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RESEARCH PAPER

Microplastic Pollution and Risk Evaluation in the Gediz River

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Abstract

Microplastics (MPs), particles less than 5 mm in diameter, enter the aquatic ecosystem through the degradation of larger plastics. They can accumulate in the environment for long periods due to their durability and buoyancy. In this study, a risk assessment of MPs was conducted at five different stations in the Gediz River via a Pollution Load Index (PLI) and a Polymer Hazard Index (PHI) calculated for dry and wet seasons to highlight the risks caused by seasonal variations of pollution levels for different types of MPs in an urban river discharging to Izmir Bay. The results showed that MPs were widespread in the area, with an average abundance of 13-211 units/L/L. During the dry season, the mean number of particles was 67±57; during the wet season, the mean number of particles decreased to 50±37. The most common type was polypropylene with 62.4%, followed by Polyethylene and Polyethylene Terephthalate (8.3% and 7.01%). The most abundant MP shapes are fragments and fibers, with 47.1% and 38.5%. During the dry season, PLI values ranged from 0.99 to 2.44, while in the wet period, they ranged from 1.08 to 2.11. Furthermore, PHI values for the MP species detected at each station ranged from 3.81 to 7.91. The results indicated that the Gediz River is a significant MPs source for Izmir Bay and demonstrates a major hazard for its overall ecological condition.

Introduction

In recent years, MPs have been considered emerging pollutants in water resources (Tan et al., 2023; Yang et al., 2023). Each year, we generate nearly 300 million tons of plastic waste—roughly equivalent to the total weight of the entire human population (Jaikumar et al., 2025). As a result of this high production level, a significant amount of unmanaged plastic waste (estimated between 4.8 and 12.7 million tons) ends up in the oceans (Nakano et al., 2024).

According to a recent study, MPs range from 0.002 to 660,000 per m^3 in the marine environment, from 0.97 to 147,900 per kilogram in sediments, and from 0.003 to 422 per individual in organisms, regardless of the sampling technique (Y. Wang et al., 2024). MPs primarily enter the oceans through rivers and lakes (Li et al., 2025). Sources of MP pollution in rivers include stormwater, urban and industrial wastewater discharges, atmospheric deposition, and agricultural activities (Kadir et al., 2025; Kazancı et al., 2025; Zhang et al., 2025; Xu et al., 2025). Although the amounts of MPs released into soils are 4 to 23 times higher than in the oceans (Kedzierski et al., 2023).There is still less emphasis placed on the risk in soils used for agricultural activities (Cai et al., 2023).

Ecological risk refers to the potential harm environmental stressors, such as pollutants, can inflict on ecosystems, including adverse effects on organisms, populations, communities, and ecosystem functions (Guo et al., 2025). The contamination of freshwater environments with microplastics is a growing threat that requires attention, as these particles can enter freshwater systems through various sources such as surface runoff (Lindfors et al., 2025), wastewater effluents (Kazancı et al., 2025), industrial discharges (Deng et al., 2020), and atmospheric deposition (Zhang et al., 2025). Once in the environment, these particles pose a significant risk due to their ability to interact with other pollutants and organisms in ways that can disrupt ecological balance and harm biodiversity (Shukur et al., 2023a). Microplastics can cause ecological risks by their ability to adsorb and concentrate harmful pollutants from their surroundings, such as heavy metals (Duan et al., 2025), persistent organic pollutants (Fu et al., 2021), and endocrine-disrupting chemicals (Cortés-Arriagada et al., 2023). When ingested by aquatic organisms, these MPs can cause physical harm, reduce feeding efficiency, and introduce toxic chemicals into the organism's body, leading to adverse biological effects. Studies have shown that microplastics can harm aquatic fauna in marine and freshwater environments (Meyyazhagan et al., 2022). MP ingestion by zooplankton, mussels (*Anodonta anatina*), and fish (*Carassius gibelio*) from the Susurluk River Basin, revealing species-specific uptake patterns—no ingestion in zooplankton, but 617 particles in mussels and 792 in fish (Başaran Kankılıç et al., 2023).

Microplastics tend to accumulate in transitional zones such as river deltas and downstream parts of river basins, which also host numerous endemic bird species and other wildlife (Arslan et al., 2022). Therefore, conducting an ecological risk assessment in these areas is particularly critical, as the potential impact of microplastic pollution on these sensitive ecosystems could be severe and far-reaching. These regions are not only ecological hotspots but also critical zones where the effects of upstream activities are most pronounced (Raju et al., 2023). For these reasons, the ecological risk of MPs is often quantified using indices such as the Polymer Hazard Index (PHI) (Lithner et al., 2011) and the Pollution Load Index (PLI) (Pan et al., 2021). These indices provide a comprehensive assessment of the ecological risk posed by MPs, enabling better management and mitigation strategies.

