

Assessing Seasonal Trends of Microplastics Distribution in Coastal Sediments of San Lorenzo Guimaras

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ABSTRACT

Microplastics pollution in marine ecosystems has gained global attention due to its environmental and health implications. However, little information on the presence of microplastics on the surface sediments exists in the Philippines despite the fact that the country is considered one of the largest contributors of plastics to the oceans. This study considered one of the pioneering researches in the Province of Guimaras, assessed the seasonal distribution of microplastics in the coastal sediments focusing on four barangays of San Lorenzo: Cabano, M. Chavez, Suclaran, and San Enrique. Sediment samples were collected during the dry (January–February) and wet (September–November) seasons and analyzed for microplastics abundance, type, size, and seasonal variation. Results revealed the presence of microplastics in all sites, with higher concentrations observed during the wet season (1420.07 - 4570.28 particles/kg (dry sediment) compared to the dry season (690.03 - 3460.17 particles/kg (dry sediment)). San Enrique exhibited the highest microplastic load among the study sites. Fragments were the dominant microplastic type, followed by pellets, filaments, and films. Microplastics in the 125–250 µm size range were most abundant in the dry season, while larger particles (250 µm – 5 mm) were more prevalent during the wet season, likely due to increased runoff and hydrodynamic forces. Statistical analyses indicated significant differences ($p = 0.001$) in microplastics distribution across sites and seasons. The study underscores the role of environmental factors such as precipitation, tidal action, and human activities in influencing microplastic deposition patterns. This data will serve as a piece of baseline information in crafting important environmental policies to address plastic pollution in the coastal areas. Long term studies are recommended to better understand, monitor, and prevent further microplastics pollution in the coastal areas of San Lorenzo, Guimaras.

Keywords: Microplastics, coastal sediments, seasonal variation, marine pollution

INTRODUCTION

Background of the study

Microplastics has attracted significant attention over recent years due to its complex effects on human safety, marine ecosystems, and environmental health. Microplastics which are plastic particles smaller than 5 mm (NOAA, 2015; Khan et al., 2025), have emerged as a consequence of the excessive production (Williams & Rangel-Buitrago, 2022) and subsequent degradation of plastics since the 1950s (Stanley et al., 2025). The increasing use of plastic in consumer products, particularly in packaging has increased waste production and contributed to the persistent microplastics debris that has emerged in freshwater (Koelman, et al., 2019; Lu et al., 2021), marine (Yang et al., 2021), and even atmospheric systems (Napper & Thompson, 2016; Welden and Lusher, 2020).

The environmental contamination of microplastics is further complicated by various mechanisms as they enter ecosystems. At least 11 million tons of plastic end in the ocean every year (UNEP, 2021), making 80% of all marine debris found from surface waters to deep-sea sediments (International Union for Conservation of Nature, 2024). As noted in various studies, organisms in all environments routinely interact with plastics, the same is

true for microplastics. Microplastics adherence is a phenomena observed on crustaceans, birds, invertebrates, and fish, (Thaharodi et al., 2024) which mistake microplastics for food and ingest them (Khan et al., 2025). Given that microplastics can act as vector of pollutants (Caruso, 2019; Amelia et al., 2021), concentrating toxic substances (Osman et al., 2023), studies were conducted to evaluate the substantial impacts of the occurrence of microplastics in both human and animal health. The presence of microplastics in coastal sediments has received increased interest in scientific studies due to their possible biological consequences and persistence in marine ecosystems. Microplastics have been found in a variety of coastal regions, including those close to urban and industrial sectors, which are frequently cited as hotspots for microplastic accumulation.

For instance, Sun et al., reported significant concentrations of microplastics in coastal sediments in China wherein Hinghai Bay has the highest average abundance of microplastics at 603.5 ± 217.6 items/kg. Further, Collacion et al., (2020) confirmed the presence of microplastics in the coastal barangays of Anilao, Iloilo, with the fiber and fragments being the most abundant.

Seasonal variability influences the distribution of microplastics in coastal ecosystems (Zong, et al., 2025) . Factors such as wind (An et al., 2024), currents, and human coastal activities significantly affect the movement and accumulation patterns of microplastics (Thushari and Senevirathna (2020). Chen et al. (2021) studied the variation of microplastics druring the dry and wet season.

It was noted that in microplastics are abundant in wet seasons than in dry season. This interspersion of microplastics between sediments and the water column suggests a dynamic relationship influenced by environmental conditions (Conaway et al., 2012), emphasizing the need for continuous monitoring in locations such as San Lorenzo, Guimaras.

