jakarta Bay (Takarina et al 2022) and the waters of Bentar, East Java (Germanov et al 2019), the estuary of Benoa Bay, Bali (Suteja et al 2021), and the Musi River, South Sumatra (Purwiyanto et al 2020). The presence of MPs in sediments has also been reported on the west coast of Sumatra (Cordova & Wahyudi 2016), Banten Bay (Falahudin et al 2020), Jakarta Bay (Takarina et al 2022) and Muara Angke, Jakarta (Cordova et al 2021).

Furthermore, humans play an essential role as the subject of pollution and the object that bears the consequences. When pollution prevention is neglected, the impact will be more significant, disrupting the sustainability of development. One of the goals of UN Sustainable Development Goals (SDGs) is SDGs no. 14 which states to conserve and utilize marine and maritime resources for sustainable development (Hidalgo-Ruz et al 2012).

West Sumatra is one of the provinces in Indonesia that has potential for tourist destinations, ranging from beaches, lakes, as well as cultural and historical centers. Currently, water quality parameters in the beach of Pariaman City have decreased due to plastic waste originating from households, industries, rivers, and tourists.

Pariaman City is one of the coastal areas that have complex activities, ranging from marine tourism to fisheries, and residential areas. This contributes significantly to marine debris pollution and is exacerbated by several rivers that empty into the sea. MPs potentially pose a more severe threat to organisms because they are easier to swallow than macroplastics (Van Cauwenberghe et al 2015).

The existence of plastic waste and the size of MPs are hazardous for fish and human health. Furthermore, the absence of basic information about plastic waste in the marine waters of Pariaman City is one of the obstacles to managing the potential of fisheries and tourism in a sustainable and environmentally friendly manner. Consequently, this study focused on MPs detection in water and sediment. The plastic waste produced will undergo a polymer oxidative degradation process in the environment due to exposure to ultraviolet radiation, other mechanical influences such as wind, waves, and biota bites, as well as anthropogenic activities that can destroy plastic into smaller forms (Van Cauwenberghe et al 2013). Gandoriah and Cermin beaches were selected as the study area because they have a high level of plastic waste pollution being close to the city, making them prone to contamination by waste from activities on land and sea.

Material and Method

Description of the study site. Pariaman City is one of the coastal areas in West Sumatra Province with a beach length of 12.7 km and a sea area of 282.69 km^2. It has long and beautiful sloping beaches with great tourism potential, focusing on fixing and developing the marine tourism sector. As of 2021, there are 26 tourist sites, 5 in the south, 12 in the central region, 3 in the east, and 6 in the north of Pariaman. The number of domestic tourists that visited the city in 2021 was 255,551. Meanwhile, there were no foreign tourists due to lockdown regulations from other countries in the last 3 years, but in 2020 there were 90 foreign tourists (Badan Pusat Statistik 2022).

In particular, Gandoriah and Cermin beaches with an area of 6.5 ha and 9 ha, per day, respectively, produce organic and inorganic wastes of 1.21 and 0.13 (m^3 day^{-1}) with an average number of visitors per year reaching 220,000 and 23,100 people (Rahmi & Azhari 2019).

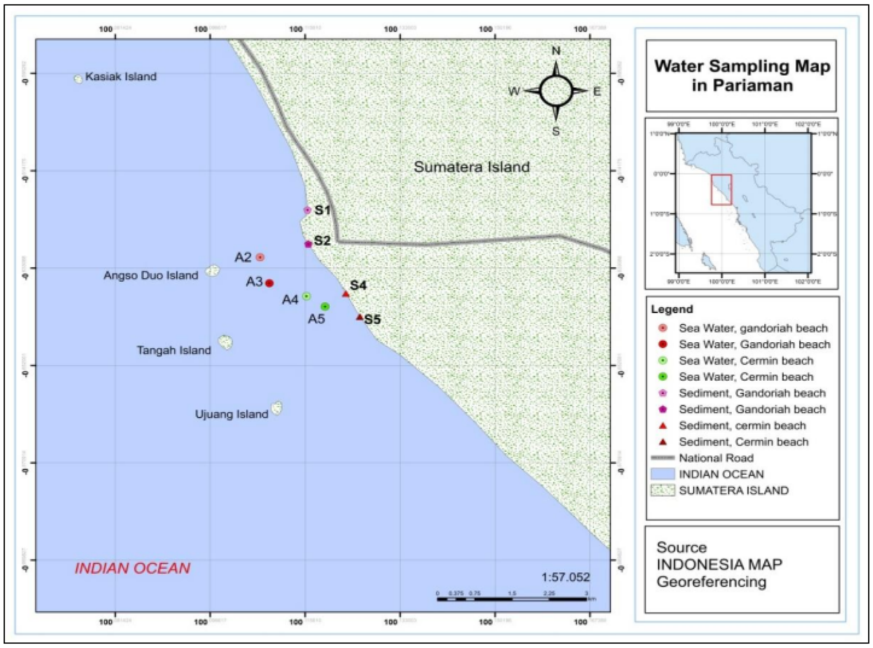

Figure 1. Map of seawater and sediment sampling locations at Pariaman Beach (map source: Indonesia Geospatial Portal 2022).