The Gediz River basin is one of Türkiye’s most important rivers flowing into the Aegean Sea. Agricultural and industrial production are the major economic activities in the basin. Also, the basin is known for its fertile soils and is home to a wide range of crops, including cereals, fruit, and vegetables. During both wet and dry seasons, a microplastic monitoring campaign was undertaken at five sites along the Gediz River, closest to the sea. The PLI and the PHI values were then calculated to assess the risks posed by microplastics to the Gediz Delta ecosystem, given the use of the river for irrigation.

Materials and Methods

Sample Collection

The Gediz River Basin, located in the western part of Türkiye, is a significant hydrological region that spans several provinces, including Manisa, İzmir, Uşak, Kütahya, Denizli, Balıkesir, and Aydın. Covering a geographical area between the latitudes of 38°04’ to 39°13’ N and longitudes of 26°42’ to 29°45’ E, the basin discharges its waters into the Aegean Sea via the Gediz River and its tributaries. The basin's diverse topographical features, including mountains, plains, and valleys, contribute to its varied climatic and hydrological conditions. The Gediz Basin is characterized by a semi-arid climate with significant variations in precipitation and temperature, making it vulnerable to seasonal and long-term climatic changes. The river's flow regime is heavily influenced by rainfall patterns, groundwater recharge, and human activities such as dam construction, agricultural irrigation, and detergent discharges (washing machine effluents) (Rathore et al., 2024) which have increased the need for sustainable water management practices within the basin to ensure equitable distribution of water resources among different sectors (SYGM, 2019).

The Menemen Plain constitutes a significant portion of the study area within the Gediz River Basin in the Aegean region. The plain is a vital agricultural area contributing significantly to the region's economy. The plains' fertile alluvial soils, coupled with their favorable climatic conditions, support a wide range of crops, including cereals, vegetables, fruits, and industrial crops like cotton and tobacco (SYGM, 2019). The strategic importance of the Menemen Plain for agricultural production in Türkiye is underscored by its capacity to produce high yields of essential food and crops with high economic gain, which are integral to local and national food security. The irrigation infrastructure in the plain is primarily fed by the Gediz River and enables intensive cultivation. However, the sustainability of agricultural practices in the Menemen Plain is intricately linked to the quality of irrigation water sourced from the Gediz River. This river is often compromised by pollutants introduced from industrial discharges, agricultural runoff, and untreated sewage, which degrade water quality. Microplastics, in particular, pose a growing concern as they have been detected in irrigation water and subsequently in irrigated crops (Silva et al., 2021). The presence of microplastics in irrigation water can potentially affect the quality of agricultural produce. Microplastics may accumulate in the soil and crops, potentially impacting crop growth and food safety. Given this, maintaining high water quality standards is crucial for sustaining agricultural productivity, protecting public health, and ensuring the quality of agricultural products.

MP samples were collected from 5 sampling sites along the Gediz River during June 2023 and January 2024 (Figure 1). These surface water samples were collected from each sampling site by retrieving 5 liters of water from the water column.

Procedures for the MPs Extraction and Identification

Samples collected for MP analysis underwent a series of steps as described by (X. Liu et al., 2019). Initially, the samples were filtered using four sets of steel sieves with different pore sizes: 500, 250, 100, and

25 microns. Each sieve was rinsed with distilled water, and the particles retained on the filters were transferred to a beaker. These samples were then dried in an oven at 60°C for 24 hours. Subsequently, hydrogen peroxide (20 mL of 5 M) was added to the dried samples, and the mixture was stirred using a magnetic stirrer at 40°C for 1 hour to complete the oxidation process of organic substances. The oxidized samples were filtered through a 10 cm diameter steel sieve with a pore size of 25 microns and then dried at 40°C for microscopic analysis. A stereomicroscope (Leica S Apo) was utilized for visual counting and analysis of the size, color, and shape of the microplastic particles in the samples. Particles suspected to be microplastics during a stereomicroscopic inspection, falling within the size range of 0.1-5 mm, underwent further analysis using Attenuated Total Reflection Fourier Transform Infrared (ATR-FT-IR) spectroscopy (Frontier series, Perkin Elmer). Only those samples with a match value exceeding 90% against reference compounds in the instrument's library were identified as microplastics.