Understanding the seasonal trends of microplastic prevalence is essential for precisely evaluating their ecological effects. Seasonal variations may induce fluctuations in sediment movement, meteorological conditions, and anthropogenic activities that affect microplastic accumulation in sediments. Kaposi et al. (2014) observed that the consumption of microplastics by marine species may be affected by seasonal variations, underscoring the necessity for multi-seasonal research to effectively evaluate possible risks to marine ecosystems.

The study by Egbeocha et al. (2018) substantiate the notion that fluctuations in environmental conditions may result in varying effects of microplastics on different marine taxa. Regular evaluations can enhance the formulation of effective management strategies to alleviate the adverse impacts of microplastics on marine organisms and promote a deeper comprehension of their interactions within trophic levels of the marine food web.

Objectives

This study aimed to assess the seasonal trends of microplastic distribution in coastal sediments of Cabano, M. Chavez, Suclaran, and San Enrique, San Lorenzo, Guimaras.

Specifically, this study aimed to:

1. Characterize the type and size of the microplastics in the coastal sediments.
2. Quantify microplastics abundance in coastal sediments across different seasons.
3. Analyze seasonal trends of microplastics concentration.

MATERIAL AND METHOD

Study Area

Four barangays with coastal areas were chosen to represent the study site namely Cabano, M. Chavez, Suclaran, and San Enrique (Figure 1). A total of two sampling stations were established at every study site. The study was conducted during the wet season (September - November) and dry season (January - February).

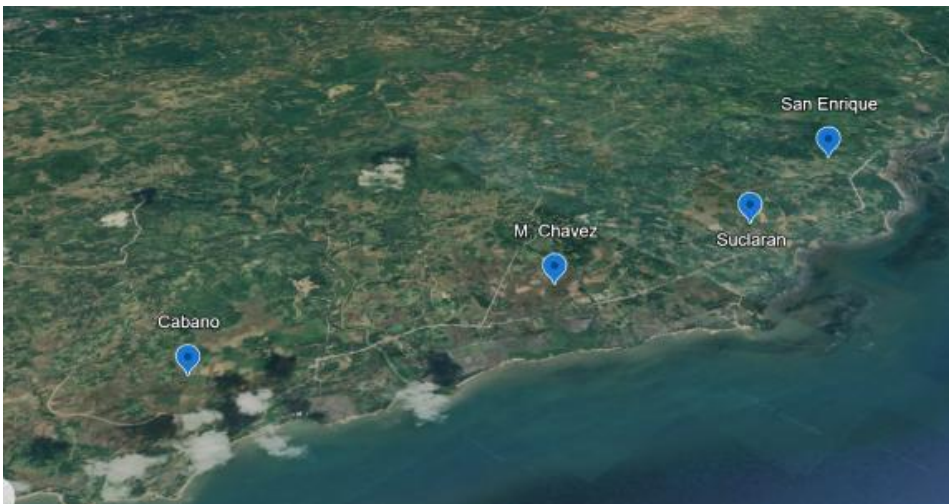


Figure 1. Study area in the coastal barangays of San Lorenzo, Guimaras (Google Earth, 2025)

Sample Collection

The study was conducted during the wet season (September - November) and dry season (January - February). Sediment sampling procedure was adopted from the guidelines for sampling microplastics on sandy beaches by Calcutt et al., 2018 wherein two transects were used for each study site. Specific coordinates of the sampling sites were recorded as shown in Table 1. Considering the study sites contain moderate amount of plastic pollution, a 100 m transect was chosen for each site. Stratified random sampling was utilized to position a 50 x 50 cm quadrat along a 100 m transect. The edge of the 50 x 50 cm quadrat was placed at the edge of the marker and the sampling square begins at that marker position. The sediment sample was collected focusing on the top 5 cm depth utilizing metal shovel and ensuring plastic is avoided. Collected samples were stored in glass bottle and covered with aluminum foil and transported to the laboratory for further processing.

Table 1. Specific coordinates of transects within each site.