Sampling of seawater and sediment. Sampling locations on the beach of Gandoriah and Cermin are shown in Table 1 and depicted in Figure 1.

Table 1

Sampling locations at Gandariah and Cermin beaches

Sampling location	*Coordinates*
ST 1 (sea water, Gandariah beach)	
A2	100°6'27,601"E; 0°37'51,528"S
A3	100°6'33,652"E; 0°38'9,682"S
ST 2 (sea water, Cermin beach)	
A4	100°6'57,857"E; 0°38'18,759"S
A5	100°7'9,959"E; 0°38'26,02"S
ST 3 (sediment, Gandariah beach)	
S1	100°6'58,594"E; 0°37'18,275"S
S2	100°6'59,091"E; 0°37'42,202"S
ST 4 (sediment, Cermin beach)	
S4	100°7'23,532"E; 0°38'16,724"S
S5	100°7'32,638"E; 0°38'32,961"S

Seawater and sediment sampling activities were carried out in March 2022, covering 8 sampling point locations, 4 each for water and sediment. The seawater sampling began with placing a plankton net of 200 m in size on the side of the ship with a distance of 1 – 2 m to avoid the turbulence caused by water friction with the ship. Plankton nets were pulled horizontally to collect MPs samples on the surface of the water (Kovač Viršek et al 2016; Nugroho et al 2018) and transferred to a glass jar. Sediment samples were taken using a stainless steel Van Veen Grab sampler with a width of 15 – 30 cm. Furthermore, the 600 – 880 grams surface sediment 0 – 10 cm in size were collected and placed into a high-density polyethylene bottle. During field activities and transportation, samples were stored in an ice box.

MPs extraction. The MPs were extracted from seawater samples based on a modified method by Suteja et al 2021. For the seawater sample, organic impurities were removed by the destruction of the material. This was carried out by adding 3 – 5 mL of hydrogen peroxide (H_2O) 30% to the baker glass and heating at 60°C for 24 – 48 h in the water bath. Afterwards, the samples were transferred to sterile filter paper specifically Whatman cellulose nitrate, pore size of 0.45 µm, and diameters 47 mm using the vacuum method, followed by drying in an oven for 24 h at 60°C. The filtrates on the 0.45 µm membrane filter media were identified for their size, shape, and abundance calculated based on the number of particles.

The MPs were extracted from dried sediment samples based on a modified flotation method. About 300 ml of a filtered NaCl solution with ρ=1.2 g mL^{-1} was added to 20 grams of the dry sediment and stirred with a mechanical shaker at 200 rpm for 10 minutes. After settling, the supernatant was filtered under vacuum through cellulose nitrate filter paper (Whatman Ø47 mm; pore size 0.45 µm). The filtrates were placed in covered sterile Petri dishes to dry overnight at room temperature (approx. 25°C) and to prevent air contamination.

MPs identification. Samples that have lost their organic matter were filtered using vacuum filtration with a membrane size of 0.4 µm. The filtrate was placed in a petri dish, while the shape and size were identified using a stereo microscope (Nikon Eclipse Ni-U) equipped with a camera. Furthermore, ATR-FTIR was used to analyze the functional groups of polymer types (Xu et al 2019). The FT-IR was operated according to an experimental setup by (Loder & Gerdts 2015) in a single reflection mode with a resolution of 8 cm, a range of 600 and 3,800 cm^{-1}, as well as 32 scans per analysis.

Quality control and assurance. To prevent contamination of the entire MPs analysis procedure, preventive and quality control measures were implemented. This procedure aims to ensure that the data obtained from this study are accurate. To observe air contamination, a clean filter paper was placed near the filter and microscope. No plastic was found on the microscope chamber air control filter, implying that there was no contamination from the glass jar, filtering process, or microscope identification. All equipment before use was rinsed with doubly distilled water (DDW) and immediately cleaned again when not in use in a dry state (Suteja et al 2021). Tables and areas adjacent to MPs samples were also cleaned. Sampling and analysis in the laboratory was done using cloth made of 100% cotton (Falahudin et al 2020; Suteja et al 2021).

Results and Discussion

Abundance of MPs in seawater and sediment. A total of 1140 MPs particles were identified in seawater, while 1379 were found in sediment from 8 sampling point locations. On the beaches of Gandoriah and Cermin, 1140 particles were found in seawater and 1379 in sediments. The average abundance of MPs in seawater at Gandoriah Beach was 6.62 particles m^{-3} while at Cermin beach, it was 15.86 particles m^{-3} (Figure 2). The average abundance in sediment on the Gandoriah coast was 17,675 particles kg^{-1}, while on the Cermin beach, it was 10,825 particles kg^{-1} as indicated in Figure 3.

