

Microplastic distribution and polymer composition across seagrass-associated matrices in tropical seagrass ecosystems: Evidence from Banaybanay, Davao Oriental, Philippines

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ABSTRACT

Microplastic pollution poses an escalating global threat to marine ecosystems, with coastal habitats such as seagrass beds being particularly vulnerable. Seagrass meadows provide critical ecological services, including carbon sequestration, nursery habitats for marine life, and shoreline stabilization, yet their integrity is increasingly compromised by plastic contamination. This study investigated the occurrence and environmental implications of microplastics in the seagrass beds of Barangay Mogbongcogon, Banaybanay, Davao Oriental. Sampling was conducted at low tide in November 2024 across four environmental matrices: seagrass blades, seagrass-bed sediments, water column, and beachline sediments. Microplastics were quantified and categorized by color and morphology using a stereomicroscope, while polymer types were identified with an Agilent Cary 630 FTIR spectrometer. Results revealed black microplastics as the most dominant, particularly in the water column (15.38%) and sediments (13.46%). Fibers were the most prevalent morphology (21.15%) in both sediments and water, while polyester was the dominant polymer type, notably in seagrass beds (SB) sediments (21.15%) and water (17.31%). Seagrass sediments recorded the highest microplastic abundance (n=19), whereas seagrass blades showed the highest density (0.056 particles per 10 blades). Statistical analysis indicated no significant associations between

color or morphology and environmental matrices, although polymer type demonstrated a significant relationship ($\chi^2(4, N=52) = 10.592, p = 0.032$). The accumulation of microplastics within seagrass habitats highlights the vulnerability of coastal ecosystems to persistent plastic pollution. These findings highlight the urgent need for enhanced monitoring and stricter waste management to address plastic pollution in seagrass ecosystems. Community-based interventions are also essential to reduce plastic inputs and safeguard the ecological functions of coastal environments.

INTRODUCTION

Global plastic production has increased substantially, rising from 370.7 million tonnes in 2018 to 413.8 million tonnes in 2023 (Mecelti et al., 2026), leading to a parallel increase in plastic waste contamination (Tiwari et al., 2019). Among the most alarming outcomes of this trend is the proliferation of microplastics (MPs), which are plastic particles less than 5 millimeters in size, are now posing a significant threat to marine ecosystems. Microplastics are generally classified into primary and secondary types: primary microplastics are intentionally manufactured small particles commonly found in household and personal care products such as cosmetics (Saini and Sharma, 2022), while secondary microplastics result from the breakdown of larger plastic debris due to the mismanagement of plastic waste and environmental degradation processes (Nathani Devi et al., 2022). Oceanographic forces,

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including waves and winds, further disperse plastics from coastal areas into various marine habitats such as seagrass, corals, mangroves, and beaches (Lechthaler et al., 2020), where they negatively affect the organisms inhabiting them (Priscilla et al., 2019) and ultimately affect the functioning of marine ecosystems (Mihai et al., 2022). Field-based evidence from coastal sediments also demonstrates widespread microplastic contamination in beach environments, which serve as important sources and transit zones for adjacent seagrass systems (Rahman et al., 2020; Tiwari et al., 2019). Previous studies further highlight that seagrass beds act as effective sinks for microplastics due to their dense canopies and reduced hydrodynamic conditions, which promote particle trapping and accumulation (e.g., Goss et al., 2018; Huang et al., 2020). This retention capacity increases the exposure of benthic organisms and epiphytic communities to microplastics, potentially impairing photosynthesis, growth, and nutrient cycling within seagrass ecosystems (Jones et al., 2020; Molin et al., 2023). Although the mere presence of MPs may not directly translate to harm (Bucci et al., 2020), their abundance in these environments could still indicate the extent and gravity of the plastics pollution problem.

Among the marine habitats where MPs could accumulate, seagrass meadows are increasingly recognized as both critical marine ecosystems and vulnerable sinks for microplastic pollution. Evidence of MP entrapment has been reported in *Enhalus acoroides* and *Cymodocea rotundata*, where microfibers adhere to blades and associate with epiphytes (Huang et al., 2019; Datu et al., 2019), underscoring the persistence of plastic contaminants in these habitats. This entrapment is particularly concerning given the ecological importance of seagrass meadows as nurseries, carbon sinks, and sediment stabilizers (Oprandi et al., 2020). Their structural complexity and location in shallow coastal zones, often influenced by wave action, land-based runoff, and episodic extreme rainfall, make them especially prone to receiving and retaining land- and ocean-derived microplastics (Orth et al., 2006; Short et al., 2011; Unsworth et al., 2020). Consequently, in addition to well-documented stressors such as storms, sedimentation, pollution, and mass tourism (Darus et al., 2022), microplastic retention represents an emerging and compounding pressure, reinforcing the need for their protection and restoration to maintain marine ecosystem balance (Valdez et al., 2020).