Sampling Site	Specific Coordinates
Cabano (Site 1)	10° 34' 23.02" N, 122° 42' 22.76" E
M. Chavez (Site 2)	10° 35' 23.14" N, 122° 42' 35.96" E
Suclaran (Site 3)	10° 36' 34.23" N, 122° 43' 14.69" E
San Enrique (Site 4)	10° 38' 22.99" N, 122° 43' 31.45" E

Sample Preparation and Extraction

Sample preparation protocol was adopted from the microplastics manual established by Inosente et. al., (2023) wherein wet sediment samples were oven-dried at 90°C until dry. Sediment samples were then isolated from large debris particles by passing through a stack of sieve with mesh sizes between 1mm and 5mm in size. Approximately one hundred fifty (150) grams of the dried sediment sample was weighed in a beaker and one hundred fifty (150) mL of 10% of KOH solution was added for organic matter digestion. The sample was digested for 40 hours in an oven maintained at 40°C with continuous stirring every 4 hours. Density separation was initiated by adding 30% NaCl solution, ensuring to double the volume of the sample. The mixture was allowed to settle overnight, allowing the microplastics sample to rise to the surface of the solution. The mixture was decanted and filtered in a Whatman filter paper. The filter paper was oven dried at 40°C to achieve the desired dryness.

Visual Inspection of Microplastics

The extracted microplastics were examined and photographed using a 3.1 - Megapixel CMOS camera connected to an Amscope microscope with magnification of 4x to 40x. The size of microplastics were analyzed using the ToupView software equipped with the digital microscope. Microplastic particles were sorted according to their

color, size, and shape using the classification from the studies of Osorio et al., (2021) and Hidalgo - Ruiz et al., (2012).

Statistical Analysis

Microplastic abundance in the surface sediment samples was expressed as the particles per kg dry weight (number of microplastics/kg sediment (dry wt). All values were reported as mean $\pm$ standard deviation. Statistical analysis for the correlation of microplastics in sediment samples were performed using SPSS software.

RESULTS AND DISCUSSION

The presence of microplastics was observed in all surface sediment samples collected from sampling sites along the four coastal barangays of San Lorenzo, Guimaras. Microplastics abundance in the sediment samples for dry season ranged from 690.03 - 3460.17 particles/ kg (dry weight) with an average standard deviation of $\pm$ 211.01. During the wet season, the microplastics abundance in the sediment samples ranged from 1420.07 - 4570.23 particles/ kg (dry weight) with an average standard deviation of $\pm$ 220.50. In general, the microplastics abundance in coastal sediments across all sites was significantly higher during wet season ($p = 0.001$) than during the dry season. Furthermore, the average microplastics abundance in the surface sediments of San Enrique was approximately twice than that of other sites (Figure 2). The observed seasonal variation may have resulted from concentrated rainfall, substantial runoff, tides (Manalo et al., 2023), flash floods, and terrestrial sources during the wet season which causes the resuspension of microplastics in sediments and migration of these plastics to coastal areas with water flows (James et al., 2020; Chen et. al., 2021). The proximity of river mouths to the sampling site, specifically for M. Chavez and San Enrique may have contributed on the high level of microplastics likely originating from household waste and river discharges during wet season. Moreover, a runoff and tributary was also observed in Suclaran and San Enrique which originated from households near the sampling area.

The results of the study conforms with the study of Eo et al., (2019) and Talbot and Chang (2022) wherein microplastics load was concentrated in the wet season due to larger amount of precipitation. The heavy rains during the wet season would lead to the runoff of terrestrial debris, increasing riverine microplastics emissions to the ocean.