The abundance of MPs in the sediment on the Gandoriah beach was greater than on the Cermin beach as shown in Figure 3. This is because, on the Gandoriah beach, there is a river estuary that carries plastic waste thereby entrapping MPs particles in a larger whirlpool which finally settle in the sediment (Claessens et al 2011).

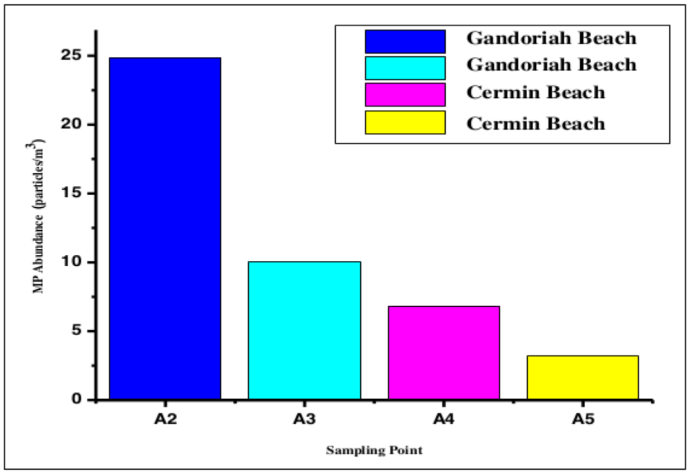

Figure 2. MPs abundance (particle m^{-3}) in different sampling points at the seawater locations.

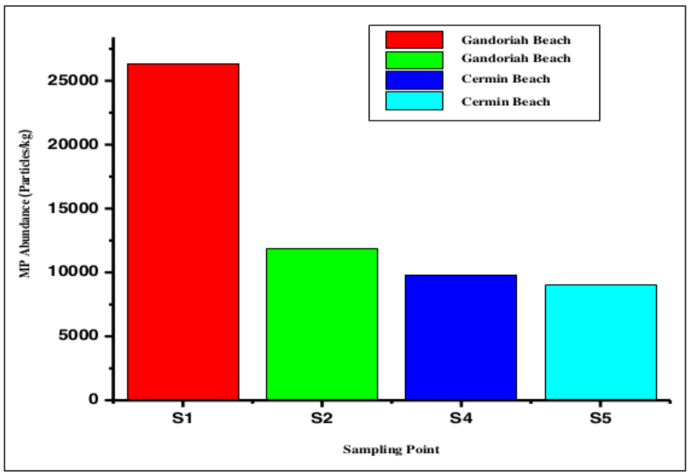

Figure 3. MPs abundance (particle kg^{-1}) in different sampling points at sediment locations.

The MPs abundance in surface water was significantly lower than that reported in Jakarta Bay 70.9 ± 27.1 x 10^3 particles m^{-3} (Takarina et al 2022), Benoa Bay, Bali-Indonesia 0.002 x 10^3 particles m^{-3} (Suteja et al 2021), Shanghai 27.84 ± 11.81 x 10^3 particles m^{-3} (Zhang et al 2019), Yellow River Bay, China 497x10^3 particles m^{-3} (Han et al 2020), Banyuurip Waters, Gresik, East Java 57.11 x 10^2 particles m^{-3} (Ayuningtyas 2019), and West Coast of Karimun Island, Riau Islands Regency 86.00-112.00 particles m^{-3} (Suriyanto et al 2020). The differences are influenced by types of human activities in coastal areas, as well as environmental factors, and population density (Wright et al 2013). The human population can also increase MPs particles in the aquatic environment. In this study, it was found that some macroplastics such as drink bottles, food wrappers, pieces of fishing nets, and waste from tourism activities floated in the waters during sampling in the sea. The slow movement of water around the estuary causes the movement of macroplastics to be slow and accumulate. Therefore, it is predicted that a plastic fragmentation process will occur leading to more deposition of MPs compared to the open ocean (Andrady 2011; Barnes et al 2009; Manalu et al 2017).

MPs identification based on shape and size. Fragments are pieces of plastic products with strong polymers, such as beverage bottles and plastic gallons (Cordova et al 2019;

Tanaka & Takada 2016). Meanwhile, the film type has a characteristic sheet-like shape and is generally used for making crackle bags or packaging (Ambarsari & Anggiani 2022). MPs fragments might occur due to mechanical forces such as wave movement, abrasion with sand, and contact with animals due to highly weathered plastic flakes (Andrady 2017).