Vulnerability of seagrass ecosystems is further amplified in tropical coastal areas exposed to wave action (Chai et al., 2022) and high runoff during extreme rainfall events (Kreitsberg et al., 2021), increasing plastics inputs to the coastal ecosystems. Poorly sorted sediments can entrap MPs in their interstitial spaces, contributing to contamination of benthic organisms (Kreitsberg et al., 2021). Tahir et al. (2019), for example reported MP contamination in both sediments (28.29%) and benthic animals (25%), demonstrating how seagrass ecosystems act as pathways for plastic pollutants into marine food webs. This is particularly concerning because microplastics can enter the human food chain through seafood consumption, including bivalves, crustaceans, and fish. Studies in aquatic organisms also show that dietary exposure to microplastics may cause physiological effects such as altered growth, weight changes, and liver damage (Hu et al., 2022).

In the Philippines, global concerns about marine plastic pollution are mirrored at the local level, where coastal ecosystems are increasingly affected by improperly managed waste. Although plastic production and use do not inherently constitute pollution,

mismanagement of plastic waste leads to accumulation in coastal and marine environments, with documented ecological consequences (Gomez et al., 2023; Perpetua et al., 2025). Studies in the national coastal waters have confirmed significant concentrations of plastic debris along shorelines and within seagrass habitats (Celmar et al., 2024; Gaboy et al., 2022; Gabriel et al., 2026; Gomez et al., 2023), contributing to habitat degradation and risks to marine biota. Barangay Mogbongcogon in Banaybanay, Davao Oriental, the Philippines, is both an ecologically significant seagrass area and a socio-economic hub, known for beachfront tourism but increasingly burdened by domestic, agricultural, and tourism-related wastes. Studies show that mismanaged wastes from coastal communities and tourist activities contribute to the entrapment of plastics in nearshore environments, which can entangle, smother, and stress seagrass meadows and associated fauna (Musa et al., 2025). Further, tourism growth correlates with increased waste generation and greater inputs of plastic debris when waste management infrastructure is inadequate (Inocente and Bacosa, 2022; Sari et al., 2022). This makes Mogbongcogon a critical site for assessing the impacts of plastic contamination on seagrass ecosystems.

Against this backdrop, the present study assessed the occurrence, abundance, and characteristics of microplastics in the seagrass beds of Barangay Mogbongcogon. Despite increasing global evidence of microplastic retention in seagrass ecosystems, there remains a critical gap in localized, matrix-specific assessments in tropical Philippine settings, particularly on their variability across environmental compartments and their potential drivers. Given that macroplastics are more visually present in the coastal environments, we hypothesized that microplastics would also be present across all sampled matrices (seagrass blades, sediments, water column, and beachline sediments) but vary in abundance and characteristics. While macroplastics were not explicitly quantified, we further hypothesized that a substantial proportion of microplastics in coastal environments could have originated from the fragmentation of larger plastic debris. We quantified microplastics in seagrass blades and sediments, the water column, and beachline sediments, and classified particles by color, morphology, and polymer type. Associations with environmental matrices, which may reflect differences in sources, transport, and retention mechanisms were also explored using association tests (Chi-square). Results of this study provide baseline insights into the occurrence and distribution of persistent plastic pollutants in seagrass habitats, which may serve as a basis for inferring potential ecological implications and guiding future studies on their effects.

MATERIALS AND METHODS

Sampling site and study design

This study was conducted in the seagrass beds of Barangay Mogbongcogon, Banaybanay, Davao Oriental, Philippines (Figure 1). A descriptive–correlational research design was employed to determine the occurrence, abundance, and characteristics of microplastics in four environmental compartments: seagrass blades, seagrass-bed sediments, water column, and beachline sediments. In this study, “seagrass bed sediments” (hereafter, SB sediments) denote sediments collected within the seagrass meadow along the transect, whereas “beachline sediments (hereafter, BL sediments)” refer to strandline sediments collected along the shoreline outside the seagrass bed.