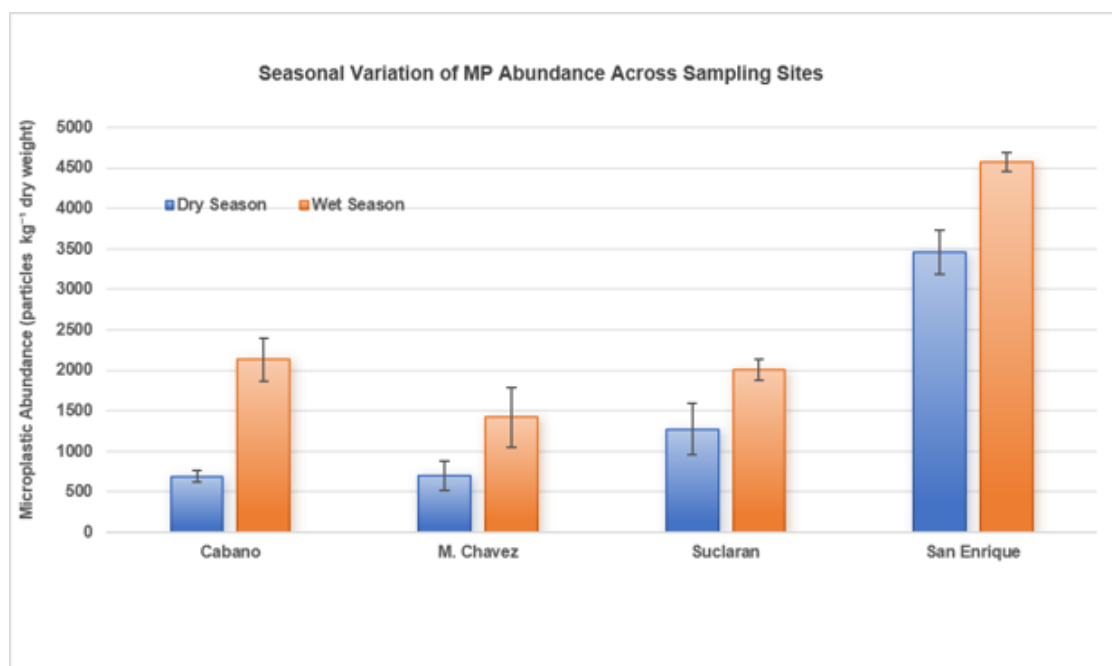


Figure 2. Microplastics abundance in the surface sediments collected from coastal areas of Cabano, M. Chavez, Suclaran, and San Enrique.

A study of the size distribution of microplastics in coastal sediments across wet and dry seasons revealed notable patterns in particle size dominance and seasonal variations. Microplastics measuring between 125 μ m and 250

μm (Figure 3) were identified as the predominant size fractions at all sites, exhibiting significantly higher concentrations throughout the dry season. This indicates that smaller microplastics, likely originating from the disintegration of larger plastic materials, tend to aggregate and deposit in sediments under conditions of less hydrodynamic disturbance. However, the wet season demonstrated

an even distribution of microplastic sizes, with marginally elevated proportions of bigger particles (250 μm - 5 mm), presumably attributable to enhanced surface runoff conveying macroplastic fragments from terrestrial sources into the coastal environment. The ubiquitous presence of microplastics across all size categories at every study site signifies many contamination sources, including urban runoff, fishing operations, and home garbage. Furthermore, location-specific disparities indicate differing levels of plastic pollution influx, with San Enrique exhibiting a comparatively elevated concentration of microplastics across all size categories, so strengthening the notion that this region may be more adversely affected by anthropogenic activity.