Ecological Risk Assessment of MPs

The Pollution Load Index (PLI) is a pollution assessment technique used to assess the degree of regional risk associated with the distribution of MPs (Zhou et al., 2024). The PLI of the river (PLI_{river}) was calculated based on the formula established by (Tomlinson et al., 1980). The PLI is a standardized monitoring and assessment approach for determining pollution levels between stations. This index includes the contamination factor (CF), which is defined as the ratio of the MP concentration (C_i) at a given location to the background value (C_{oi}), which is the lowest MP concentration observed in that area (Huang et al., 2023):

$$CF_i = \frac{C_i}{C_0} \quad (1)$$

PLI based on CF is defined as follows: (Tomlinson et al., 1980).

$$PLI_i = \sqrt{CF_i} \quad (2)$$

$$PLI_r = \sqrt[n]{PLI_1 * PLI_2 * \ldots\ldots PLI_n} \quad (3)$$

In the PLI analysis, the background value used was the lowest observed MP concentration among the five stations for each period (dry and wet). For the dry period, this value was 10 units/L, obtained from Station 1 during October 2023. For the wet period, the background value was 13 units/L, recorded at Station 4 during the January 2024 sampling period.

The level of risk associated with microplastic contamination was categorized into four tiers: Level I (minor risk), Level II (high risk), Level III (dangerous), and Level IV (extremely dangerous) (Table 1). These

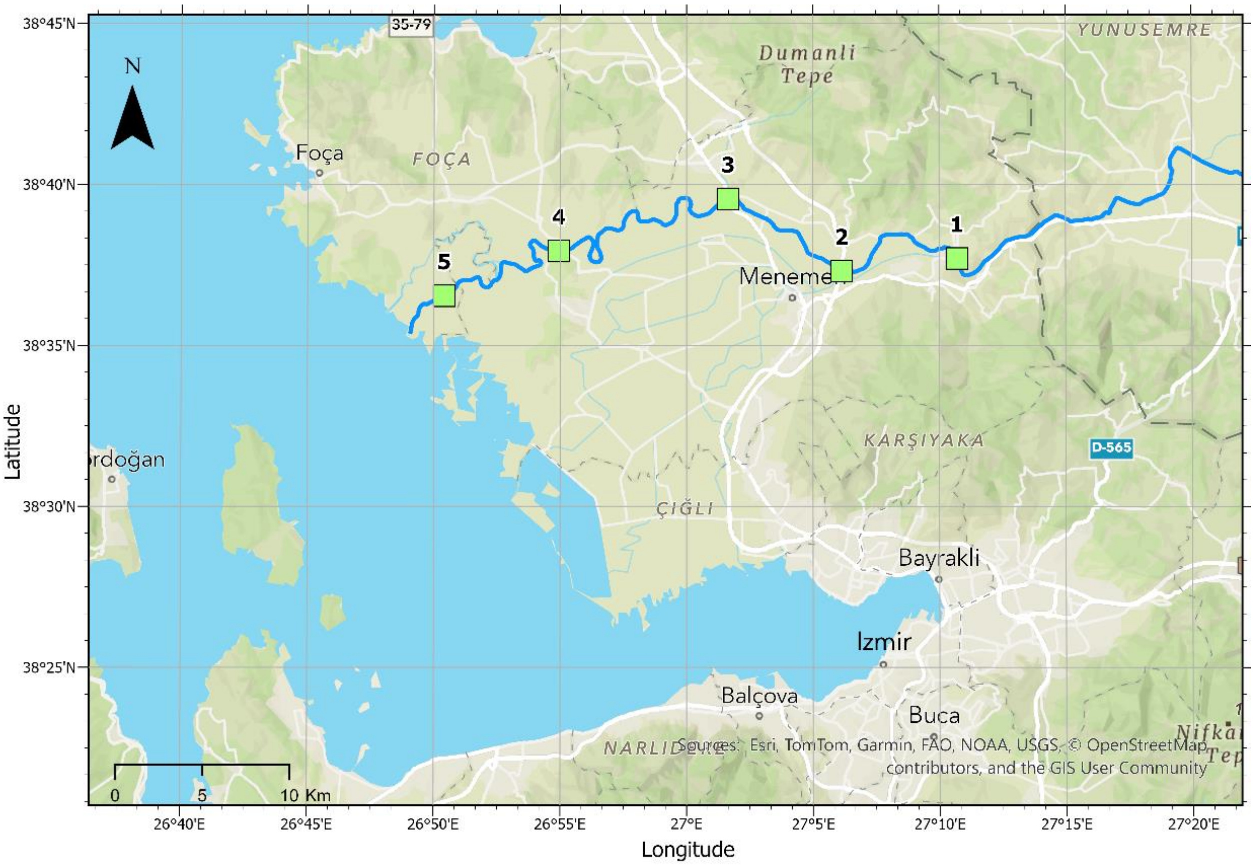

Figure 1. Locations of sampling sites.

classifications align with Pollution Load Index (PLI) values as follows: PLI<10 for Level I, 10<PLI <20 for Level II, 20<PLI<30 for Level III, and PLI>30 for Level IV, as stated by (Arredondo-Navarro et al., 2024).

