

Classification of microplastic characteristics in surface water and sediments in the lower Mekong river (Vietnam) in the dry season

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Abstract: *The study analyzes the distribution and composition of microplastics at 17 locations along the Mekong River (Vietnam) during the dry season (April 2024). Microplastic samples were collected from both surface water and riverbed sediments. Optical microscopy was used to observe and identify the shape characteristics of microplastics, while Fourier Transform Infrared (FTIR) spectroscopy was applied to analyze the polymeric composition. Preliminary results indicate that the distribution of microplastics at monitoring stations depends on various factors, including geographical location, degree of urbanization, transportation activities, population density, riverside exploitation activities, and the hydrological characteristics of the river. Higher densities of microplastics were found in areas near urban centers and residential activities, as well as in riverside exploitation zones. The most common microplastic shapes identified were fibers and fragments. FTIR analysis revealed that Polystyrene (PS), Polypropylene (PP), Polytetrafluoroethylene (PTFE), and Nylon are the primary types of polymers. Comparisons between surface water and sediment samples showed that microplastic accumulation was higher and more diverse in water, with fragments consistently accounting for a larger proportion in most samples. The study provides an overview of the microplastic pollution status in the Mekong Delta river system, serving as a foundation for further research on the environmental impacts on riverside communities.*

Keywords: *Microplastics, Mekong River Delta, Dry season, Microscopy, FTIR*

1. Introduction

In the early years of the 20th century, plastics began to be researched and produced, but they were not widely recognized or used [1]. By the 1950s, plastics became widely used and developed rapidly due to human demand [2] because of their flexibility, durability, malleability, and lightweight properties. Today, the variety of products and types makes it easy for people to access plastic products, leading to a surge in production from 2005 to 2017 [3]. In 2018, plastic production reached 359 million tons, with an annual growth rate of 3% (PlasticEurope, 2019) [4], and it is projected to increase to 1,800 million tons by 2050 [5]. Since the early 1970s, awareness has increasingly focused on pollution arising from plastic disposal and related material solutions [6]. The contradiction between the advantages and disadvantages of durability has made plastics difficult to decompose, persisting in the natural environment [3].

After half a century, Thompson and colleagues (2004) first mentioned microplastics as a new source of pollution [7]. Microplastics are tiny fragments of plastic materials, resulting from environmental factors such as temperature, light, humidity, and human activity, measuring less than 5 mm [8]. However, during the degradation process, plastics gradually lose their inherent integrity, becoming brittle and less durable [9]. Microplastics can be found almost everywhere, including sediments, water (both marine and freshwater), organisms, air/dust, wastewater treatment plants, and salt [10]. Plastic pollutants in aquatic

ecosystems have gained widespread attention and research efforts since the early 1970s [6]. However, compared to marine environments, the occurrence of microplastics in river systems is still not well understood, particularly in river sediments [11].

Currently, microplastic pollution is one of the most hazardous types of pollution affecting the environment, organisms, and human life [12]. Vietnam is known as one of the highest plastic-consuming countries in Southeast Asia [13]. The Mekong Delta in Vietnam is concerned about several issues related to microplastics, such as a lack of wastewater treatment facilities and poor management of plastic waste from agriculture, aquaculture, and related activities [14]. As a result, research on the presence of microplastics in this area has gained more attention. However, the number of studies is still limited, with some focusing only on specific areas, such as peatlands in Long An Province [15], or broader regions like the Tien River (the northern branch of the Mekong Delta) [14].

To observe and identify microplastics, optical microscopy is one of the most commonly used tools [16], [17]. To facilitate the detection of microplastics in samples, Raman spectroscopy and Fourier-transform infrared (FTIR) spectroscopy are applied as modern methods that provide more reliable results compared to optical microscopy [7]. The use of scanning electron microscopy combined with energy-dispersive X-ray spectroscopy (SEM/EDS) allows for the rapid and efficient screening of large quantities of microplastic particles, minimizing misidentification [16]. In recent years, thermal analysis, including thermogravimetric analysis combined with differential scanning calorimetry and pyrolysis gas chromatography/mass spectrometry (Pyr-GC/MS), has been used to quantify microplastics in environmental samples [18].

This study aims to identify the shapes and classify common microplastics in the environment through observations using optical microscopy and attenuated total reflectance Fourier-transform infrared (ATR-FTIR) spectroscopy throughout the Mekong River area (Vietnam).