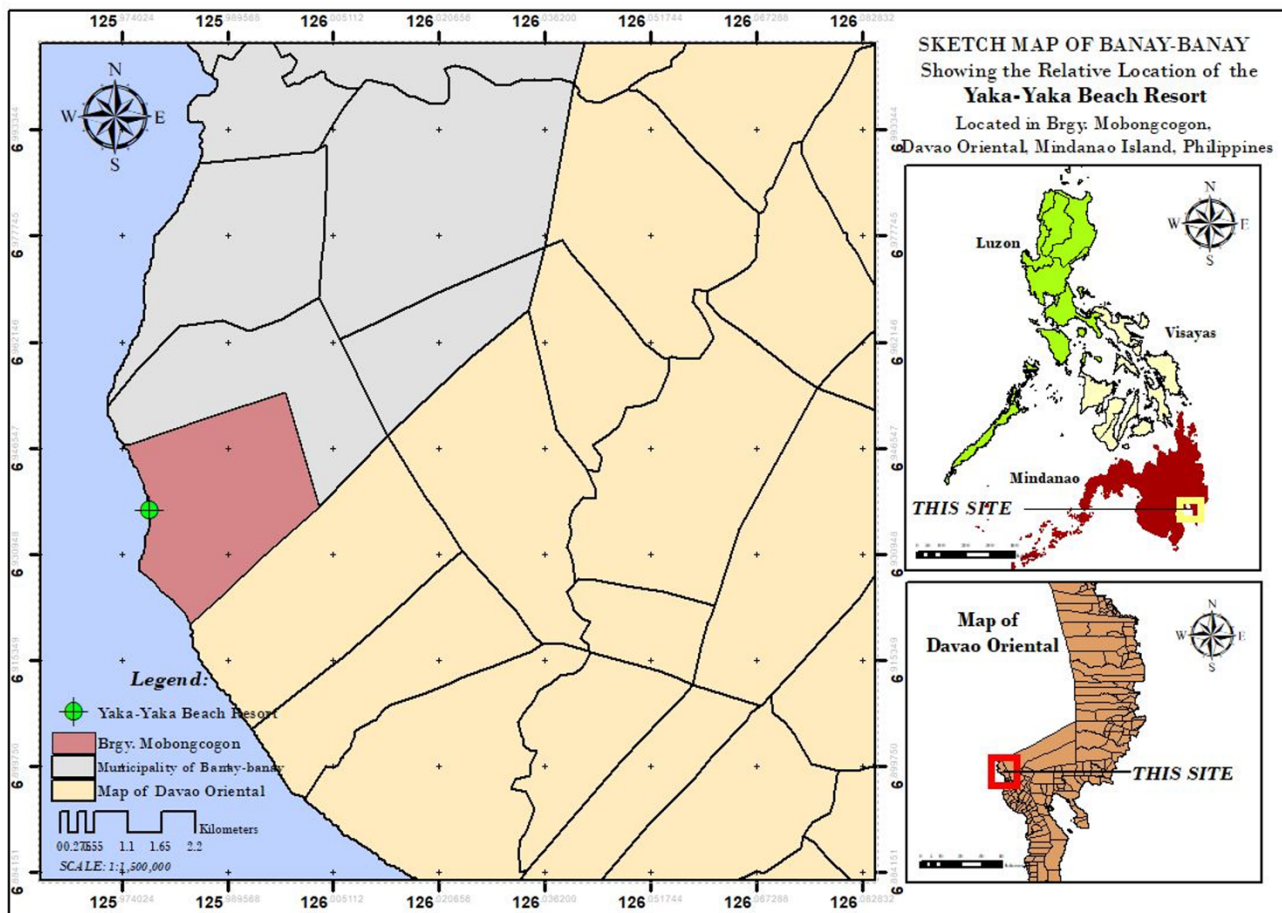


Figure 1: Study area in Barangay Mogbongcogon, Banaybanay, Davao Oriental.

Sample collection

Sampling was undertaken in November 2024 during the year's lowest tide to ensure optimal collection conditions. The sampling protocol followed the Handbook for Quantifying Plastics in the Marine Environment (Onda et al., 2023), and all materials, including pre-filtered distilled water, aluminum foil, glass containers, sediment corers, quadrats, and transect tapes, were thoroughly cleaned prior to fieldwork to minimize contamination.

For seagrass blade collection, a 50-meter transect was established perpendicular to the shoreline following the method of Jones et al. (2020). Quadrats measuring 1×1 m were placed at 10-meter intervals along the transect, and ten blades were collected from each quadrat, resulting in a total of 60 blades. Samples were immediately transferred to glass containers with metal caps and sealed with aluminum foil. The upper 5 cm of SB sediment samples were collected simultaneously along the same transect, with one core sample was randomly taken every 10 meters to yield six cores per transect. Surface water samples were gathered from the same quadrat points where seagrass blades were collected and were stored in glass containers identical to those used for plant material. Beachline sediments were obtained by establishing three 30-meter transects parallel to the shoreline along the strandline. Within each transect, sediments were collected using 25×25 cm quadrats placed at regular intervals while maintaining a 2 m spacing between consecutive quadrats to prevent cross-contamination.

