ISSN: 2710-0588

Occurrence and Characteristics of Microplastics in the Dasha River of Jiaozuo City

Mengnan Li

Henan Polytechnic University, Jiaozuo 454003, China

Abstract

To investigate the distribution and pollution characteristics of microplastics in China's aquatic environments, this study focused on the Dasha River in Jiaozuo City. Microplastic abundance and morphological features were analyzed using stereomicroscopy, while polymer composition was determined through Fourier-transform infrared spectroscopy. The results showed that microplastic abundance in the Dasha River ranged from 1.05 to 8.5 n/L, with an average concentration of 4.91 n/L. The majority of microplastics, representing 72.9% of the total, had a particle size below 1 mm, Fiber-shaped particles were most dominant at 62.7%, In terms of color, white microplastics were most prevalent, comprising 34% of the observed particles. Polyethylene terephthalate was the predominant polymer type, making up 31.7% of the identified compositions. Comparative analysis revealed distinct spatial variations in microplastic abundance between the Dasha River and other aquatic systems, with contamination levels classified as moderate to low on a global scale.

Keywords

Dasha River, microplastics, abundance.

1. Introduction

Since the 1950s, global plastic production has exhibited exponential growth, reaching an annual output of 400 million metric tons by 2024. However, due to the widespread use of plastic products and inadequate waste management practices, approximately 35% of plastic items are discarded after single use, with only about 9% being recycled globally. This has led to significant ecological and environmental pressures. Under the combined effects of photodegradation, mechanical abrasion, and chemical weathering, plastic waste gradually fragments into microplastics (MPs), defined as particles smaller than 5 mm. These emerging contaminants have become a growing environmental concern worldwide. To date, microplastics have been widely detected across various environmental matrices, including marine ecosystems[1-3], freshwater systems[4,5], freshwater systems[6, 7] and the atmosphere[8]. Upon ingestion by organisms, microplastics can accumulate in the digestive system, leading to physical blockage, reduced feeding efficiency, inhibited growth, and even mortality[9]. More critically, due to their hydrophobic nature, microplastics efficiently adsorb heavy metals and persistent organic pollutants, acting as vectors that enhance the bioavailability of these contaminants and induce synergistic toxic effects, posing multifaceted threats to ecosystem health[10]. Studies suggest[11]that coastal ecosystems exhibit higher exposure risks to microplastic pollution compared to open oceans, Existing data indicate that coastal regions, heavily influenced by anthropogenic activities, have become hotspots for marine microplastic accumulation.

Existing data indicate that coastal regions, heavily influenced by anthropogenic activities, have become hotspots for marine microplastic accumulation. (e.g, the Yellow River[12], Qin River[13], Yi-Luo River [14, 15]and Si shui River [16]), systematic investigations on microplastic pollution in the Dasha River watershed remain lacking. Therefore, this study

ISSN: 2710-0588

selects the Dasha River in Jiaozuo City as a case study, combining field sampling and laboratory analyses to examine the contamination characteristics and potential sources of microplastics in the aquatic environment. The findings aim to provide a scientific basis for microplastics pollution control and management in riverine ecosystems.

2. Materials and Methods

2.1. Study Area Description

Jiaozuo City is situated in northwestern Henan Province, characterized by a topographical gradient descending from north to south. The northern region comprises the Tai hang Mountain range (elevation: 200–500 m), while the central area consists of the Qin River Plain, and the southern boundary adjoins the Yellow River. As a typical resource-based city historically dominated by coal mining, Jiaozuo exhibits well-developed industrial, agricultural, and tourism sectors with high population density. The climate is classified as warm temperate semi-humid monsoon, with an average annual temperature of 16.8°C and mean precipitation of 582.3 mm[17]. The Dasha River, part of the Hai River Basin, originates in Duohuo Town (Lingchuan County, Shanxi Province) and flows through Bo ai County, Jiaozuo urban area, Wuzhi County, and Xiuwu County before entering Xinxiang City. Its total length measures 115.5 km, with approximately 56 km within Jiaozuo. The average annual runoff ranges between 80–110 million m^3, supplying water for domestic, agricultural, and partial industrial use for about 500,000 residents. The river irrigates 15%–20% of Jiaozuo's arable land. In March 2025, we collected 13 surface water samples (W1–W13) from the main river channel. Sampling sites W1 and W13 represent the entry and exit monitoring sections of Dasha River within Jiaozuo City boundaries. Due to low-flow conditions during the dry season, W1 was designated as a continuous sampling point. Sites W2, W4, W6, W8, W10 and W12 were located downstream of tributary confluences, whereas W3, W5, W7, W9 and W11 were positioned upstream of these junctions.