2. Research subjects

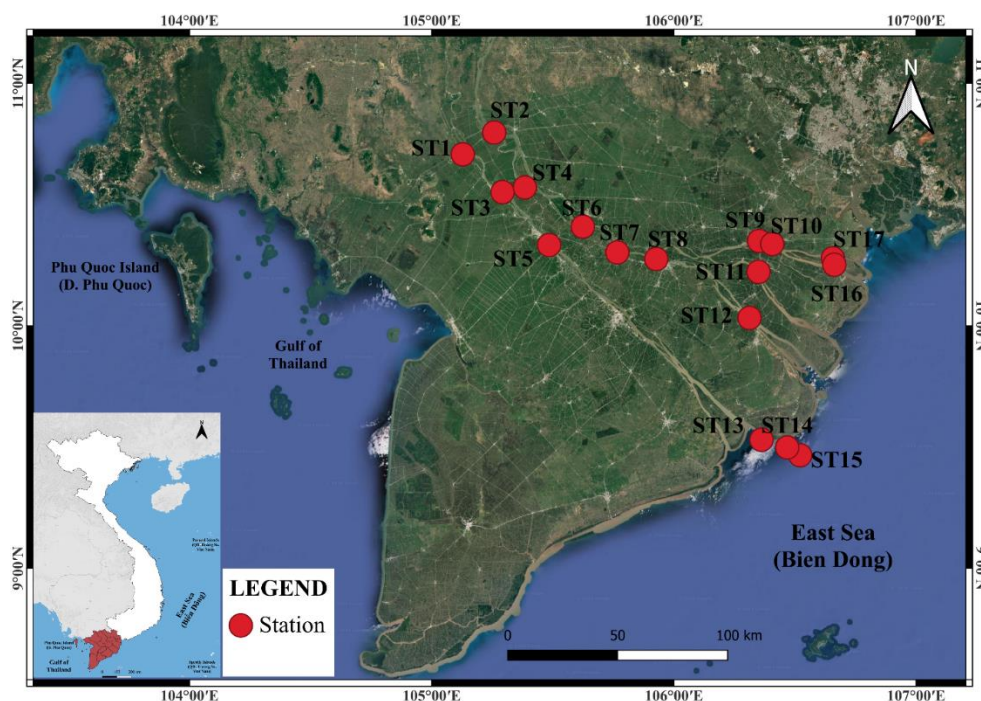


Fig. 1. Study area and sampling locations

The Mekong Delta (Vietnam) is one of the largest delta plains in the world, covering approximately 39,000 km² and supporting tens of millions of people in southwestern Vietnam [19]. The river flow into the Mekong Delta varies seasonally, typically ranging from 2,100 m³s⁻¹ in April (low flow season) to 40,000

m³s⁻¹ in September (high flow season) [20]. The climate is tropical monsoon, with two distinct seasons: the rainy season from May to October and the dry season from November to April. This region is influenced by two tidal sources: a regular semi-diurnal tide of 3.5 m from the East Sea and irregular tides of 0.8 to 1 m from the Gulf of Thailand [20].

In this study, surface water and sediment samples were collected during the dry season along both banks of the Mekong River (Vietnam) on April 11 and 12, 2024 (Fig. 1). Water and sediment samples were taken from 17 different locations along the banks of the Tien River and Hau River, from the upstream areas of Chau Doc (An Giang) and Tan Chau (Dong Thap) to the river mouth area (Cu Lao Dung). Notably, sediment samples were not collected from two locations: ST5 (Vam Cong Ferry) and ST15 (Cu Lao Dung). Most samples were collected around ferry or boat landing areas, where there is a high density of people and vehicles, such as Tan Long Ferry (ST17) and Vam Cong Ferry (ST5), or in densely populated areas like Lien Hoa Pagoda (ST16) and My Tho yacht harbor (ST9). Detailed information is provided in Table 1.

Tab. 1. Locations of Samplings along Lower Mekong River (Vietnam)

Station	Latitude	Longitude	Station name	Description
ST1	10°42'25.66"N	105° 7'41.04"E	Chau Giang Ferry, Chau Doc, An Giang.	Upstream of Hau River, ferry crossing, densely populated.
ST2	10°47'50.07"N	105°15'28.40"E	Tan Chau Ferry, Hong Ngu - Dong Thap.	Upstream of Hau River, ferry crossing, densely populated.
ST3	10°33'4.60"N	105°17'31.99"E	Nang Gu Ferry, Binh My, Chau Phu, An Giang.	Upstream of Hau River, continuous ferry service, populated riverbanks.
ST4	10°34'14.01"N	105°23'5.05"E	Kien An ferry terminal, Kien An, Cho Moi, An Giang.	Upstream of Tien River, near shipyard, densely populated.
ST5	10°19'59.04"N	105°29'4.16"E	Vam Cong Ferry, Long Xuyen City, An Giang.	Midstream of Hau River, strong current with boats passing through.
ST6	10°19'59.04"N	105°29'4.16"E	Cao Lanh bridge embankment, Dong Thap.	Midstream of Tien River, calm waters, lots of trash and stones.
ST7	10°18'8.73"N	105°45'57.96"E	Hoang Sa Street, Sa Dec, Dong Thap.	Midstream of Tien River, floating water hyacinth, densely populated.
ST8	10°16'31.27"N	105°55'37.09"E	My Thuan Hydrological Station, Vinh Long.	Downstream of Tien River, boats passing through.