Furthermore, the fragment type has the physical characteristics of an irregular, thick shape with sharp edges (Ebere et al 2019). They are formed from macroplastic fragmentation due to weather and mechanical processes (Barnes et al 2009). This study found 3 dominant forms of MPs, namely fragments, films, and fibers as indicated in Figure 4. The shape of the film particles is in the form of very thin plastic fragments, while the source of the films includes food packaging (Ayuningtyas 2019). Additionally, the fibers come from broken fishing lines, plastic ropes, and synthetic fabric or textile materials (Cordova et al 2019; Zhu et al 2018).

Among the MPs forms, the highest average abundance at the sea and sediment levels was fragments with 58.48%, followed by film 37.30%, and fiber 4.21% as shown in Figures 4 and 5.

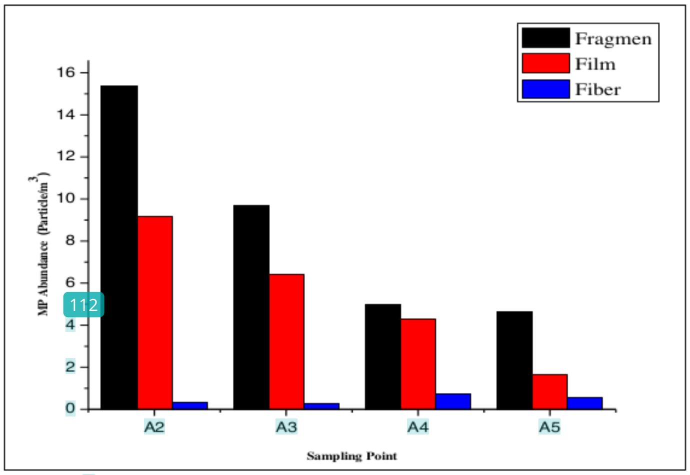

Figure 4. MPs abundance (particle m^{-3}) in different sampling points based on the shape of the particle from seawater.

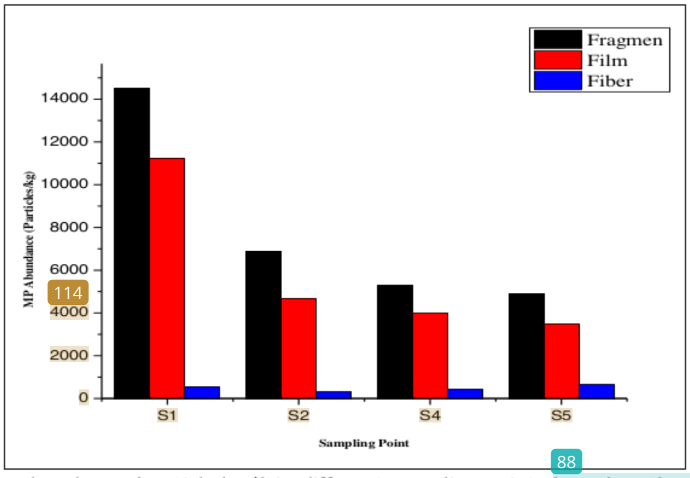

Figure 5. MPs abundance (particle kg^{-1}) in different sampling points based on the shape of the particle from sediment.

The abundance of MPs in seawater samples at Gandoriah and Cermin beaches is presented in Figure 4. On the Gandoriah beach, the order of dominance was fragment 55.75% > film 36.67% > fiber 7.58%, while at the Cermin beach, it was fragment 63.13% > film 34.03% > fiber 2.48%. Furthermore, on both beaches, the abundance of the same MPs form found was fragment > film > fiber. The dominance in the presence of fragments is probably associated with high human activities (Zhao et al 2018).

The abundance of MPs forms in sediments was dominated by fragments, for Gandoriah Beach, the order was fragment 60.82% > film 36.36% > fiber 2.82%, while at Cermin Beach, it was fragment 56.36% > film 40.19%> fiber 3.46% as shown in Figure 5. The dominance of fragments in seawater and sediment stems from the degradation of larger macroplastics such as drink bottles, the remains of discarded jars, rice wrappers, fast food packaging, and office waste disposal. It is suspected that the MPs fragment type originated from anthropogenic activities by rivers and tourist beaches (Browne et al 2011; Sari Dewi et al 2015).

The film is a secondary plastic polymer derived from the fragmentation of bags or packaging and has a low density. The shape is probably caused by the surrounding community that uses plastic bags and packaging (Azizah et al 2020). Meanwhile, this study found the lowest form as fiber, usually flat and flexible particles with smooth or angular edges (Zhang & Wang 2019).