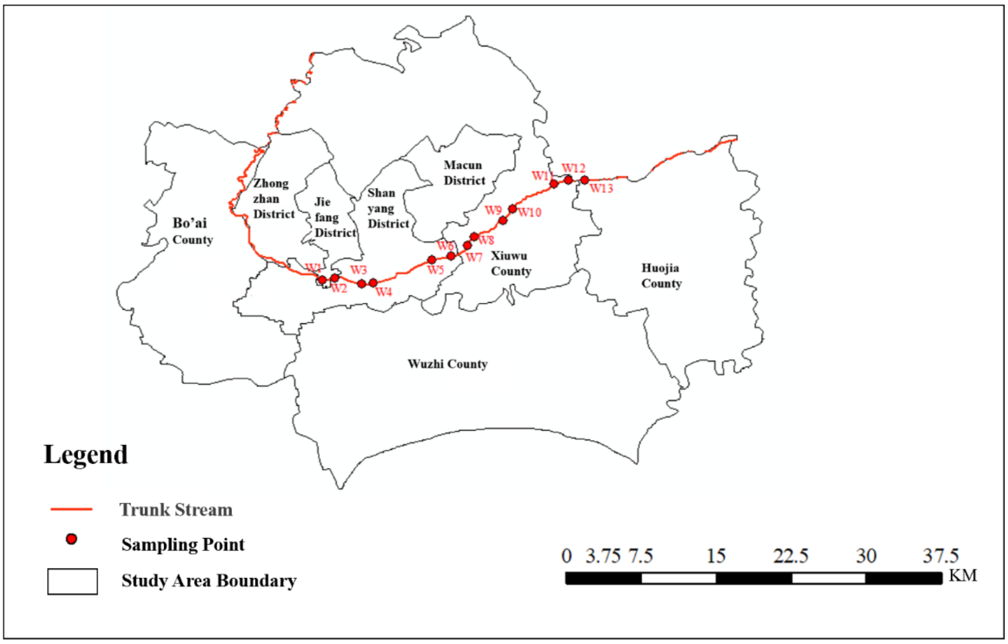

Figure 1. Location map of the sampling sites in the study area.

2.2. Sample Collection

Water sampling was conducted following the Technical Guidelines for Water Quality Sampling (HJ 494-2009) issued by the Ministry of Ecology and Environment of China. Sampling sites were

ISSN: 2710-0588

strategically positioned along river margins based on preliminary field surveys. To minimize disturbance of water column and riverbed sediments, all samples were collected using glass water samplers, thereby ensuring representative water samples unaffected by substrate interference. At each sampling location, 20 L of surface water was collected and immediately filtered through a 5-mm stainless steel sieve to exclude plastic particles exceeding this size threshold. The filtered samples were then transferred to pre-cleaned amber glass bottles, properly labeled, and transported to the laboratory under controlled conditions. All samples were refrigerated at 4°C until subsequent microplastic extraction and analysis. During field operations, each sampling site was thoroughly documented through photographic records and GPS coordinates (latitude/longitude) to precisely log geographical positions and characterize surrounding environmental conditions.

2.3. Sample Pretreatment

To ensure methodological reliability, systematic pilot tests were conducted using water samples collected from various river sections to validate the pretreatment protocol prior to formal experiments. The optimized procedure consisted of four sequential steps: pre-filtration, digestion, density separation, and final filtration.

For pre-filtration, water samples were processed through a vacuum filtration system equipped with 0.45-μm pore-size, 50 mm diameter glass fiber filters. After pre-filtration, rinse all the substances on the filter membrane with ultrapure water into a 500ml erlenmeical flask. Digestion was then performed by adding 50 mL of 30% H_2O_2 solution under continuous stirring with a glass rod. The flasks were sealed with aluminum foil and rubber stoppers, followed by incubation in a constant-temperature shaker (25°C, 100 rpm) for 72 h to ensure complete organic matter decomposition. Then add 200 mL of saturated NaCl solution to the digested sample for density separation, stir with a glass rod for 3 min, and allow it to stand for 24 h. A 0.45-μm pore-size, 50-mm diameter glass fiber filter membrane was used for final filtration. After extraction, the membrane was carefully transferred to a petri dish using tweezers, covered with a lid, labeled, and placed in a drying oven. The oven temperature was maintained at 60°C for 12 h to ensure complete drying before further analysis.

2.4. Microplastic Analysis

The pretreated samples were examined under a stereomicroscope (XTL-240), and the quantity, morphology, color, and particle size of microplastics in each sample were systematically recorded. Microplastics were systematically classified into five size categories: 0-500 μm, 500-1000 μm, 1000-2000 μm, 2000-3000 μm, 3000-5000 μm. Morphological classification included four primary types: fibers, fragments, films, and granules. Color variants were categorized as white, black, yellow, green, blue, red, transparent, or other. Microplastic abundance was quantified as the number of particles per liter of water (n/L).

For polymer identification, sample were selected and analyzed using Fourier-transform infrared spectroscopy (FT-IR, AIM-9000). Spectral data were compared against standard polymer libraries to determine the chemical composition of each specimen.

2.5. Quality Assurance and Quality Control

Rigorous contamination prevention measures were implemented throughout sample collection, processing, and analysis. All equipment was thoroughly rinsed with ultrapure water prior to use, with strict avoidance of plastic materials. Laboratory surfaces were cleaned with cotton cloths before experimentation, and researchers wore cotton lab coats, face masks, and nitrile gloves during all procedures. Prior to water sampling, containers were triple-rinsed with site-specific water. During filtration, digestion, and density separation processes, all glassware and instruments were covered with aluminum foil to prevent airborne contamination. Method blanks (ultrapure water) underwent identical pretreatment procedures, with no detectable plastic particles observed, confirming the absence of procedural or environmental contamination.