ST9	10°20'59.09"N	106°21'4.97"E	My Tho Marina, My Tho, Tien Giang.	Downstream of Tien River, boats anchored, strong winds, lots of trash, water hyacinth.
ST10	10°20'14.08"N	106°24'21.11"E	Lien Hoa Pagoda, Cho Gao, Tien Giang.	Downstream of Tien River, densely populated, frequent pilgrims, fish release activities.
ST11	10°13'20.75"N	106°20'57.00"E	My Hoa Hydrological Station, Ben Tre.	Ham Luong River, densely populated, water hyacinth present.
ST12	10° 1'56.34"N	106°18'42.81"E	Co Chien Bridge, Mo Cay Nam, Ben Tre.	Co Chien River, stagnant, weak current.
ST13	9°31'47.64"N	106°21'41.04"E	Cu Lao Dung, Soc Trang.	Tran De River mouth, Hau River.
ST14	9°27'57.18"N	106°31'16.20"E	Cu Lao Dung, Soc Trang.	Tran De River mouth, Hau River.
ST15	9°29'52.62"N	106°28'2.64"E	Cu Lao Dung, Soc Trang.	Tran De River mouth, Hau River.
ST16	10°15'7.04"N	106°39'43.64"E	In the middle of the river, Phu Thanh, Tan Phu Dong, Tien Giang.	Tien River, flowing into Tieu River mouth. Sample contaminated with sand from riverbank. Construction site along the shore.
ST17	10°16'41.31"N	106°39'21.27"E	Tan Long Ferry, Phu Thanh, Tan Phu Dong, Tien Giang.	Tien River branch, flowing into Dai River mouth, continuous ferry service.

3. Methodology

3.1. Survey and field methods.

Water samples: At each sampling location, surface water samples were collected three times in succession using stainless steel buckets, with each collection equivalent to 10 liters of water. The samples were then poured through a filter with a mesh size of 25 micrometers (μm) (Fig. 2), allowing the microplastics to settle in a funnel, resulting in approximately 20 ml of concentrated sample. The water samples were subsequently stored in brown glass bottles to prevent any increase in microplastic concentration that could occur from using plastic containers.

Sediment Samples: Sediment was collected using a stainless steel sediment sampling device, specifically a hand-operated grab sampler designed for collecting riverbed sediment (Fig. 3). This method is suitable for gathering sediments from underwater environments, including rivers, lakes, reservoirs, and other locations. The collected sediment was then placed in ziplock bags and transported to the laboratory of the Department of Oceanology, Meteorology and Hydrology for further analysis.



Fig. 2. Filter net



Fig. 3. Sediment sampling hoe

3.2. Laboratory analysis method

Water sample processing:

To avoid environmental contamination during chemical analysis and to minimize costs and hazards during experiments, this study utilized castor oil to separate microplastics from water samples [21]. The water sample processing followed these steps (Fig. 4):

Step 1: Pour 20 ml of the water sample from the brown glass bottle into a pear-shaped funnel. Shake it thoroughly for 30 seconds to mix the compounds. Add castor oil to the funnel at a ratio of 1:10 and shake well for 3 minutes. Allow the funnel to stand vertically for 1 hour.

Step 2: Transfer the water and sediment that settled at the bottom of the funnel into a glass beaker and cover it with aluminum foil. The oil layer on top is then filtered under vacuum using Whatman GF/C filter paper with a diameter of 47 mm, thickness of 0.26 mm, and pore size of 1.2 μm. Rinse and wash the funnel with 50 ml of ethanol to prevent oil and plastic residues from adhering to the funnel walls.

Step 3: Place the sample into a closed Petri dish and put it in an oven set at approximately 60°C for 72 hours.

Step 4: Examine the sample and classify the microplastics based on their shapes.

Step 5: Record the results.

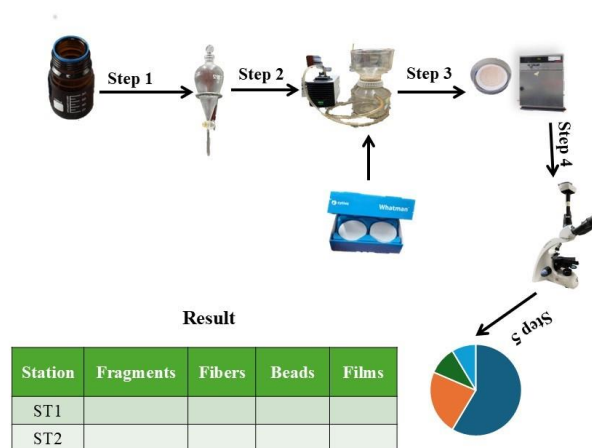


Fig. 4. Water sample analysis process

Sediment sample processing:

V. Hidalgo-Ruz (2012) [22] the methods for analyzing and separating microplastics from the environment have been synthesized in previous studies. When sediment samples from rivers are brought back from the field, they need to be dried in an oven at 60°C until completely dry. The processing of river sediment involves the following steps to achieve the final product (Fig. 5):

Step 1: Take 10 g of the dried sediment sample to treat the organic matter present in the soil. Add 20 ml of FeSO₄ and stir the mixture, then add 20 ml of H₂O₂ to accelerate the reaction. Place the mixture into a beaker and use a stirrer at a speed of 240 rpm and a temperature of 70°C for 30 minutes to ensure thorough mixing and faster organic separation. After each stirring session, add an additional 20 ml of H₂O₂ and continue stirring with the programmed device until no more bubbles are produced.

Step 2: Place the sample in the oven at approximately 60°C until dry, for about 72 hours.

Step 3: Dissolve the dried sample in 50 ml of ZnCl₂ and transfer it to a sedimentation funnel; the plastic particles will be retained by the zinc salts.

Step 4: Filter under vacuum using Whatman GF/C filter paper with a diameter of 47 mm, thickness of 0.26 mm, and pore size of 1.2 µm. Rinse and wash the funnel with distilled water to prevent plastic residues from adhering to the funnel walls.