Fibers can come from the disposal of sewage treatment plants and rope fragmentation (Browne et al 2011; Liebezeit & Dubaish 2012). The existence is also influenced by fishing activities that come from fishing gear, namely lines and degraded nets (Crawford & Quinn 2017). This is based on the conditions encountered in the field such as fishing activities and island tourism activities, as well as the lack of awareness on not throwing garbage in the sea. Another source of MPs fiber includes textile factories, namely yarn residue from clothes and plastic ropes (Anbumani & Kakkar 2018). Similar results were found in a study conducted in Sumba waters with the dominant form of MPs being 45.45% fiber (Cordova & Hernawan 2018). Another study carried out at Rambut Island showed that fiber was more dominant than other types (Assidqi 2015). Furthermore, similar results were found on the Belgian coast (Claessens et al 2011), Spiekeroog and the Kachelotplate Islands (Liebezeit & Dubaish 2012), as well as in the mangrove area of Singapore (Mohamed Nor & Obbard 2014).

The different types of MPs found at different locations might be influenced by variations in the sampling methods applied, processing and analysis techniques used, as well as the oceanographic (tidal and current), and meteorological conditions (Abayomi et al 2017; Browne et al 2011; Enders et al 2015; Kanhai et al 2017; Lusher et al 2014; Yonkos et al 2014).

MPs identification by size. The MPs sizes found in this study were classified into five categories: < 100 µm; 101–300 µm; 301–500 µm; 501– 1,000 µm; and >1,000 µm according to the measurement conducted using the Motic Plus 3.0 software. As shown in Figure 6a (seawater), the dominance of MP size 101–300 µm 49.53% is shown by the histogram in red. In sediments (Figure 6b) the size of MPs is dominated by sizes 101 – 300 µm of 41.44%, while sizes < 100 µm are the lowest. 1.72%. MP category percentages for 301 – 500 µm, 501 – 1,000 µm, > 1,000 µm were 30.09%, 23.71%, and 3.04%, respectively.

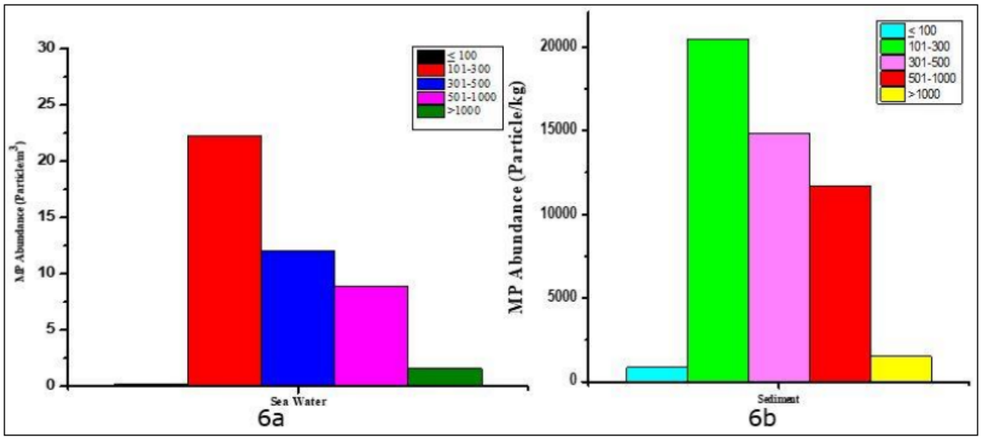

Figure 6. The abundance of MPs based on particle size in: 6a seawater (particle m^{-3}); and 6b sediment (particle kg^{-1}).

The MPs size is a determinant of potential impacts on organisms in the aquatic environment. The smaller the size, the greater the risk of being swallowed by the organism and this can cause harm to various marine macrofauna as well as important pelagic fish. MPs with a size of < 100 µm are often found in the digestive tract of marine organisms. This indicates that marine organisms cannot distinguish between their food and MPs (Cordova & Hernawan 2018). In previous studies, the percentage of MPs size dominance on the coast of Pariaman was smaller than in the waters of Benoa Bay, Bali (Suteja et al 2021). The highest to lowest MPs percentage based on size was 500 – 1,000 µm (37.9%), > 1,000 µm (35.7%), 300 – 500 µm (22.1%), and < 300 µm (4.3%). Furthermore, in the northern coastal waters of Surabaya, it was found that the size ranges obtained were < 300 µm (0.122%), 300–500 µm (45.478%), 500–1,000 µm (48.539%), and > 1,000 µm (5.861%) with a dominant size of 500-1,000 µm (Cordova et al 2019). The dominance in this study was greater compared to the water surface in the estuary of the Yellow River, China, which is dominated by the size < 200 µm at 87.94% (Han et al 2020; Suteja et al 2021). This difference in the size distribution is caused by the influence of hydrodynamic conditions (De Troyer 2015), wind speed (Kukulka et al 2012), and the presence of bio-fouling (Pedrotti et al 2016).