2.6. Statistical Analysis

Data processing and analysis were performed using Excel 2021, Spatial mapping of sampling sites was conducted with ArcGIS 10.8, The vector data utilized in the cartographic process were obtained from the Geospatial Data Cloud Platform (https://www.gscloud.cn) and the National Geographic Information Public Service Platform(https://www.tianditu.gov.cn). All other graphical representations were generated using Origin 2025 software.

3. Results and Discussion

3.1. Microplastic Abundance in Dasha River Water

Microplastic abundance in 13 sampling sites along the main channel of Dasha River in Jiaozuo City is shown in Figure 2. The detection rate was 100% across all samples, with microplastic abundance ranging from 1.05 to 8.5 n/L, and an average abundance of 4.91 n/L. Table 1 presents recent data on microplastic distribution in domestic and international rivers. The Dasha River exhibited higher microplastic levels than the Nandu River[18], Yulin River[19], Muttukadu Backwater [20], coastal rivers in Melbourne[21] Qing River [22], These rivers with lower abundances are characterized by low population density and dispersed plastic industries, which may explain their reduced microplastic concentrations. Comparatively, the Dasha River's microplastic abundance was similar to that of the Yangtze River Estuary[23] , but lower than Alabama[24], Wei River[25], Elbe[26], Surma River[27], Yellow River[28], Maozhou River[29], Manas River[30], Han River[31]. The Yangtze River Estuary shows spatial variability in microplastic concentrations, with large river systems contributing to elevated microplastics in marine environments. The Elbe and Maozhou Rivers, influenced by industrial zones and tidal flows, experience resuspension of microplastics from sediments into the water column. Meanwhile, the Alabama, Wei, Surma, Yellow, Manas, and Han Rivers demonstrate higher microplastic abundances due to dense populations and intensive economic activities. Particularly in the Surma and Wei Rivers, sampling sites adjacent to industrial/commercial districts and agricultural areas showed the highest microplastic abundances, indicating human activities as a significant contributor to microplastic pollution. In summary, the microplastic abundance in surface waters of Dasha River falls within the moderate-to-low range globally.

Figure 2 clearly demonstrates that microplastics in the Dasha River water were predominantly concentrated in the middle and upper reaches. Among all sampling sites, W2 exhibited the highest microplastic abundance reaching 8.5 n/L. This elevated concentration can be attributed to three primary factors. First, the sampling site is located downstream of the confluence where the Xingfu tributary joins the main Dasha River channel, allowing microplastics from the tributary to flow into and accumulate in the main stem. Second, this sampling point represents a characteristic agricultural-rural transitional zone featuring extensive undeveloped lands along both riverbanks and surrounded by multiple administrative villages. The area attracts substantial recreational activities including gatherings, barbecues and fishing, resulting in intensive human presence and consequent improper disposal of plastic products and waste into the adjacent river water. Third, the riverbanks at this sampling location showed significant accumulation of domestic waste, particularly discarded clothing and plastic products, likely originating from improper waste management practices in nearby residential areas, which directly contributes to increased microplastic levels in the main channel of Dasha River. In contrast, sampling site W13, located at the outflow boundary of the Jiaozuo section of Dasha River, exhibited the lowest microplastic abundance of 1.05 n/L due to its low population density and absence of recreational facilities. Meanwhile, site W1 showed relatively high

ISSN: 2710-0588

microplastic levels at 7.3 n/L, attributable not only to recreational activities such as gatherings, barbecues and fishing in adjacent undeveloped lands along the riverbanks, but also to the presence of a nearby equestrian club. The club's daily operations generate various wastes including horse husbandry byproducts, wear particles from riding equipment, and visitor-generated litter, which enter the watercourse through surface runoff and rainwater wash-off, consequently elevating microplastic concentrations. Sites W3 and W4, with respective microplastic abundances of 6.7 n/L and 5.65 n/L, are situated within the Dasha River Ecological Park which contains various recreational facilities and rest areas. The substantial visitor flow to these amenities contributes significantly to microplastic pollution in this section of the river.