Step 5: Place the sample into a closed Petri dish and put it in the oven at approximately 60°C for 72 hours.

Step 6: Examine the sample and classify the microplastics based on their shapes.

Step 7: Record the results.

Microplastic particles on the filter are identified and counted using an Euromex stereomicroscope, magnified 100 times.

Microplastic particles on the filter paper were identified and counted using a Euromex stereo microscope magnified 100 times compared to real life.

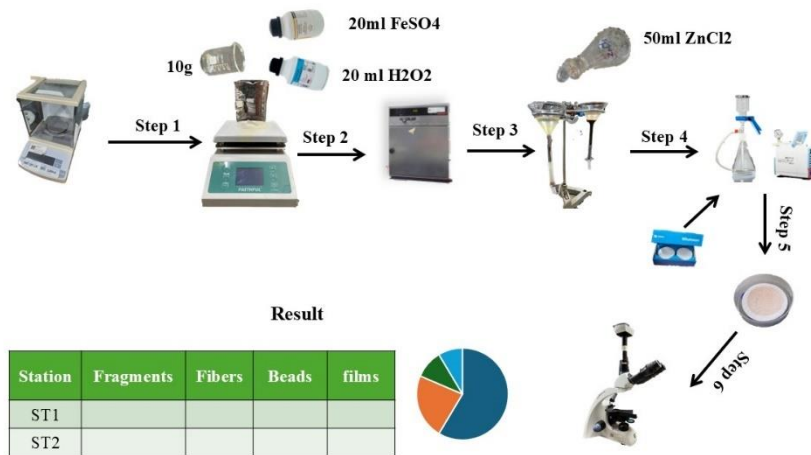


Fig. 5. Sediment sample analysis process.

3.3. Analysis Using Attenuated Total Reflectance Fourier-Transform Infrared Spectroscopy (ATR-FTIR)

The Thermo Scientific Nicolet iS5 Fourier-transform infrared spectrometer (FTIR) spectroscopy has been widely utilized in microplastic (MP) pollution research since 2004 [10]. FTIR is currently the most popular method for identifying microplastics. Recent advances in micro-FTIR (m-FTIR) imaging have enabled the automatic identification of microplastics concentrated on filter membranes without prior sorting[23].

FTIR is a widely recognized, rapid, and fairly reliable method for identifying the polymer types of various microplastics[10].

In this study, we employed Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) spectroscopy in the spectral range of 4000 – 400 cm⁻¹. The samples were tested three times, yielding consistent results. The operating principle of the spectral transformation process is explained in Figure 5 [24]. The typical components of a Fourier Transform Infrared Spectrometer include a source, an interferometer, a sample chamber, a detector, and a computer. The source emits infrared energy. This beam passes through a control aperture that regulates the amount of energy transmitted to the sample and finally to the detector. The beam enters the interferometer, where the interference of two light beams is used to make precise measurements. The interferometric signal obtained exits the interferometer and enters the sample chamber. This is where specific energy frequencies characteristic of the sample are absorbed. Samples with the same frequencies will be absorbed, resulting in digitized outputs sent to the computer for Fourier transformation. Finally, the infrared spectrum is presented for analysis and evaluation.

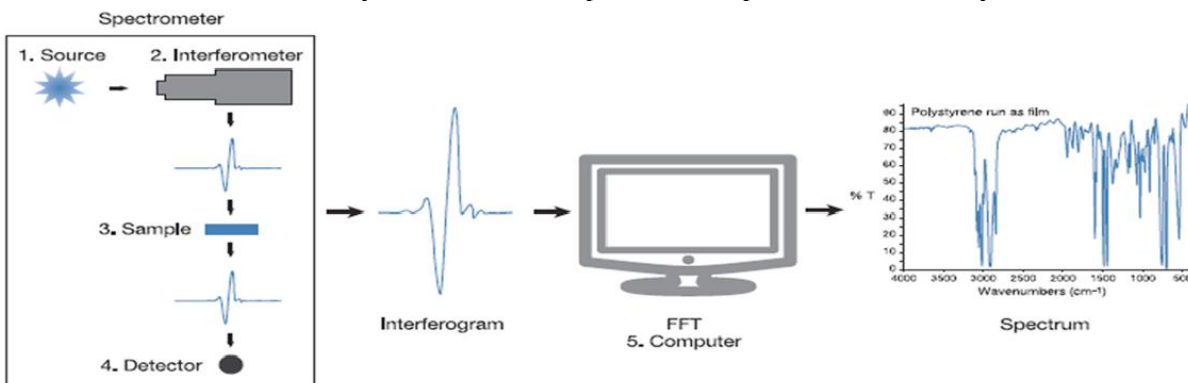


Fig. 6. Infrared spectrometer analysis diagram

4. Results

4.1. Microplastic Morphology

Based on the classification by Hendrickson et al (2018), this study categorizes microplastics into four basic types: fragments, fibers, beads, and films (Table 2) [25]. According to their origin in the environment, microplastics are divided into two main categories: primary microplastics and secondary microplastics.

Primary microplastics are those that are directly released into the environment through products such as facial cleansers and moisturizers, which contain microbeads. Secondary microplastics arise from the degradation of plastic waste through human activities and production processes, such as plastic bags, bottles, and fishing gear. These materials begin to break down and transform into very small fragments, fibers, or films that are often difficult for the human eye to see and recognize. [26],[27].