Microplastics extraction and characterization

In the laboratory, seagrass blade samples were processed by rinsing each pooled sample of ten blades with filtered distilled water and transferring them into clean 500 mL beakers. Samples were digested with a 10% potassium hydroxide (KOH) solution at a 3:1 solution-to-sample volume ratio and left for 48 hours, with stirring

every 12 hours to facilitate complete digestion. Seagrass-bed (SB) sediment and beachline (BL) sediment samples were oven-dried at 80°C for 72 hours and subsequently subjected to density separation using a zinc chloride (ZnCl_2) solution with a density of 1.5 g/mL . A total of 100 g of dried sediment was mixed with 200 mL of ZnCl_2 in 500 mL tall glass beakers, covered with aluminum foil, and allowed to stand undisturbed for 48 hours. The supernatant was carefully decanted and filtered through Whatman GF/C filters, rinsed with filtered distilled water, and retained for analysis. Water samples were processed using vacuum filtration through Whatman GF/C filter paper, and the retained materials were examined microscopically.

To ensure reliability of results, quality control procedures were applied. Spiked samples containing known quantities of microplastics, including polyethylene terephthalate (PET), polypropylene (PP), low-density polyethylene (LDPE), high-density polyethylene (HDPE), and polyvinyl chloride (PVC), were prepared in triplicate. Recovery efficiency was required to be $\geq 80\%$. Procedural blanks consisting of filtered distilled water ($n = 3$) were included to monitor potential contamination introduced during handling or analysis. The values obtained from blanks were subtracted from those of environmental samples to account for background contamination and ensure accuracy.

Microplastics retained on filters were visually identified and sorted using a stereomicroscope with up to $40\times$ magnification. The minimum detectable size of microplastic particles under the stereomicroscope was approximately $100\ \mu\text{m}$, and particles smaller than this threshold were not reliably detected or included in the analysis. Microplastics were categorized by morphology, primarily fibers and fragments, and visually classified by color, including black, red, white, blue, yellow, and maroon. A representative

subset of particles selected by matrix was subjected to Fourier Transform Infrared (FTIR) Spectroscopy using an Agilent Cary 630 spectrometer. This technique identified polymer types based on their infrared absorption spectra, allowing precise categorization of polymers such as fiber-reinforced polymers, PTFE, elastomers, and semi-synthetics, following methods outlined by Löder and Gerdtz (2015) and Akkajit et al. (2021).

Microplastics counting and statistical analyses

Microplastic abundance was calculated separately for each environmental compartment. For seagrass blades, abundance was expressed as the number of particles/10 blades. For SB and BL sediment samples, results were normalized to the number of particles per 100 g dry weight, while abundance in the water column was expressed as the number of particles per 150 mL of water following Phuong et al. (2018). Descriptive statistics were computed in Microsoft Excel 365. Chi-square tests were conducted to assess associations between microplastic characteristics, such as color, morphology, and polymer type, and environmental matrices. Statistical significance was determined at $p < 0.05$.

RESULTS AND DISCUSSION

Characteristics of Microplastics: Color, Morphology, and Polymer Composition

A total of 52 MP particles were identified across four environmental compartments: seagrass blades, seagrass-bed sediments, the water column, and beach sediments. Six colors were observed, specifically red, white, maroon, yellow, blue, and black, indicating potentially diverse inputs. As shown in Figure 2, black dominated both the BL and SB sediments and seagrass blades, while blue and red were the minor components. Black MPs were the most abundant across all matrices, accounting for over 50% of total observations and reaching their highest proportion in the water column ($n=8$, 15.38%). The MPs detected ranged in size from $\sim 100 \mu\text{m}$ to $\leq 5 \text{ mm}$, consistent with the standard definition of microplastics (Ho et al., 2024), while particles smaller than $100 \mu\text{m}$ were not consistently detected due to methodological limitations, likely leading to an underestimation of total abundance. These findings are consistent with observations of Seng et al. (2020), where black and blue MPs dominated in seagrass habitats located near coastal communities with active human use, but differed from Huang et al. (2020), who reported blue as the most abundant (often exceeding 40%) in relatively less disturbed or hydrodynamically different sites. Such variations suggest that differences in proximity to anthropogenic sources, such as settlements and tourism activities, as well as site-specific environmental conditions, may influence the color distribution of microplastics.