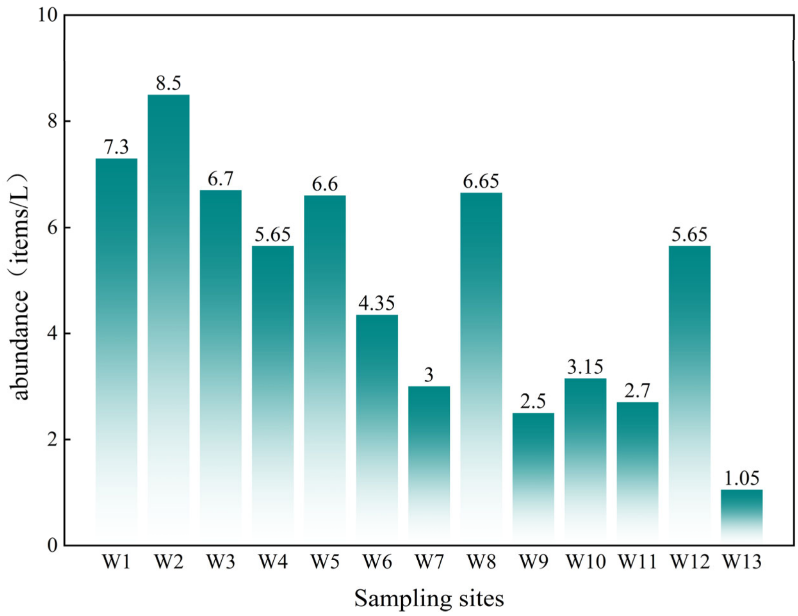

Figure 2. Microplastic abundance at sampling sites in Dasha River

Table 1. Microplastic abundance in surface water of rivers worldwide

No.	River	Region	Microplastic abundance (n/L)	Reference
1	Nandu River	Hainan, China	0.09−0.85	[18]
2	Yulin River	Chongqing, China	1.30×10^{-2}	[19]
3	Muttukadu Backwater	India	0.195	[20]
4	Coastal rivers in Melbourne	Australia	0.06−2.5	[21]
5	Qing River	Beijing, China	0.17±0.11	[22]
6	Yangtze River Estuary	China	4.137±2.461	[23]
7	Alabama River	United States	12−135	[24]
8	Wei River	China	3.67−10.7	[25]
9	Elbe River	Germany	5.57±4.33	[26]
10	Surma River	Bangladesh	10.2	[27]
11	Yellow River	China	31.05±7.74	[28]
12	Maozhou River	Shenzhen, China	4.0±1.0−25.5±3.5	[29]
13	Manas River	Northwest China	21±3-49±3	[30]
14	Han River	China	6.26±1.431	[31]
15	Dasha River	Jiaozuo, China	4.91	This study

ISSN: 2710-0588

3.2. Morphological Characteristics of Microplastics in Dasha River Water

The size distribution of microplastics in Dasha River water samples was predominantly concentrated in the <1 mm range. Fibrous particles constituted the predominant morphological type, while white coloration represented the most frequently observed color variant. Figure 3 illustrates the proportional distribution of microplastic categories observed under stereomicroscopic examination at 40× magnification.

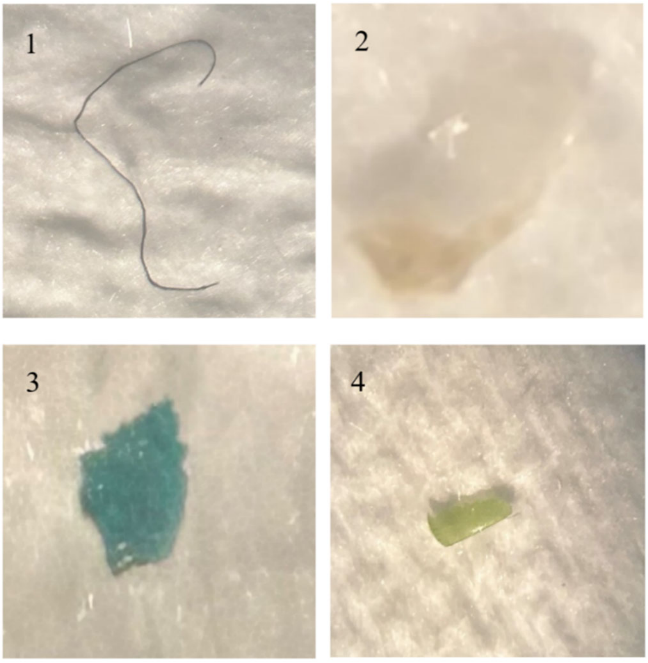

Figure 3. Morphological types of microplastics observed under stereomicroscope
1 Fiber; 2 Film; 3 Granule; 4 Fragment

Based on the size characteristics of microplastics in Dasha River water samples, Figure 4(a) classifies the particles into five size ranges: less than 0.5 mm, 0.5-1 mm, 1-2 mm, 2-3 mm, and 3-5 mm. Regarding size distribution, microplastics in the 0.5-1 mm range accounted for the highest proportion at 39.4%, followed by those smaller than 0.5 mm at 33.5%. The 1-2 mm size fraction represented 15.5% of the total, while the 2-3 mm and 3-5 mm ranges constituted significantly smaller proportions at 6.6% and 5.0% respectively. Overall, microplastics smaller than 1 mm dominated the surface water samples, collectively representing 72.9% of the total abundance and being detected at all sampling sites. These findings align with previous studies conducted in the Yellow River basin[12, 28], Yangtze River estuary[23], and Qinling-Wei River Plain[32] . The predominance of small plastic particles in environmental samples likely originates from the environmental degradation of larger plastic items. Through prolonged exposure to photo-oxidation, hydraulic forces, and mechanical abrasion, larger plastic debris undergoes gradual fragmentation and weathering, resulting in continuous size reduction and consequent increase in the abundance of smaller microplastics. This phenomenon has been well documented in studies of North America's Great Lakes[33], China's Yangtze River estuary[23], and the Three Gorges Reservoir[34].