MPs identification with FTIR. FTIR analysis was used to identify MPs on the surface of the Ross Sea, from the English Channel (Cincinelli et al 2017; Cole et al 2014; Jung et al 2018). The advantages of FTIR spectroscopy include simple, efficient, non-destructive identification and can distinguish most plastic polymers based on infrared absorption bands (Jung et al 2018). Generally, in marine waters, polypropylene (PP), polyethylene (PE), polystyrene (PS), polyethylene terephthalate (PET), and polyvinyl chloride (PVC) are the most dominant plastic polymers. PVC is more likely to sink, while PP, PE, and PS float more easily. Nylon has a density greater than seawater, for example 1.14 gram cm^{-3} (Akovali 2012; Terekhina et al 2019) making it easier to sink in bottom waters and sediments (Gomiero et al 2018).

During the analysis, the potential of the sample to contact with infrared radiation makes FTIR useful for determining the specific molecular vibrations (Nandiyanto et al 2019). As shown in Figure 7, the type of polymer found in MPs was suspected to be polyamide (PA) due to the strong peak intensity at wave number 3330 cm^{-1} which corresponds to the N-H strain vibration of aromatic primary amines. NH stretch bonds in amine compounds have a range of wave numbers between 3360-3310 cm^{-1}. Furthermore, the wave number 2896.37 cm^{-1} implies C-H strain, because the C-H bond stretch in alkane compounds has a range of 2900-2880 cm.$^{-1}$ The wave numbers 1639.84 cm^{-1} showed the C=O at the range of 1680-1630 cm^{-1} while the C-N bond was demonstrated at wave numbers 1320.27 and 1032.20 cm.$^{-1}$ According to a previous study, the presence of CN stretch bonds is usually identified in amide compounds with a wave number range of 1090-1020 cm^{-1} (Nandiyanto et al 2019). Besides, polyamides are widely used as fishing lines or food wrappers (Naji et al 2017; Suteja et al 2021).

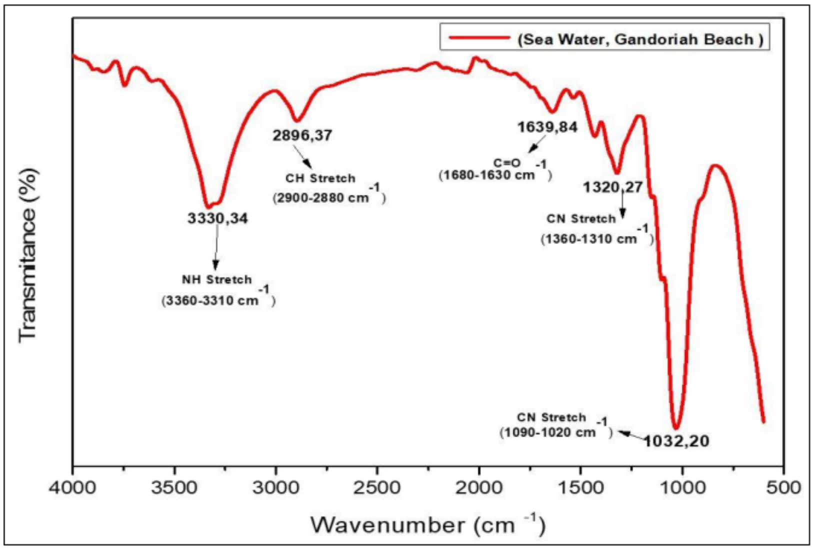

Figure 7. PA spectrum of seawater samples.

The prominent peak at wave number 1.475 cm^{-1} indicates the vibration of the C-H bend which has a range of 1485-1445 cm^{-1} while the C-Cl bonds were found at wave number 797 cm^{-1} with a range of 800-700 cm^{-1}. Figure 8 of the sample spectrum show that the type of MPs polymer was Poly Vinyl Chloride (PVC) based on the stretching vibrations of CH_2 and C-Cl (Jung et al 2018). PVC is generally found in plastic films, bottles, and glass (Andrady 2011).

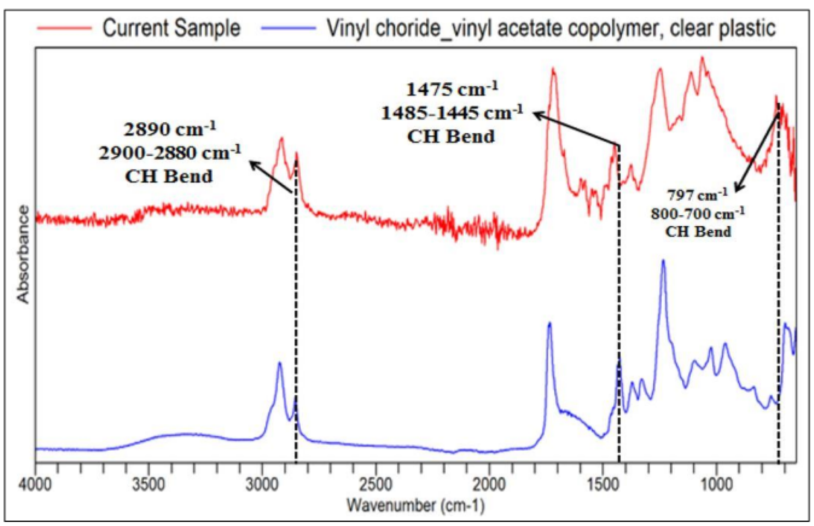

Figure 8. PVC spectrum on the sample.