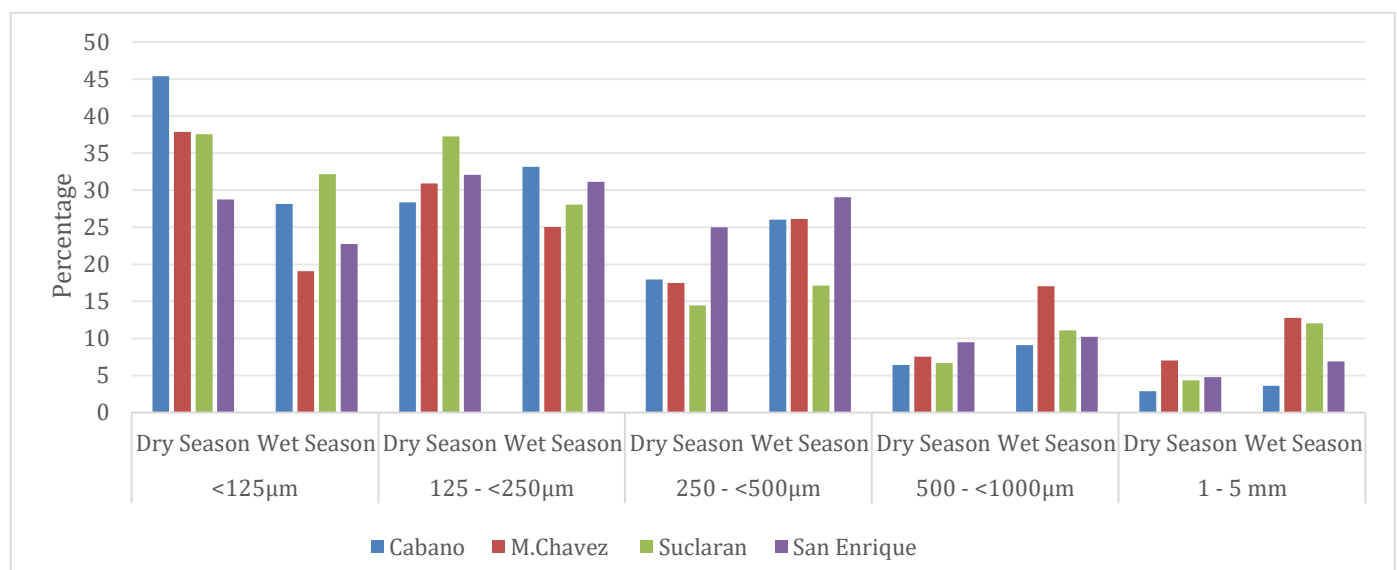


Figure 3. Relative proportion of different sizes of microplastics collected from the surface sediments of Cabano, M. Chavez, Suclaran, and San Enrique.

Microplastics are emerging contaminants that present considerable environmental hazards owing to their durability, capacity to carry toxic substances, and possible consumption by aquatic life forms (Stapleton et al., 2023; Ziani et al., 2023). A critical characteristic affecting their impact is color, which influences degradation, bioavailability, and function as vectors for pollutants (Caruso, 2019). Figure 4 depicts the seasonal and spatial distribution of microplastics by color across all sites, highlighting significant patterns in their occurrence across all sampling sites and seasons. Colored microplastics were the dominant color category across all sampling sites and seasons, indicating their widespread occurrence in the study area. Their abundance was generally higher during the wet season (44.56%), suggesting that runoff may contribute to the transport of pigmented plastic particles into coastal environments. White microplastics were the second most abundant category, accounting for 26.37% and 21.09% of the total microplastics during the wet and dry seasons, respectively. Transparent microplastics occurred at lower proportions, comprising 24.25% during the wet season and 15.38% during the dry season. Black microplastics also exhibited considerable abundance, with a 13.78% increase during the dry season. Overall, seasonal variations in microplastic color composition suggest that hydrological conditions and runoff processes influence the distribution and accumulation of microplastics in coastal sediments.

Table 2. Potential sources and environmental impacts of microplastics color categories

Color Category	Possible Sources	Environmental Impact	REFERENCES
Colored	packaging materials, fragmented consumer plastics	Increase ingestion by marine organisms due to resemblance to prey items	Kaposi et al. (2014); Talbot & Chang (2022); Napper & Thompson (2016)

Transparent	Fishing lines, food packaging films, plastic bags	Susceptible to UV degradation and nanoplastic formation	Xia et al. (2021); Yang et al. (2021)
Black	Tire wear particles, synthetic rubber, road dust	Act as vectors transporting contaminants through aquatic and terrestrial ecosystems.	Eo et al. (2019); Sun et al. (2021)
White	Polystyrene products, food containers, foam packaging	High buoyancy promotes dispersal and redistribution in aquatic environments	Sun et al. (2021); Koelmans et al. (2019); Xia et al. (2021)