Figure 4(b) reveals that fibers constituted the predominant morphological type among all microplastic shapes in Dasha River surface water samples, accounting for 62.7% of the total and being detected at all sampling sites. This finding is consistent with studies conducted in the Nanfei River[35], six rivers in Tongzhou District of Beijing[36], and Yueyang Nanhu Lake[37]. The high prevalence of fibrous microplastics likely results from two primary sources: domestic

ISSN: 2710-0588

wastewater discharge from treatment plants and anthropogenic activities along the riparian zone, which introduce substantial terrestrial debris into the aquatic system. This observation aligns with Zhao et al.'s conclusion that[23] most microplastic fibers in marine environments originate from wastewater discharge during the washing of synthetic textiles. In addition to laundry sources, abandoned fishing gear such as nylon ropes and nets from fishing activities represents another significant potential origin of microplastic fibers. Fragments represented the second most abundant shape at 29.5%, primarily derived from the progressive degradation and fragmentation of plastic products under environmental stressors. Granules and films accounted for smaller proportions at 4.2% and 3.6% respectively, mainly originating from the breakdown of plastic bags and agricultural films, as well as wear particles from vehicle tires.

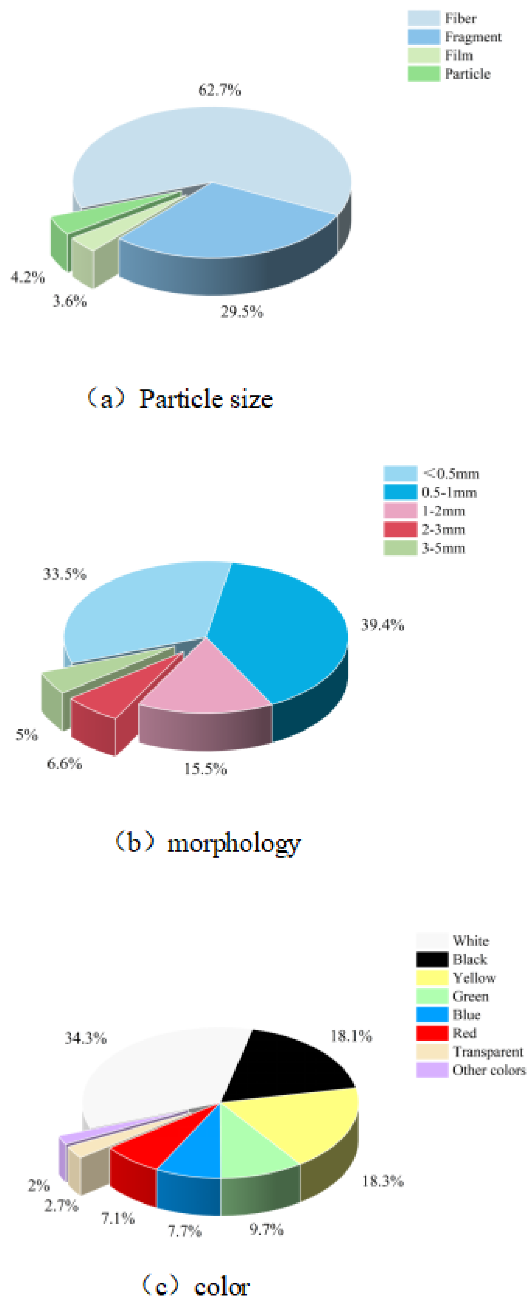

Figure 4. Morphological characteristics of microplastics in Dasha River water, Jiaozuo City

As shown in Figure 4(c), white-colored plastic particles represented the highest proportion (34%) among identified samples in Dasha River surface water a finding consistent with studies

ISSN: 2710-0588

conducted in Guangzhou's Pearl River[38] , Renhuai's Chishui River[39] , and Haihe River[40]. The color distribution followed with yellow (18.3%), black (18.1%), green (9.7%), blue (7.7%), red (7.1%), transparent (2.7%), and other colors (2%). Approximately 78% of daily-use plastic products are manufactured using transparent/semi-transparent substrates initially. During sample processing, all collected specimens underwent filtration through glass fiber membranes, where potential interference from adhering impurities such as soil particles made it challenging to accurately distinguish between white and transparent microplastics under optical microscopy. To maintain classification consistency, this study strictly identified only particles with typical transparent film morphology as transparent microplastics, while uniformly categorizing all white or indistinct particles as white microplastics. This methodological approach explains the predominance of white particles and relatively low proportion of transparent microplastics in our results. White microplastics were detected at all sampling sites, while transparent microplastics were found at most locations except W2 and W8. The presence of other colored microplastics likely results from environmental weathering processes and ultraviolet radiation-induced discoloration of plastic materials. The observed color distribution patterns reflect both original manufacturing characteristics of plastic products and their subsequent environmental transformation processes in aquatic systems.