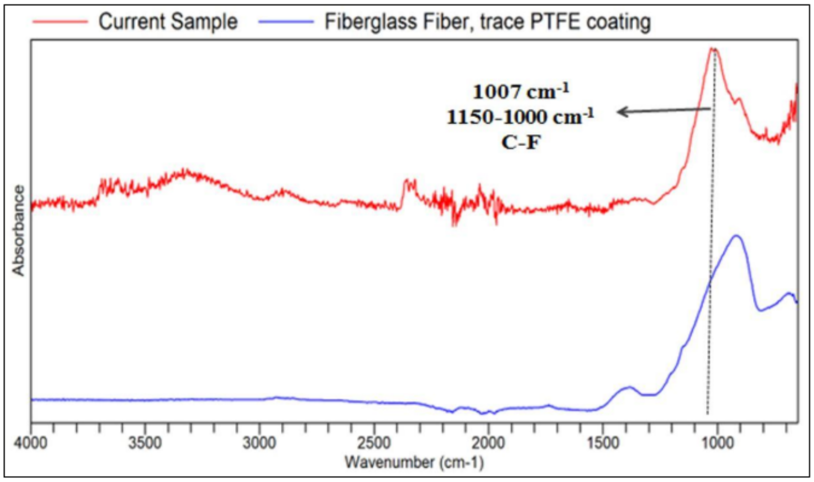

Figure 9. PTFE spectrum on the sample.

Poly Tetra Fluoro Ethylene (PTFE) is characterized by having a strong C-F bond (Puts et al 2019) as shown in Figure 9. The predicted significant peak with PTFE appeared at wave number 1004 cm^{-1}, indicating CF strain vibration (Jung et al 2018). The characteristic peak of PTFE appeared at wave numbers 1201, 1147, 683, 554, and 509 cm^{-1} in each of the functional groups as follows strain vibration CF_2, bending vibration C-C-F, CF_2, and CF_2. PTFE is applied as a lubricant, in the fireworks, electronics, aerospace, and cable industries, heat-resistant coatings, biomedical materials, membranes in batteries, water purification, and others (Puts et al 2019).

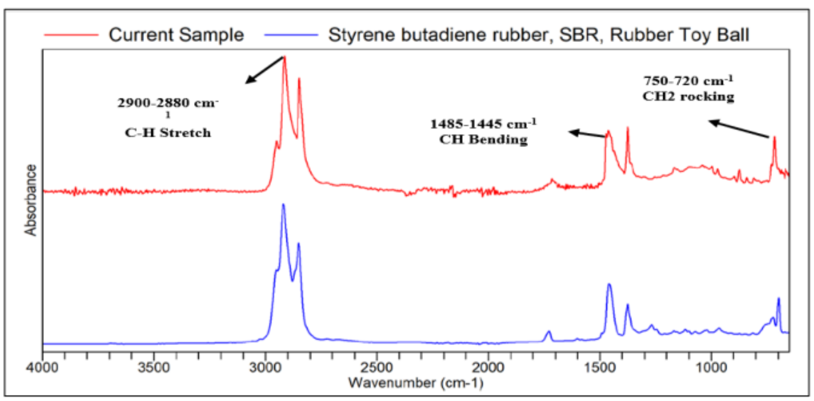

Figure 10. PE spectrum on sample.

Figure 10 shows the IR spectrum of the PE sample with a strong peak intensity at wave numbers of 2900 cm,$^{-1}$ 1465 cm^{-1}, and 750 cm^{-1} indicating a C-H strain vibration, C-H_2 bend bond, and the C-H_2 rock bond. PE and PS materials usually come from packaging products, toys, household appliances, and plastic bags, while PP comes from food packaging, pipes, and vehicle parts (Permatasari & Radityaningrum 2022). PE is one of the five main plastic commodities commonly found in MPs, namely: polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS) and polyethylene terephthalate (PET) (Andrady 2017). Polyethylene is the main material for making plastic bags and containers and is one type of plastic that is often found floating on the water (GESAMP 2015) due to the shape and its thin size.