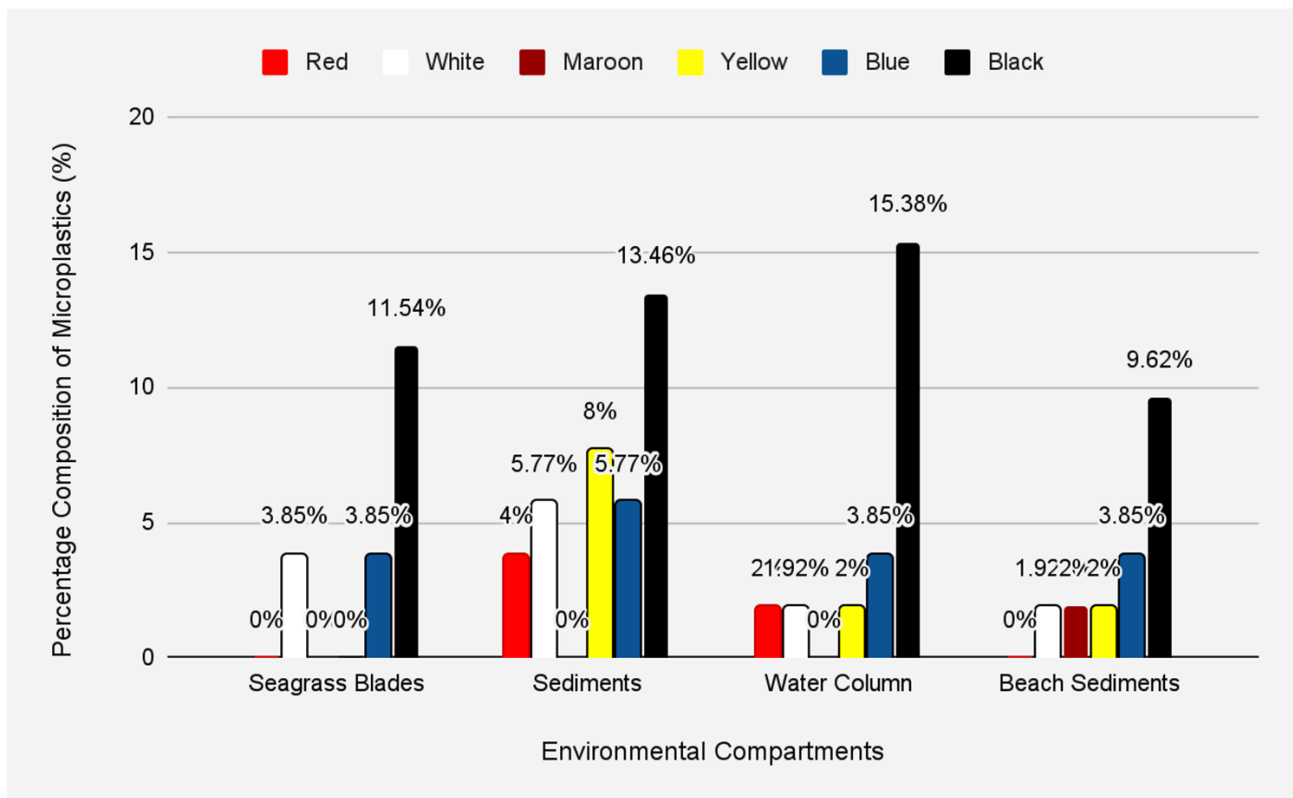


Figure 2: Percentage composition of microplastics in terms of color.

The contrasting color distributions between compartments may reflect varying sources and sinks, as well as limited mixing between and among them. For instance, BL sediments exhibited fewer MPs overall, with black ($n = 3$, 23.08%) and white ($n = 2$, 15.38%) being most common. This differed from Graca et al. (2020), who found transparent MPs dominating in coastal sediments from the Southern Baltic Sea, a temperate region with different hydrodynamic conditions and waste profiles compared to tropical coastal environments like the Philippines. These

differences suggest that regional variations in climate, sources of plastic inputs, and coastal processes may influence the observed microplastic composition. In sediments beneath seagrass beds, black was again most prevalent ($n = 7$, 36.84%), whereas global studies often report blue as the dominant color (Duncan et al., 2018; Gago et al., 2018; Kreitsberg et al., 2021). These differences suggest that MPs in Mogbongcogon may have originated from multiple local sources, including household waste, laundry effluents releasing synthetic fibers, fishing activities (e.g., nets and

ropes), and tourism-related litter, and were differentially retained across matrices. Potential links between color and polymer type were further explored through FTIR analysis, which provides more reliable identification of material sources.