3.3. Polymer Types of Microplastics in Dasha River Water, Jiaozuo City

Fourier-transform infrared (FTIR) spectroscopic analysis identified eighteen distinct polymer types in surface water microplastics from Dasha River: PP, PE, PVC, PET, PA, PB, PC, PU, PS, PIP, PPO, PAN, PTFE, PVAL, HDPE, PMMA, PEEK, ABS. Figure 5 presents representative FTIR spectral comparisons of the detected microplastics.

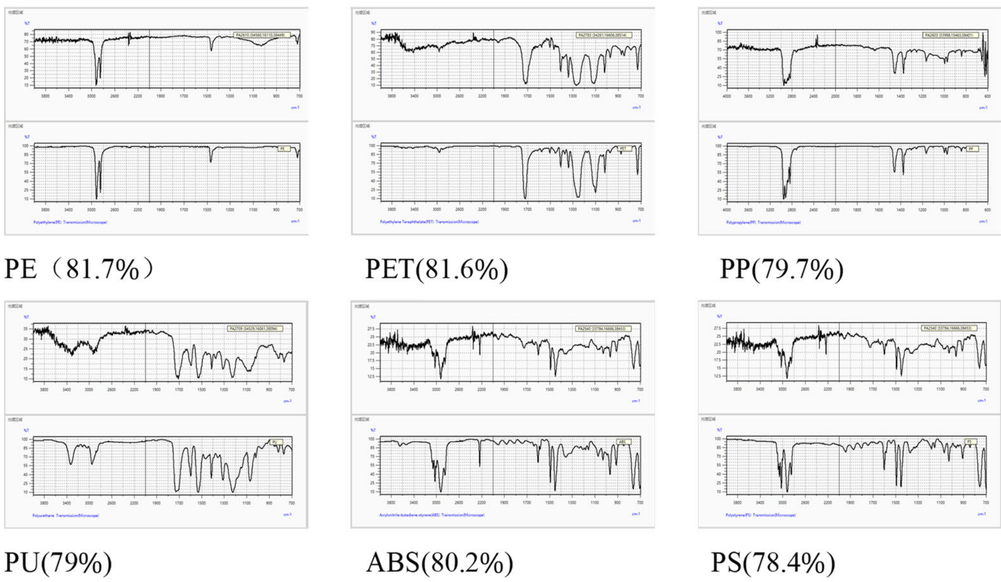

Figure 5. Comparative FTIR spectra of microplastics

As shown in Figure 6, polyethylene terephthalate (PET) was the predominant polymer type in Dasha River water samples, accounting for 31.7% of the total microplastics. This was followed by polyethylene (PE) and polypropylene (PP) at 16.4% and 12.1% respectively. Polyamide (PA), polycarbonate (PC), polyvinyl chloride (PVC), and polyvinyl alcohol (PVAL) constituted 14.1%, 5.6%, 3.4%, and 3.0% respectively, while all remaining polymer types each accounted for less than 3% of the total. The primary sources of PET microplastics include synthetic textiles (such as polyester clothing), which release fibers during washing processes. These fibers enter wastewater treatment plants through domestic sewage and ultimately discharge into the Dasha

ISSN: 2710-0588

River watershed. These findings are consistent with studies by Yao et al.[41] and Zhou et al[42]. PE and PP as the most widely produced and utilized general-purpose plastics globally, dominate applications in packaging materials, disposable products, and daily consumer goods. Their prevalence in these widespread applications explains their frequent detection as environmental microplastic pollutants. The polymer composition profile observed in this study reflects both local usage patterns of plastic products and the transport pathways of microplastics in urban watershed systems.

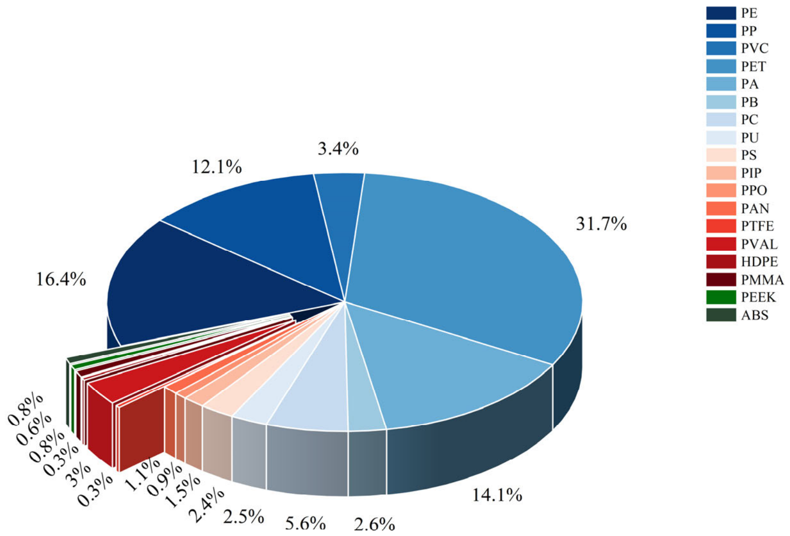

Figure 6. Polymer types of microplastics in Dasha River water, Jiaozuo City

4. Conclusions

4.1 Microplastics were detected in all water samples from Dasha River in Jiaozuo City, with an average abundance of 4.91 n/L and a maximum abundance of 8.5 n/L, ranking at a moderate-to-low level globally, indicating significant spatial variability in microplastic pollution across different river sections due to varying influencing factors.