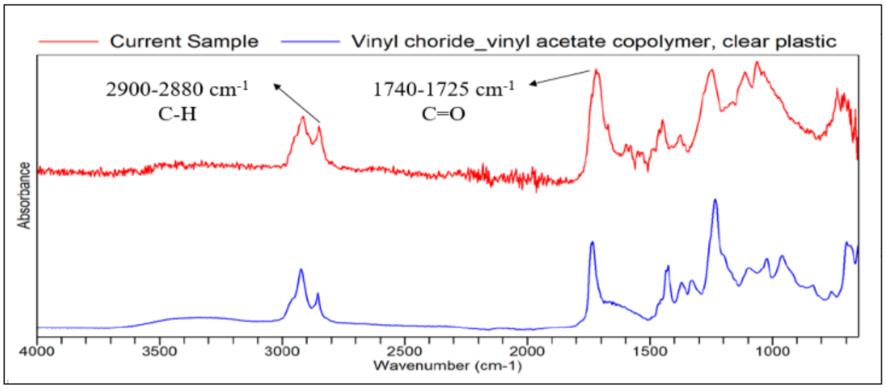

Figure 11. PU spectrum on the sample.

The IR spectrum of the suspected PU sample presented in Figure 11 shows a strong peak intensity at wave numbers 2790 and 1730 cm^{-1} indicating strain vibrations of C-H and C=O (Nandiyanto et al 2019). Polyurethanes are widely used in the flexible foam industry, semi-flexible and rigid foam, coatings, adhesives, elastomers as well as resins (Ashida 2006; Neswati et al 2019).

Based on the FTIR identification results, the types of polymers found in MPs on the beach of Gandoriah are PE (polyethylene), PA (polyamide), PU (polyurethane), and PVC (polyvinyl chloride). Meanwhile, on the Cermin beach, the suspected types include PA (polyamide) and PTFE (Polytetrafluoroethylene). The presence of high-density MPs was found on the seawater, namely PA, PU, and PVC. All three are polymers with a density greater than seawater (ρ = 1.02 gram cm^{-3}) (Terekhina et al 2019) making it easier to sink in bottom waters and sediments (Gomiero et al 2018). Generally, low-density MPs namely PE and PP are more common in surface waters, because high-density polymers are more likely to sink. However, high-density polymers have also been identified in surface waters in several studies. For example, (Barrows et al 2017; Castillo et al 2016; Loder & Gerdts 2015; Pan et al 2019; Wang et al 2020), concluded that factors other than the density influence the MPs distribution, such as boat movement, tides, winds, and storms which culminate in turbulence and vertical mixing (Kukulka et al 2012; Lattin et al 2004; Lusher 2015; Reisser et al 2014; Wang et al 2020). Most of the MPs settle in the sediment because the transport tends to be slower than in the water column thereby causing the high abundance in the sediment (Manalu et al 2017; Nugroho et al 2018; Su et al 2016; Van Cauwenberghe et al 2013).

Polyamide polymers detected both in seawater and in sediments were thought to have come from fishing activities. Moreover, the sampling location was close to the Fish Auction Place (FAP), as well as tourist and household activities around the coast. Around the beach area, there is still a lot of plastic waste that is scattered and not managed properly. Polyvinylchloride (PVC) and polyurethane (PU) are among the polymers that make up about 80% of plastic production, usually constitute the majority of marine debris (GESAMP 2019; Zhang & Wang 2019) and are the most abundant synthetic plastic compositions (Andrady 2011). In this study, PTFE polymer was found in sediments but not in seawater. Generally, PTFE is used as a lubricant, for fireworks, electronics, aerospace, and cable industries, as well as heat-resistant coatings, biomedical materials, membranes in batteries, water purification, and others (Puts et al 2019).

Conclusion. Based on the results, the number of MPs in the seawater and sediment samples was 1140 and 1379 particles respectively. The average abundance in seawater was 6.62 –15.86 particles m^{-3} while in sediment, it was 10,825 – 17,675 particles/kg. Furthermore, the most dominant form in surface water was fragment 58.37% > film 36.34% > fiber 5.29%, and for sediment was fragment 58.59% > film 38.27% > fiber 3.14%. The MPs sizes found in this study were classified into five categories namely < 100 μm; 101 – 300 μm; 301 – 500 μm; 501 – 1000 μm; and > 1000 μm. Overall, MPs on the coast of Pariaman seawater were dominated by the size of 101 – 300 μm at 49.53%, while the size < 100 μm was the lowest percentage at 0.44%. The percentages of categories measuring 301 - 500 μm, 501 - 1000 μm and > 1000 μm were 26.76; 19.72, and 3.55%, respectively. Moreover, the types of polymers detected in the samples were polyethylene, polyamide, polyvinyl chloride, polyurethane, and polytetrafluoroethylene. This implies that various types of MPs can pollute the aquatic environment. These results provide useful information on which parts of the coastal waters of Pariaman City should be prioritized first regarding management.

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