Morphological analysis revealed a strong dominance of fibers over fragments in all compartments, consistent with environmental microplastic inputs. All laboratory procedures followed contamination-control protocols as described in Onda et al. (2023), with procedural blanks confirming the absence of detectable laboratory contamination. As shown in Figure 3, fibers were most abundant in sediments (n = 11, 21.15%) and the water column (n = 11, 21.15%), followed by seagrass blades (n = 8, 15.38%) and

beach sediments (n = 6, 11.54%). This trend mirrors global patterns in which fibers are recognized as the most common microplastic type in marine ecosystems (Datu et al., 2019; Li et al., 2023). The prevalence of fibers is largely attributed to laundry effluents, synthetic textiles, and fishing gears (Tang, 2024). Fibers also can remain buoyant longer and are easily transported by currents, explaining their dominance in the water column and their subsequent deposition in seagrass beds. The consistent presence of fragments across compartments, although less dominant, indicates secondary breakdown of larger plastics, reinforcing that both land-based discharges and *in situ* degradation could be contributing to pollution loads.

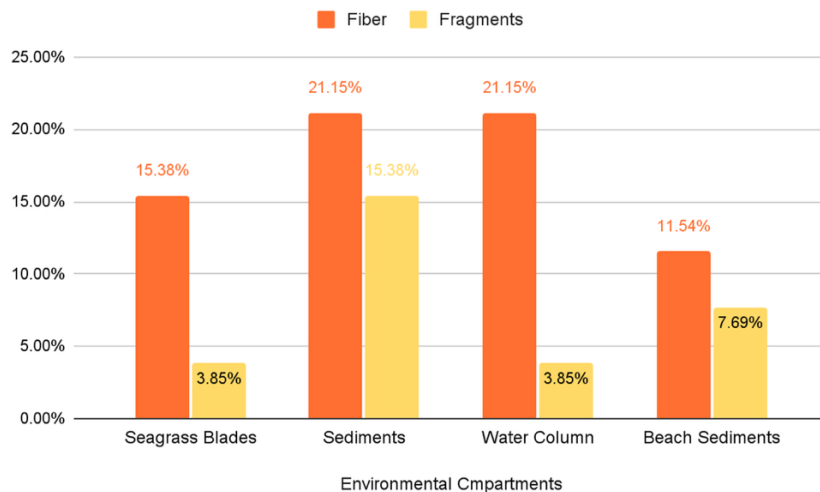


Figure 3: Percentage composition of microplastics in terms of morphology.

Polymer analysis revealed that polyester was the most abundant polymer type, particularly in sediments (n = 11, 21.15%) and the water column (n = 9, 17.31%), consistent with the observations on based on morphology, also consistent with the dominance of fibers observed in morphological analysis. This is followed by fiber-reinforced polymers (n = 6, 11.54%), PTFE (n = 5, 9.62%), elastomers (n = 4, 7.69%), and semi-synthetics (n = 3, 5.77%). The relative distribution of polymer types is illustrated in Figure 4, which highlights polyester's dominance compared with other polymers. This pattern differs from global studies where polyethylene and polypropylene often dominate (Browne et al.,

2011; Sun et al., 2018; Nunes et al., 2023). Polyester's predominance strongly implicates synthetic textiles, ropes, and some fishing gears as key sources of contamination. This is further supported by the heavy reliance on fishing activities and household laundry practices in coastal communities. Importantly, polyester's density and resistance to degradation may increase its likelihood of settling into sediments, explaining its high prevalence in the benthic compartment. The detection of PTFE and elastomers also indicates contributions from industrial or household products (Aharaby et al., 2026), suggesting mixed-source pollution.

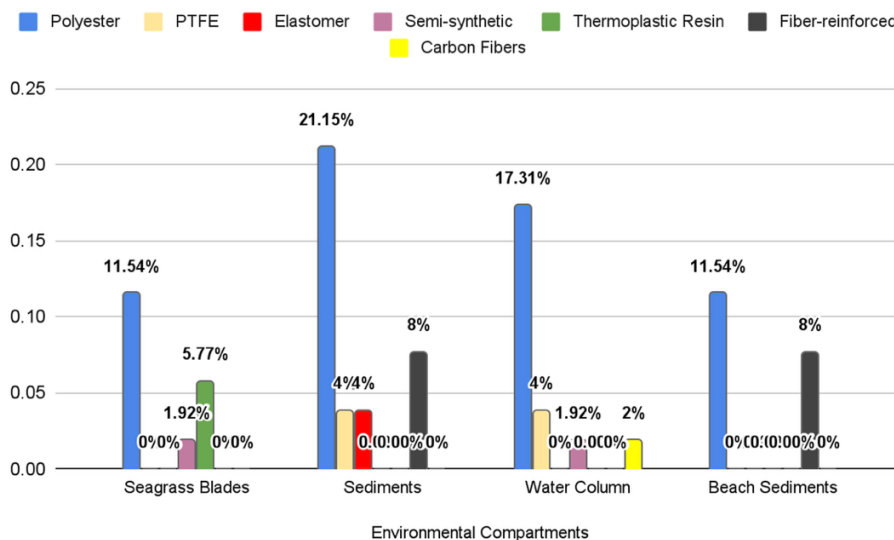


Figure 4: Percentage composition of microplastics in terms of polymer type.