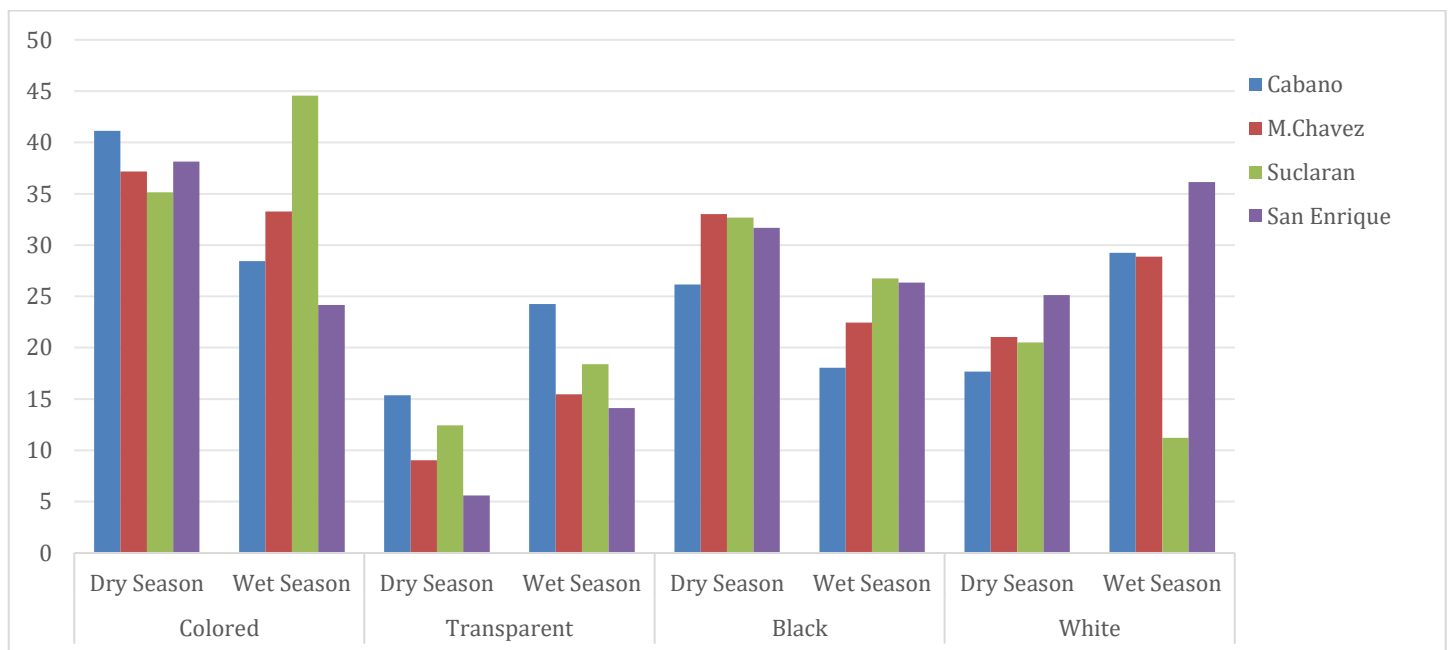


Figure 4. Relative proportion of different color of microplastics collected from the surface sediments of Cabano, M. Chavez, Suclaran, and San Enrique.

The investigation of microplastic types in coastal sediments throughout wet and dry seasons showed significant variations in composition and seasonal distribution. Fragments were found to be prevalent across various microplastic categories, comprising an average of 46.64% during the dry season and 41.46% during the rainy season across all sites. This indicates that fragmented plastic debris, presumably originating from the degradation of bigger plastic items like packaging and fishing equipment, significantly contributes to microplastic contamination in the examined sites. Pellets, comprising an average of 35.75% during the dry season and 29.57% during the wet seasons generally consisting of pre-production

plastic materials or degraded microplastics, were the second most prevalent category, exhibiting rather consistent concentrations during both seasons. Filaments, presumably derived from fishing nets, ropes, and synthetic fibers from apparel, were found in diminished amounts but exhibited minor increases during the rainy season, perhaps attributable to surface runoff conveying fibers from home and industrial wastewater. Films, typically linked to plastic bags and flimsy plastic packaging, demonstrated modest concentrations, with a marginal rise in certain areas during the dry season, potentially attributable to sediment retention over time. Foam, typically sourced from polystyrene materials utilized in packaging and fishing floats, was the least prevalent microplastic kind, suggesting less intake or accelerated disintegration in marine ecosystems. Seasonal variations demonstrate that while microplastic fragments and pellets are consistently present, increased runoff and hydrodynamic forces during the wet season can redistribute and transport smaller particles, leading to fluctuations in the relative abundance of different microplastic forms (Xia et al., 2021).