Tab. 2. Classification and Description of Basic Microplastic Morphology

Morphology	Description
Fragments	Irregular shape, usually rigid. Fragments must have a distinct three-dimensional shape, likely to be secondary microplastics.
Fibers	Length is more than three times the width, cylindrical in shape. Primarily derived from synthetic fabrics and classified as primary microplastics.
Beads	Spherical in shape, likely to be primary microplastics.
Films	Length and width are significantly greater than thickness; can be as thin as paper and flexible. Originates as secondary microplastics.

4.1.1. Microplastic Morphology Classification in Water Samples.

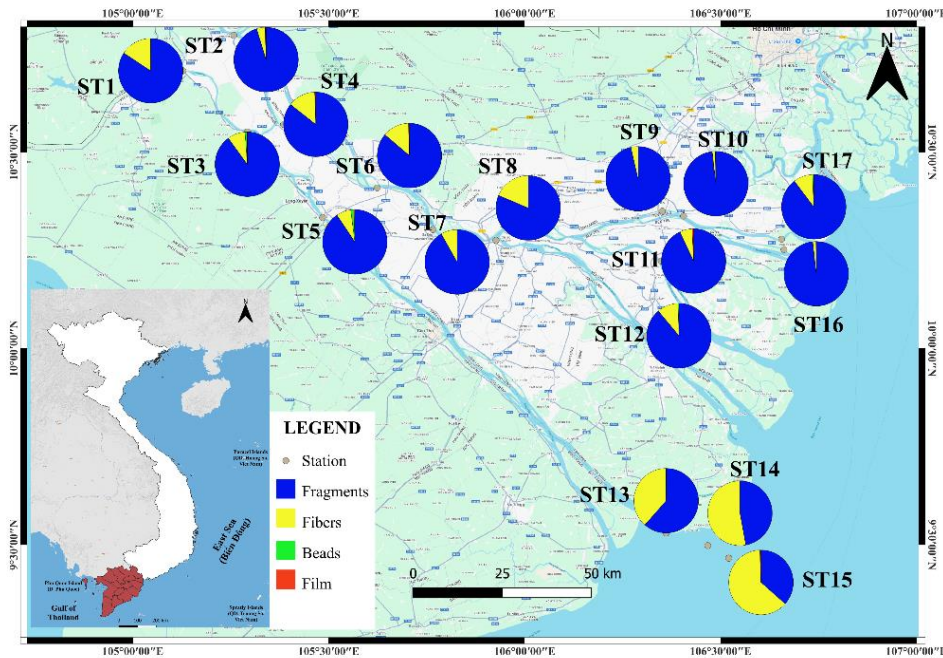


Fig. 7. Water sample results

Figure 7 and Table 3 present the occurrence of microplastics in water samples. Generally, fragments and fibers are the most common forms observed, with significant differences between the shapes. Fragments account for the highest percentage in most locations, at about 83.2%, while fibers make up 16.3%, beads 0.3%, and films 0.2%. However, samples taken at ST13, ST14, and ST15 in the river mouth region show a dominance of fibers, with the highest percentage at ST15 at about 63%. Fragments and fibers are secondary microplastics, formed from the degradation of larger plastic materials discarded into the environment, which over time break down due to environmental factors. Fibers, being lighter and longer, are more easily carried away by currents compared to other types of microplastics [25]. At locations ST9, ST10, and ST16, the average occurrence of fibers is lower, at 3.6%, 1.5%, and 1.6%, respectively. This rate is significantly lower than the average (9.7%). These three areas have dense populations, and most household waste is directly released into the environment; for instance, ST10 often sees visitors who release fish on the 1st and 15th (lunar calendar) of every month for religion, while ST16 is a material storage site, where fragments are more prevalent than fibers.

The total number of observable microplastics was 28,220 particles, averaging 1,660 particles per location. The area with the highest density of microplastics is ST16, with 12,595 particles; observations of the surrounding environment indicate that this area has a storage site for construction materials like soil, sand, and stones from construction sites. Hence, the results may be confused with other materials. The area with the lowest density of microplastics is ST8, with 129 particles. This is the My Thuan hydrological station (Vinh Long province), where the flow was weak and the wind calm at the time of sampling, resulting in minimal environmental impact.

At locations from the upper to the middle reaches (from ST1 to ST8), the number of microplastics is lower compared to downstream locations (ST9 to ST17). This is because microplastic particles can be easily transported from upstream to downstream areas.

Conversely, in the river mouth region (ST13, 14, 15), the number of microplastics is significantly lower due to the sparse population density in these areas. During transportation, microplastics may have adhered to surfaces or are in transit, reducing their concentration and quantity along the way.