Abundance and Distribution of Microplastics

Microplastic counts and densities varied across environmental matrices. As presented in Table 1, the upper 5 cm of SB sediments contained the highest number of particles (n = 19) but a relatively low density (0.011 particles/100 g), likely reflecting dilution across larger sediment mass/volume. In contrast, seagrass blades showed

fewer MPs (n = 10) but the highest density (0.056 particles/10 blades), highlighting the potential of seagrasses to act as MP filters by trapping particles through their leaf structures and epiphytic communities.

Table 1: Abundance of microplastics in each type of samples.

Samples	Microplastic counts (Particles)	Microplastic density (Particles per 10 blades or per 100 g or per 150 mL)
Seagrass Blades	10	0.056 particles/10 blades
Sediments	19	0.011 particles/100 g
Water Column	13	0.005 particles/150 mL
Beach Sediments	10	0.008 particles/100 g

The water column contained 13 MPs at a density of 0.005 particles/150 mL. This density is lower than those reported in the Yellow Sea (Sun et al., 2018) and Hangzhou Bay (Qu et al., 2022). These differences may partly reflect variations in the size ranges of MPs analyzed as Sun et al. (2018) focused on particles $\geq 330 \mu\text{m}$ and Qu et al. (2022) on particles $\geq 150 \mu\text{m}$, while our study included MPs $\geq 100 \mu\text{m}$. Localized nearshore circulation driven by tidal exchange, wave action, and wind-induced currents in Mogbongcogon may facilitate the dispersion of particles, reducing their accumulation in the water column while promoting deposition in sediments and attachment to seagrass blades. Hydrodynamic processes, including tides, waves, and wind-driven currents, influence the transport and redistribution of microplastics in coastal waters through resuspension, surface drifting, and Langmuir circulation (Zhang, 2017). Tidal fluctuations can directly affect MP abundance and movement, with studies reporting changes in their concentrations during flood and ebb tides as water levels and current velocity vary (Alves et al., 2025). Beach sediments contained the lowest concentration among sediments (0.008 particles/100 g), possibly due to tidal flushing, wave action, and wind-driven redistribution that can remove lighter or surface plastics from the strandline and carry them back into the water column or alongshore. These patterns suggest that seagrass habitats, compared to open beach areas, may serve as temporary accumulation zones for microplastics, where reduced hydrodynamic energy can facilitate particle settling and short-term retention (Tang, 2024; Xue et al., 2025).

It is important to note that the reported abundance values likely underestimate the true MP load in the study area, as the analytical approach was limited to particles $\geq 100 \mu\text{m}$ detectable under stereomicroscopy. Smaller microplastics and nanoplastics, which are increasingly recognized as environmentally significant (Zhao et al., 2022), were not captured in this study. This methodological constraint should be considered when comparing results with studies employing higher-resolution techniques such as micro-FTIR or Raman spectroscopy.

Association Between Microplastic Characteristics and Environmental Matrices

Statistical tests revealed no significant association between microplastic color and environmental matrix ($\chi^2(25, N = 52) = 30.939, p = 0.191$), nor between morphology and compartment ($\chi^2(3, N = 52) = 1.934, p = 0.586$). The absence of significant relationships suggests that visually identifiable traits such as color and shape may not strongly influence microplastic partitioning across environmental matrices in this system. This pattern aligns

with findings from multi-compartment studies (water, sediment, and biota), where microplastic distribution is often driven more by environmental transport processes and habitat characteristics than by particle appearance (Qu et al., 2022; Pagter et al., 2020). Similar variability across coastal habitats has also been reported in seagrass-associated systems, where accumulation patterns are highly heterogeneous (Huang et al., 2020; Gomez et al., 2023; Boshoff et al., 2023).

In contrast, a significant association was observed between polymer type and environmental matrix ($\chi^2(4, N = 52) = 10.592, p = 0.032$, Cramer's V = 0.451), indicating that polymer composition is a more important determinant of distribution patterns. This is consistent with evidence that microplastic fate in marine environments is influenced by intrinsic polymer properties and environmental interactions, including transport behavior, fragmentation, and weathering processes (Wang et al., 2016; Zhang et al., 2017; Yu et al., 2025). Studies in coastal sediments have similarly demonstrated that polymer types are unevenly distributed across depositional environments, reflecting differential transport and retention mechanisms (Alomar et al., 2016; Graca et al., 2017; Qu et al., 2022).