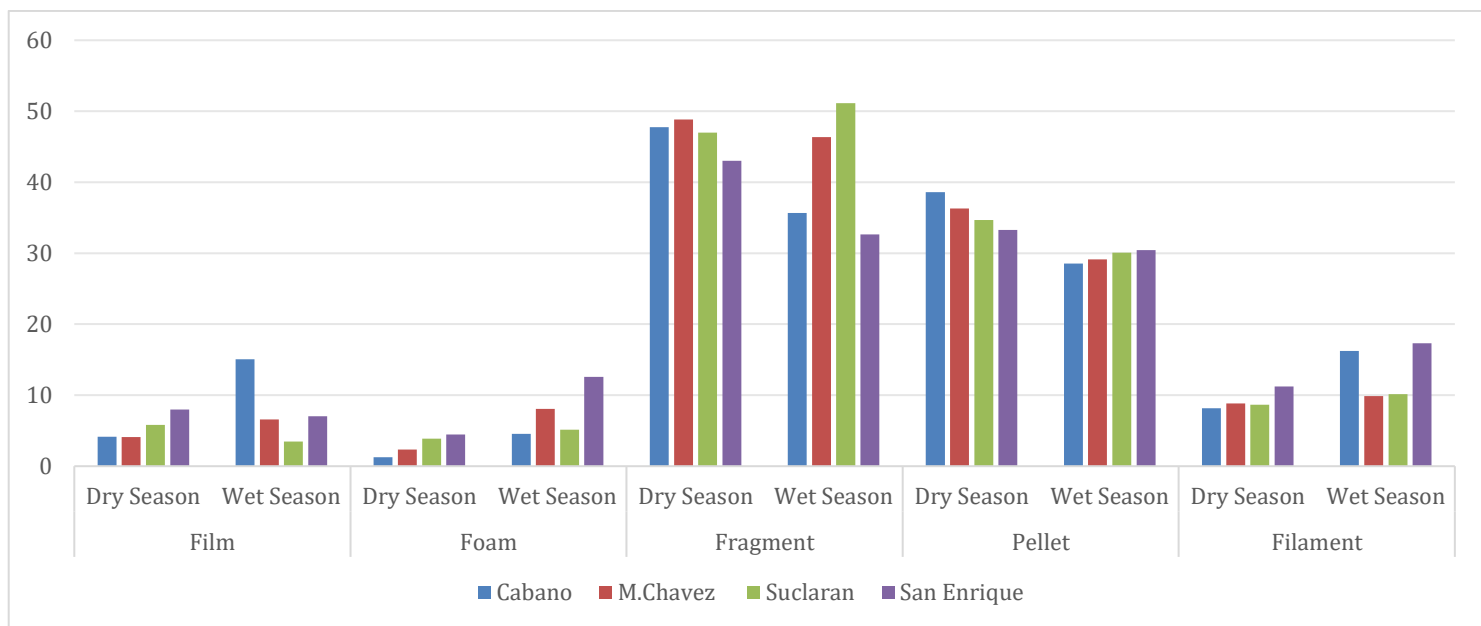


Figure 5. Relative proportion of different types of microplastics collected from the surface sediments of Cabano, M. Chavez, Suclaran, and San Enrique.