Tab. 3. Water and Sediment sample results

Station	Water sample results (Particles)				Total	Sediment sample results (Particles)				Total
	Fragments	Fiber	Beads	Films		Fragments	Fiber	Beads	Films	
ST1	273	51	0	0	324	566	36	2	5	609
ST2	322	52	1	1	376	889	54	12	6	961
ST3	576	57	6	1	640	850	56	3	0	909
ST4	1110	49	2	4	1165	201	27	8	1	237
ST5	666	54	12	3	735					
ST6	695	107	2	2	806	29	60	4	1	94
ST7	551	49	0	0	600	213	84	11	0	308
ST8	105	24	0	0	129	330	73	10	11	424
ST9	2243	83	0	0	2326	641	101	26	7	775
ST10	5313	81	5	10	5409	308	69	28	1	406
ST11	1118	75	0	9	1202	332	46	3	1	382
ST12	561	67	3	0	631	539	80	15	4	638
ST13	88	55	0	0	143	712	390	12	1	1115
ST14	68	117	0	1	186	521	162	33	3	719
ST15	82	92	0	0	174					
ST16	12378	206	3	8	12595	538	106	6	1	651
ST17	734	79	5	0	818	299	62	17	5	383
Medium	1581.4	76.4	2.3	2.3	1662.3	464.5	93.7	12.7	3.1	574.1

4.1.2. Classification of sediment sample morphology

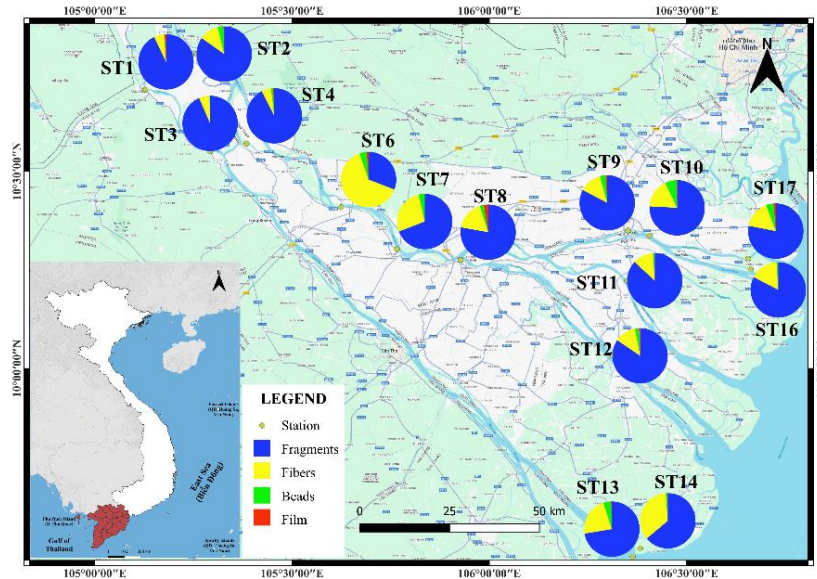


Fig. 8. Sediment sample results

Figure 8 and Table 3 present the quantity of microplastics in sediment samples. At these stations, a significant difference remains between the shapes of the identified microplastics. Fragments account for the highest percentage in most locations, about 77.9%, while fibers make up 18.8%, beads 2.7%, and films 0.6%. However, compared to water samples, sediment samples show a higher occurrence of granules at the stations. These plastic particles are usually derived from primary plastics, making them heavier and more likely to settle into sediments compared to other types of plastics[25]. ST10 has the highest proportion of microplastics in the form of beads (6.9%). At ST8 and ST9, films appear more frequently than at other stations. Films are a form of secondary microplastics, degraded from materials discarded by humans; they are typically thin, lightweight, and flexible, which makes them prone to settling and being compacted into the sediment over time due to gravity and environmental factors.

For sediment samples, the total number of observable microplastics was 6,494 particles - 4.3 times lower than in water samples, averaging 541 particles per location. As the degradation and settling times of different microplastics have not yet been determined, the reason for this discrepancy cannot be explained. However, based on the results from the two samples - water and sediment - it can be inferred that the decomposition time has not been long enough for microplastic particles to settle to the bottom. The area with the highest density of microplastics is ST13, with 1,103 particles. This is a river mouth area, while the location with the lowest density is ST6, with 94 particles; at this site, fibers account for the highest proportion (63.8%). The main causes have not yet been specifically identified and are currently being re-examined.

4.1.3. Comparison and comments

Figure 9 illustrates the total microplastics found in all samples, showing an uneven distribution in both water and sediment samples. Fragments accounted for the highest proportion across all samples, comprising 80.7%, followed by fibers at 18%. Beads made up only 1%, while films represented a mere 0.3%, indicating very low or negligible occurrence.

The results reveal that the quantity of microplastics in water is 3.2 times greater than that found in sediment samples across the 15 locations. Eight locations—ST4, ST6, ST7, ST9, ST10, ST11, ST16, and ST17—exhibited higher microplastic counts in water samples compared to sediment. These areas typically have denser populations, which may lead to greater waste discharge into the environment through various pathways, such as household wastewater and littering, predominantly consisting of secondary microplastics.

In contrast, the remaining seven locations showed slightly higher microplastic counts in sediment samples, though the differences were not substantial. Notably, the upstream stations ST1, ST2, and ST3

exhibited higher microplastic quantities in sediment compared to water. These locations often serve as confluences for river branches, where weak flow allows sediments more time to settle compared to other areas.