4.2 Microplastics in the Dasha River water of Jiaozuo City were predominantly smaller than 1 mm in size, with fibrous particles representing the most common morphology at an average proportion of 63.7%. While white-colored microplastics constituted the majority, various colored particles were also present. The microplastic polymer composition was PET, with additional detection of PE, PP, PVC and other polymers.

References

[1] ARISEKAR U, ARIVUKUMAR E, IBURAHIM A, et al. Unveiling microplastic contamination in seafood: Source, fate, analytical methods, health impacts, mitigation strategies and scientometric trends [J]. Marine Pollution Bulletin, 2025, 220: 118414.

[2] JOLAOSHO T L, RASAQ M F, OMOTOYE E V, et al. Microplastics in freshwater and marine ecosystems: Occurrence, characterization, sources, distribution dynamics, fate, transport processes, potential mitigation strategies, and policy interventions [J]. Ecotoxicology and Environmental Safety, 2025, 294: 118036.

[3] LIU F, LORENZ C, ZHAO G. From land to sea: Hydrological source tracking of microplastics in coastal sediments [J]. Environmental Research, 2025, 283: 122132.

[4] IORDACHESCU L, NIELSEN R V, PAPACHARALAMPOS K, et al. Point-source tracking of microplastics in sewerage systems. Finding the culprit [J]. Water Research, 2024, 257: 121696.

ISSN: 2710-0588

[5] PARK T-J, LEE S-H, LEE M-S, et al. Occurrence of microplastics in the Han River and riverine fish in South Korea [J]. Science of The Total Environment, 2020, 708: 134535.

[6] YAN P, ZHANG S, XING H, et al. Spatial distribution of microplastics in Mollisols of the farmland in Northeast China: the role of field management and plastic sources [J]. Geoderma, 2025, 459: 117367.

[7] YU F, JI Y, YAN C, et al. Distribution, sources and multi-dimensional environmental risk assessment of microplastics in soils and groundwater along the middle and lower reaches of the Yellow river [J]. Journal of Hazardous Materials, 2025, 494: 138698.

[8] LUO X, ZHANG Y, KANG S, et al. Atmospheric emissions of microplastics entrained with dust from potential source regions [J]. Journal of Hazardous Materials, 2025, 488: 137509.

[9] YUAN W, LIU X, WANG W, et al. Microplastic abundance, distribution and composition in water, sediments, and wild fish from Poyang Lake, China [J]. Ecotoxicology and Environmental Safety, 2019, 170: 180-7.

[10] SHI M, LI R, XU A, et al. Huge quantities of microplastics are “hidden” in the sediment of China's largest urban lake—Tangxun Lake [J]. Environmental Pollution, 2022, 307: 119500.

[11] LIU Y-C, WU L, SHI G-W, et al. Characteristics and sources of microplastic pollution in the water and sediments of the Jinjiang River Basin, Fujian Province, China [J]. China Geology, 2022, 5(3): 429-38.

[12] Li H T, Ma Z F, Guo Y, et al. Distribution and source characterization of microplastics pollution in Zhengzhou Section of the Yellow River [J]. China Environmental Science, 2024,44(7):4136-4144.

[13] ZHANG Fawen, LI Yinyue, DENG Zhengyun, et al. Pollution characteristic and risk assessment of microplastics from sewage outlets in the Qin River(Jiaozuo section)[J]. Chinese Journal of Environmental Engineering, 2023, 17(12): 3978-3987.

[14] Hao S Z, Wang G H, Huang J, et al. Microplastic Pollution Characteristics and Ecological Environmental Risk Assessment in Water and Sediments of Yiluo River Basin. [J]. Environmental Science: 1-18

[15] He B, Zhao C M, Ma Z F, et al. Characteristics, Distribution and Risk Assessment of Microplastics in Surface Water of Sewage Outlet of Yiluo River (Gongyi Section). Research of Environmental Sciences, 2024, 37(09): 1948-57.

[16] Zhao C M, He B, Li H T, Occurrence Characteristic and Risk Assessment of Microplastics in Sishui River (Xingyang Section), Environmental Science, 2024, 45(03): 1457-67.

[17] Yang C., Jiao Y., Yu C, et al. Investigation of rainstorm flood and embankment danger situation of Jiaozuo ‘21·7’. Yellow River, 2023 45 (07), 58-61.

[18] Li G, Xiong X, Zhan C, et al. Study on microplastic pollution in the Nandu River. Acta Scientiae Circumstantiae, 2022 4 (02), 205-12.

[19] MAO Y, LI H, GU W, et al. Distribution and characteristics of microplastics in the Yulin River, China: Role of environmental and spatial factors [J]. Environmental Pollution, 2020, 265: 115033.