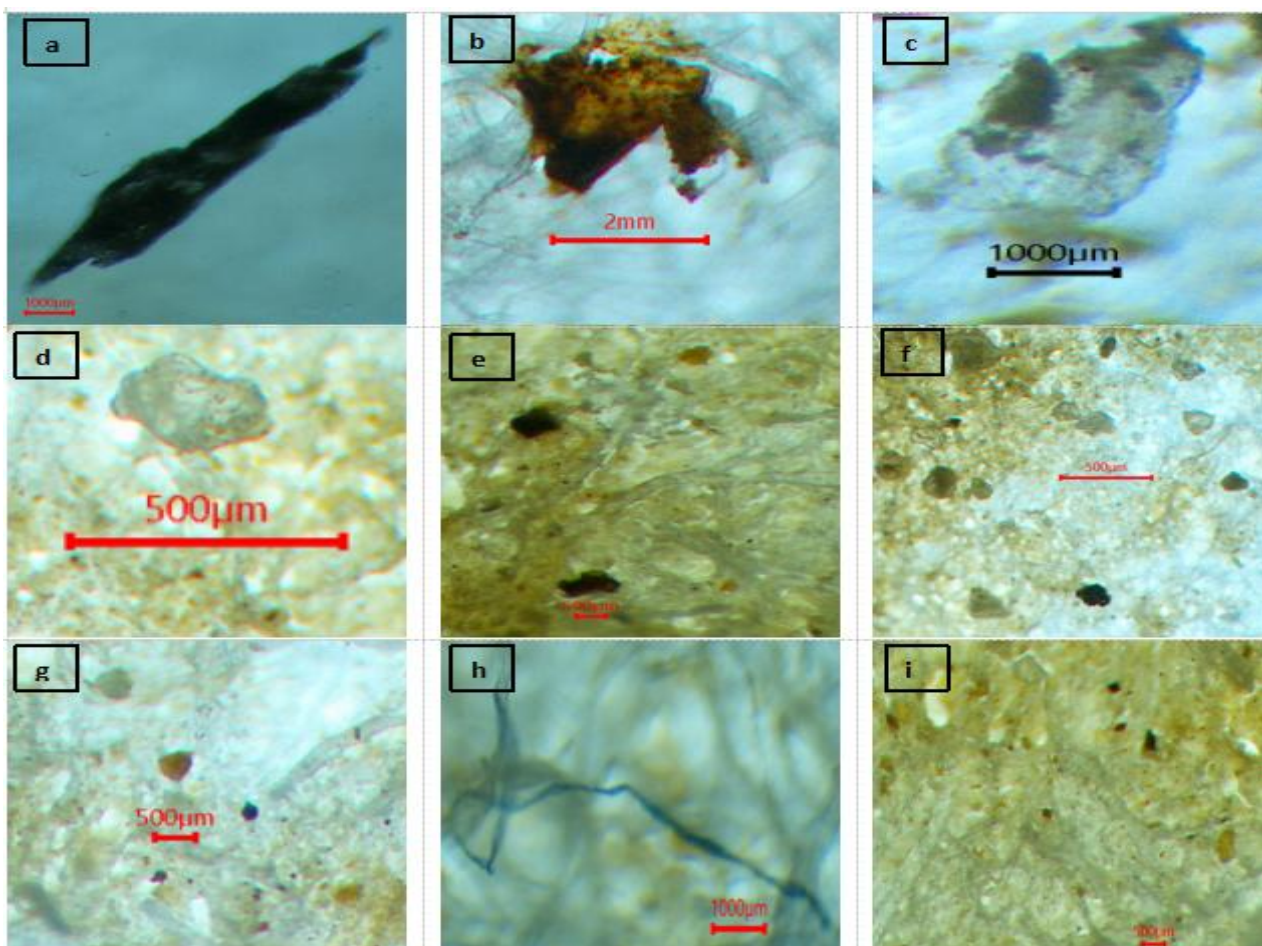


Figure 7. Representative microscopic photographs of found microplastics in the four sampling sites. (a - b) Films, (c - d) Foam, (e & i) pellets, (f - g) fragments, (h) fiber

LIMITATIONS

The microplastics sampling was conducted only at selected four coastal barangays and may not fully represent the spatial heterogeneity of microplastic distribution throughout the entire coastal area. Seasonal and

hydrodynamic variations occurring outside the sampling period may also influence microplastic abundance and characteristics. Additionally, although visual characterization enabled the identification of microplastic abundance, size, shape, and color, polymer composition was not determined through Fourier Transform Infrared Spectroscopy (FTIR). Hence, some particles visually classified as microplastics may have been misidentified, and the specific polymer types has not been confirmed. Further studies should be considered to incorporate broader spatial and temporal sampling and spectroscopic verification to improve the accuracy and reliability of microplastic assessments in the coastal areas of San Lorenzo, Guimaras.

CONCLUSION

This study assessed the seasonal distribution of microplastics in coastal sediments of San Lorenzo, Guimaras, specifically in Cabano, M. Chavez, Suclaran, and San Enrique. The results confirmed the presence of microplastics in all sampling sites, with a higher concentration during the wet season (1420.07 - 4570.28 particles/kg (dry sediment) compared to the dry season (690.03 - 3460.17 particles/kg (dry sediment)). San Enrique exhibited the highest microplastic abundance, suggesting significant contamination from local sources and environmental factors such as runoff and hydrodynamic processes. The dominant microplastic types were fragments, pellets, filaments, and films, with fragments being the most prevalent in all sites. Smaller microplastic particles (125–250 μm) were more abundant during the dry season, while larger particles (250 μm – 5 mm) were more prominent during the wet season, likely due to increased runoff transporting larger plastic debris into the coastal environment.

The study highlights the seasonal influence on microplastic distribution, with environmental conditions such as precipitation, riverine and terrestrial input, playing a crucial role in their transport and deposition. The significant variation across sites suggests that both natural hydrodynamic forces and human activities contribute to microplastic pollution. This data will serve as a piece of baseline information in crafting important environmental policies to address plastic pollution in the coastal areas. Lastly, these findings emphasize the necessity of continuous monitoring and the implementation of pollution management strategies to mitigate microplastic contamination in coastal ecosystems.

RECOMMENDATIONS

Based on the result of the study on the assessment of the seasonal abundance of microplastics in coastal sediment, following recommendations were made:

1. Continuous monitoring and long-term study to better understand contamination sources and distribution patterns.
2. Implement local awareness campaigns to educate local communities on the environmental impact of plastic waste.
3. Strengthen waste management policies including reduction of single - use plastics.
4. Improve wastewater management systems to reduce the transport of microplastics to marine environment.
5. Strengthen collaboration between NGOs, LGUs, research institutions, and local communities to develop evidence-based policies.
6. Enforce strict regulations on plastic waste disposal to reduce microplastic pollution.

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