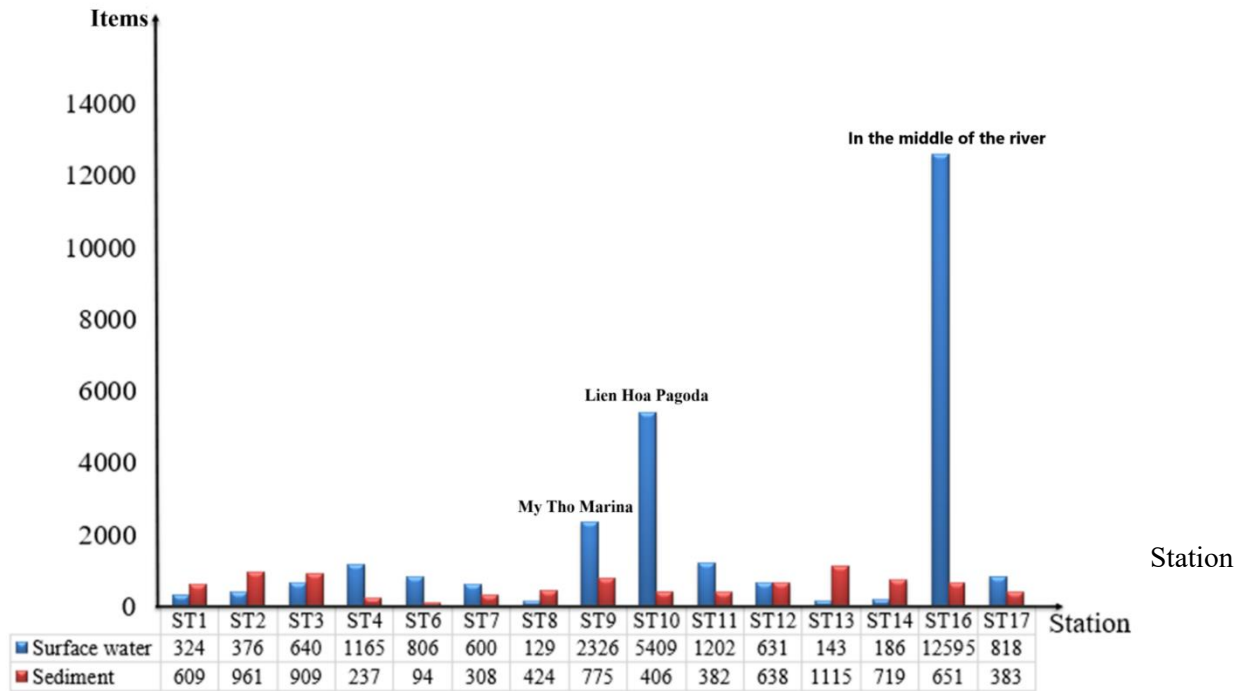


Fig. 9. Total plastic particles in water and sediment at sampling locations

4.2. Analysis of Microplastic polymer composition using ATR-FTIR

4.2.1. Water samples

After analyzing by Attenuated Total Reflection Fourier Transform Infrared (ATR-FTIR) ranging from 400 cm⁻¹ to 4000 cm⁻¹, the results are shown in Table 6. The results show that the most common polymer components of microplastics in water samples are Polystyrene (PS) and Nylon, some stations have Polytetrafluorethylene (PTFE) and Polypropylene (PP). PS comes from foam packaging boxes, coffee cups, trays, bowls, cardboard boxes, takeaway food containers, Nylon is the most common synthetic fiber commonly used to make clothes, cables or other industrial products... Due to their convenience, speed and reduced cleaning time, disposable products are invading the environment unintentionally without people's knowledge. The habit of using nylon bags instead of wicker baskets to store food or other human items has gradually increased the amount of waste from nylon bags very quickly. Observations from the environment around the sampling locations show that nylon bags are thrown away and stick to water hyacinths floating on the surface. Over time, under favorable environmental conditions, nylon bags or other plastic items will decompose and gradually become microplastics. Polytetrafluorethylene (PTFE) is derived from insulated wires and cables, connectors, optical fibers or coatings from kitchen utensils such as non-stick pans... and Polypropylene (PP) is derived from fibers and fabrics, bottle straps, films, heat-pressed sheets, ..

Tab. 6. Results of peak analysis and transmission of water samples

Status	Peak spectrum (400 – 4000 cm ⁻¹)	Transmittance (%)	Polymer Type
1	507	22.6	Polytetrafluorethylene (PTFE)
2	528 - 530	25 - 26	Polystyrene (PS)
3	1633 - 1635	70 -71	Nylon (all polyamides)
4	3301 - 3330	49 - 50	

Figure 10 shows the peak spectrum of the water sample. Most of the samples received have three peaks but only two types of polymers are commonly found, PS and Nylon. The characteristic peaks collected are 528 – 530 cm⁻¹ for Polystyrene (PS), 1633 – 1635 cm⁻¹ and 3301 – 3330 cm⁻¹ for Nylon (all polyamides). At station ST17, there is also a peak of 506 – 507 cm⁻¹ for Polytetrafluorethylene (PTFE). Materials that can produce PTFE can be insulating wires and cables, optical fibers, cooking coatings, etc.