[20] M V P, VIJAYAPRABHAKARAN K, T D P, et al. Microplastics pollution in tropical estuary (Muttukadu Backwater), Southeast Coast of India: Occurrence, distribution characteristics, potential sources and ecological risk assessment [J]. Journal of Hazardous Materials Advances, 2024, 16: 100521.

[21] SU L, SHARP S M, PETTIGROVE V J, et al. Superimposed microplastic pollution in a coastal metropolis [J]. Water Research, 2020, 168: 115140.

[22] WANG C, XING R, SUN M, et al. Microplastics profile in a typical urban river in Beijing [J]. Science of The Total Environment, 2020, 743: 140708.

[23] ZHAO S, ZHU L, WANG T, et al. Suspended microplastics in the surface water of the Yangtze Estuary System, China: First observations on occurrence, distribution [J]. Marine Pollution Bulletin, 2014, 86(1): 562-8.

[24] HASHMI S I, BARRICK A, HOANG T C. Discovery of microplastics in the Alabama River: Distributions, transport and loads, sources, and relative comparison with world rivers [J]. Journal of Hazardous Materials, 2025, 495: 138813.

[25] DING L, MAO R F, GUO X, et al. Microplastics in surface waters and sediments of the Wei River, in the northwest of China [J]. Science of The Total Environment, 2019, 667: 427-34.

ISSN: 2710-0588

[26] SCHERER C, WEBER A, STOCK F, et al. Comparative assessment of microplastics in water and sediment of a large European river [J]. Science of The Total Environment, 2020, 738: 139866.

[27] RAHMAN M H, IZLAL S, ISLAM T, et al. Occurrence and risk assessment of microplastics in surface water, sediment, and biota of Surma River, Bangladesh [J]. Journal of Contaminant Hydrology, 2025, 273: 104620.

[28] Yang Z, Li M, Deng Z, et al. Occurrence characteristics and ecological risk assessment of microplastic pollution in the Yellow River Basin. Environmental Science, 2025 46 (08), 5316-24.

[29] WU P, TANG Y, DANG M, et al. Spatial-temporal distribution of microplastics in surface water and sediments of Maozhou River within Guangdong-Hong Kong-Macao Greater Bay Area [J]. Science of The Total Environment, 2020, 717: 135187.

[30] WANG G, LU J, TONG Y, et al. Occurrence and pollution characteristics of microplastics in surface water of the Manas River Basin, China [J]. Science of The Total Environment, 2020, 710: 136099.

[31] Zhang S., Lin L., Pan X, et al. Occurrence characteristics of microplastics in water of Han River (Danjiangkou Dam downstream to Xinglong section). Research of Environmental Sciences, 2022 35 (05), 1203-10.

[32] BIAN P, LIU Y, ZHAO K, et al. Spatial variability of microplastic pollution on surface of rivers in a mountain-plain transitional area: A case study in the Chin Ling-Wei River Plain, China [J]. Ecotoxicology and Environmental Safety, 2022, 232: 113298.

[33] ERIKSEN M, MASON S, WILSON S, et al. Microplastic pollution in the surface waters of the Laurentian Great Lakes [J]. Marine Pollution Bulletin, 2013, 77(1): 177-82.

[34] ZHANG K, GONG W, LV J, et al. Accumulation of floating microplastics behind the Three Gorges Dam [J]. Environmental Pollution, 2015, 204: 117-23.

[35] Wang X, Li S, Wang N, et al. Distribution characteristics and sources of microplastics in Nanfei River. Bulletin of Soil and Water Conservation, 2020 40 (05), 201-8.

[36] Men C, Li D, Zuo J, et al. (2022). Spatial distribution and potential sources of microplastics in rivers of Tongzhou District, Beijing. Environmental Science, 2022, 43 (07), 3656-63.

[37] Wen X, Yin L, Jiang C, et al. Pollution characteristics of microplastics in surface water of Yueyang South Lake, a typical urban lake. Environmental Chemistry, 2022 41 (11), 3579-88.

[38] LIN L, ZUO L-Z, PENG J-P, et al. Occurrence and distribution of microplastics in an urban river: A case study in the Pearl River along Guangzhou City, China [J]. Science of The Total Environment, 2018, 644: 375-81.

[39] LI J, OUYANG Z, LIU P, et al. Distribution and characteristics of microplastics in the basin of Chishui River in Renhuai, China [J]. Science of The Total Environment, 2021, 773: 145591.

[40] LIU Y, ZHANG J, CAI C, et al. Occurrence and characteristics of microplastics in the Haihe River: An investigation of a seagoing river flowing through a megacity in northern China [J]. Environmental Pollution, 2020, 262: 114261.

[41] Yao R, Liu H, Li,Y, et al. Pollution characteristics of microplastics in beach sediments of Xiamen Bay. Environmental Science, 2022 43 (11), 4931-8.

[42] Zhou G, Xu C, Shen C, et al. Distribution, composition characteristics, and ecological risk of microplastics in the water environment of Dianshan Lake. Acta Scientiae Circumstantiae, 2022 42 (04), 214-24.