The higher occurrence of polyester in sediments and the water column may reflect widespread use and environmental persistence, as well as its tendency to undergo biofouling and aggregation, which can increase effective density (Wang et al., 2016; Yu et al., 2025). Sediment retention processes are particularly pronounced in structured coastal habitats, where particle settling and trapping are enhanced by reduced hydrodynamic energy (Gacia et al., 1999; Alomar et al., 2016).

The spatial distribution of microplastics in this study indicates that seagrass ecosystems in Mogbongcogon function as effective retention and accumulation zones within coastal environments. Higher microplastic densities in seagrass blades (0.056 particles/10 blades) and sediments (Table 1), compared with the water column (0.005 particles/150 mL), suggest enhanced particle deposition and trap within vegetated habitats. This pattern is consistent with the ability of seagrass ecosystems to slow water flow and promote sedimentation processes (Sanchez-Vidal et al., 2021; Boshoff et al., 2023). The accumulation of MPs in benthic compartments, particularly sediments beneath seagrass beds (n = 19), aligns with reports of microplastic deposition in both seagrass blades and surrounding sediments, highlighting their role as depositional zones in coastal systems (Tahir et al., 2019; Tahir et al., 2020; Datu et al., 2019; Huang et al., 2020). The dominance of fibers across

compartments further supports their entrapment within vegetated structures, while variations in distribution suggest that meadow complexity influences trapping efficiency (Boshoff et al., 2024). Overall, the observed patterns reflect the interaction between seagrass structural complexity, hydrodynamic conditions, and anthropogenic inputs, with potential modulation of trapping processes by environmental disturbances (Arriessgado et al., 2024). Although particle size was not directly measured in this study, existing literature indicates that size is an important factor influencing transport and deposition behavior, with smaller particles more likely to remain suspended and larger particles more prone to sedimentation (Wang et al., 2016; Zhang et al., 2017; Yu et al., 2025). Thus, size may further explain variability in microplastic distribution across matrices in addition to polymer composition and habitat structure.

The significant polymer–matrix association observed here is supported by previous studies showing that microplastic distribution in coastal ecosystems is shaped by a combination of polymer properties and habitat-mediated retention processes (Alomar et al., 2016; Sanchez-Vidal et al., 2021; Boshoff et al., 2023). These findings highlight the role of seagrass meadows as selective depositional environments that influence the spatial distribution and potential ecological exposure of microplastics in coastal systems.

CONCLUSION AND RECOMMENDATIONS

This study revealed that microplastic pollution is present in the coastal ecosystems of Mogbongcogon, with 52 particles identified across seagrass blades, SB sediments, the water column, and BL sediments. The dominance of black fibers composed primarily of polyester were dominant underscores the likely contribution of domestic laundry effluents, fishing gear, and land-based activities to local plastic inputs. Microplastics accumulated in seagrass blades and sediments, suggesting that these matrices act as primary sinks in this system. The significant association between polymer type and environmental matrices indicates that the fate of microplastics is influenced not only by hydrodynamic processes but also by the physical and chemical properties of the polymers.

Although this study is a snapshot assessment and did not measure ecological or socio-economic outcomes directly, the accumulation of microplastics in SB and BL sediments highlights potential pathways for plastics to persist in the environment and enter local food webs. Based on these findings, targeted actions should focus on: improving waste management, reducing synthetic fiber release, and strengthening monitoring of polymer-specific pollution. Future studies should expand sampling over time and include particle size and degradation assessments to better evaluate ecological impacts. Hence, these results provide evidence of microplastic accumulation patterns in Mogbongcogon's seagrass ecosystems and underscore the importance of continued monitoring and localized mitigation measures.

The significance of this research extends across multiple levels. For the local community, the findings contribute to greater awareness of microplastic pollution and its potential consequences for food security and human health, particularly in seafood-dependent households (Tahir et al., 2020; Miller et al., 2020; Hasegawa and Nakaoka, 2021). For policymakers and tourism stakeholders, the results provide a scientific basis for waste management, conservation, and sustainable tourism strategies, mitigating both ecological degradation and economic losses. Finally, for the scientific community, this study enriches the growing body of literature on microplastic pollution in tropical seagrass ecosystems, an area that remains underexplored, by generating localized data

that can inform broader environmental monitoring and management efforts.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

Cate Princess Romina conceptualized the study, contributed to data collection, sample processing, and laboratory analyses. She also assisted in drafting the initial version of the manuscript. Phoebe Nemenzo-Calica supervised the study and provided methodological guidance. She also led the writing, revision, and finalization of the manuscript. Emily Antonio contributed to project administration, fieldwork coordination, and validation of laboratory protocols. She also assisted in data interpretation and manuscript editing.

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