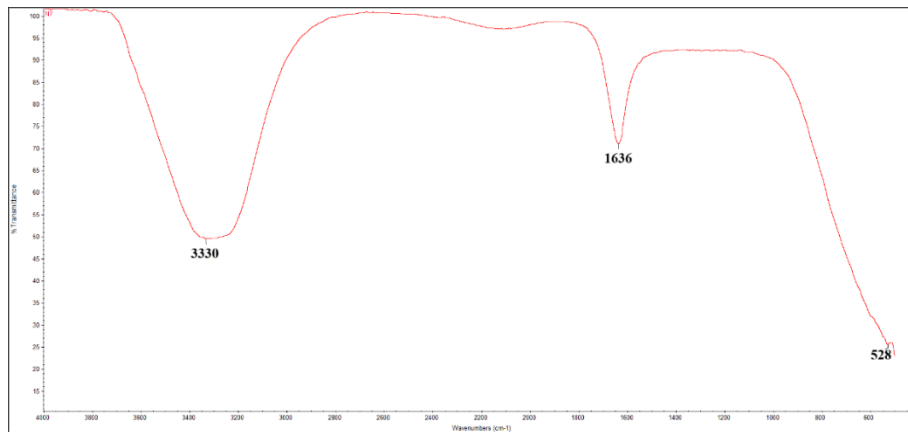


Fig. 10. Spectrum of water sample in ST8

4.2.2. Sediment samples

Table 7: Results of peak spectral analysis and transmittance of sediment samples

Status	Peak spectrum	Transmittance	Polymer type
1	505 - 510		Polytetrafluorethylene (PTFE)
2	629		
3	686 – 690		Polystyrene (PS)
4			Nylon (all polyamides)
5	912 – 913	80 – 90	Cellulose acetate (CA)
6	998 - 1006	94	Polypropylene (PP)
7	1029	94	Polystyrene (PS)

Figure 11 illustrates the characteristic spectral peaks of the sediment samples. For the sediment samples, the number of peaks is greater and more complex. Currently, this study has not clarified the sources of the microplastic particles or whether hydrodynamic factors influence the sedimentation process in this area.

Common peaks observed in the sediment samples are $505 - 510 \text{ cm}^{-1}$, $686 - 690 \text{ cm}^{-1}$, $912 - 913 \text{ cm}^{-1}$, $998 - 1006 \text{ cm}^{-1}$, and some peaks like $525 - 531 \text{ cm}^{-1}$. Certain peaks appeared only at specific locations: for example, 629 cm^{-1} at ST16, which may indicate Polytetrafluoroethylene (PTFE), and 1029 cm^{-1} at ST1, which may correspond to Polystyrene (PS, aromatic CH bending).

Additionally, the sediment samples revealed the presence of another polymer: Cellulose Acetate (CA), which originates from films, backing plastics, sunglasses, and synthetic fibers. Cellulose-2.5-acetate is also a raw material for producing what are known as cellulose beads. From this, we can conclude that in terms of microplastic morphology, round plastic particles are present at all stations in the sediment samples and are more abundant than in the water samples.



Fig. 11. Spectral peaks of sediment sample in ST8

PS and Nylon are two types of polymers present in nearly all sediment and water samples. However, the sediment samples exhibit greater diversity and richness in polymer types, with the additional presence of PTFE and PP. This indicates a broader spectrum of microplastics in environmental samples.

Further research is necessary to identify the sources and assess the level of pollution in this area.

5. Conclusions

In the coastal area of the Mekong River (Viet Nam), both water and sediment samples reveal the following findings:

- The most common form of microplastics found in the samples is fragments, followed by fibers in second place, while beads and films are present in very low quantities or not at all in some samples.
- In areas with high population density, active riverside activities, and continuous transportation, the amount of identified microplastic waste is higher than in other regions.
- The predominant polymer types identified are Polystyrene (PS) and Nylon, which are present in nearly all sediment and water samples. The sediment samples show greater diversity and richness in polymer types, also containing Polytetrafluoroethylene (PTFE) and Polypropylene (PP).
- The highest concentration of microplastics in water was found at ST2, with 12,595 particles, while the lowest was at ST8, with 129 particles. The identified polymer peaks include $506 - 507 \text{ cm}^{-1}$ for PTFE, $528 - 530 \text{ cm}^{-1}$ for PS, and $1633 - 1635 \text{ cm}^{-1}$ and $3301 - 3330 \text{ cm}^{-1}$ for Nylon.
- The sediment sample with the highest count was at ST13, with 1,115 particles, and the lowest was at ST6, with 94 particles. Additional identified polymer peaks in sediment include $506 - 507 \text{ cm}^{-1}$ for PTFE,

528 – 530 cm^{-1} for PS, 1633 – 1635 cm^{-1} and 3301 – 3330 cm^{-1} for Nylon, and 998 – 1006 cm^{-1} for PP.

This study focused on the dry season to analyze the concentration of suspended or settled microplastics. The results will serve as a basis for comparison with the upcoming rainy season to assess the impact of hydrodynamics on the transport and sedimentation processes of microplastics.

The results obtained through optical microscopy are somewhat subjective and not highly reliable. To ensure the presence of plastics at the sampling sites, this study employed a combination of methods: optical microscopy for microplastic identification and Attenuated Total Reflectance Fourier-Transform Infrared Spectroscopy (ATR-FTIR) for polymer classification in environmental samples. This approach provides clearer and scientifically meaningful results.

The specific origins of the microplastic particles have not yet been clearly determined, nor is it established whether they originate locally or are transported from other areas. Therefore, further research is needed to identify the river dynamics to understand the influence of flow and other dynamic factors on the sedimentation and transport of microplastics.

Tables and figures (with descriptions)

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