The Polymer Hazard Index (PHI) is a comprehensive tool designed to evaluate the ecological risks of various microplastics (MPs) in aquatic environments. It provides a quantitative measure of the potential hazard of different polymers based on their chemical properties, environmental persistence, and toxicity (Lithner et al., 2011). The PHI is calculated using a formula that considers each polymer type's concentration and specific characteristics within a given area, allowing for a detailed assessment of the overall risk associated with MP pollution. This index is widely utilized as a standardized method to assess and compare the hazard levels of MPs across different stations or regions, providing valuable insights into the potential environmental impact and helping to guide targeted mitigation strategies. The calculation of the PHI is shown in Eq. (4), where PHI is the hazard index for assessing the polymer hazard, S_n is the hazard score of MP polymers, and P_n is the ratio of each MP type.

$$PHI = \sum S_n * P_n \quad (4)$$

The PHI value was used to classify the hazard level into five groups (I-V) (Table 2). The S_n values are detailed in Table 3 and are given in detail in the study of Lithner et al. (2011).

Quality Control and Assurance

Preventing contamination is a critical aspect of microplastics research. Against the risk of contamination of samples with microplastics from laboratory conditions such as atmospheric transport, clothing, consumables, and equipment, a sensitive approach was maintained at every stage of the present study. Briefly, metal buckets and steel ropes were utilized for field sampling, and the cleanliness of all containers in contact with samples was ensured by thoroughly washing them with ultra-pure water and subsequent drying. Laboratory work involved using aprons and latex gloves; glass or steel materials were preferred over plastic whenever possible. Steel buckets and ropes were washed with pure water before each use to prevent cross-contamination between sampling stations during fieldwork. During analysis, beakers and steel sieves containing samples were covered with aluminum foil. Furthermore, blank petri dishes were placed inside the fume hood during heat treatments and on the microscope table during analysis to detect contamination from the laboratory environment.

Method validation studies were conducted using reference microplastics of polyethylene (PE), polystyrene (PS), and polypropylene (PP) standards. Initially, the reference microplastics were cut into small fragments between 1.05 and 2.7 mm. A known quantity of each polymer type was added to 2-liter glass beakers containing wastewater and river water matrices,

Table 1. The hazard level criteria for MP pollution. (Han et al., 2024)

Risk category	PLI	CF	Risk category
I	<10	CF < 1	Minor
II	10–20	1 < CF < 3	Medium
III	20–30	3 < CF < 6	High
IV	>30	CF > 6	Danger

Table 2. The polymer hazard index (PHI) risk categories (Lithner et al., 2011)

PHI	Hazard Category	Risk Category
0–1	I	Minor
1–10	II	Moderate
10–100	III	High
100–1000	IV	Very High
>1000	V	Extremely High

Table 3. Hazard score of MPs polymer type (Lithner et al., 2011)

Polymer	Abbreviation	Hazard score	Risk Level
Polyethylene	PE	11	I
Polypropylene	PP	1	II
Polystyrene	PS	30	II
Polyethylene terephthalate	PET	4	II
Polyamide	PA	47	II
Polyacrylonitrile	PAN	9	V

followed by continuous mixing for 24 and 48 hours. The recovery rate was determined to be greater than 95% for both river water and wastewater samples.

Statistical Analyses

The data obtained from field measurements and laboratory analyses were statistically evaluated using R statistical software (v4.2.2). The Shapiro-Wilk test was used to assess the normality of the data distribution. One-way variance analyses (ANOVA or Kruskal-Wallis tests) were conducted to compare the differences in MP counts and seasons.

Results and Discussions

Abundance of MPs in Dry and Wet Seasons

The mean abundances of MPs were 50±36 and 67±58 units/L in the wet (May 2023, November 2023, and January 2024) and dry (June 2023, September 2023, and October 2023) periods, respectively, in samples collected from 5 stations (Figure 2). During the wet period, the highest number of 127 units/L was counted at station 3, while the lowest number of 13 units/L was counted at station 4. During the dry period, the highest value of 211 units/L and the lowest value of 10 units/L were recorded at station 1 (Figure 2). There were no significant differences in mean MP concentrations (67±58 and 52±36, respectively) between dry and wet periods ($P<0.05$). Also, there were no significant variations in mean MP concentrations between the sampling sites ($P<0.05$). Huang et al. (2023) evaluated the seasonal effect of MP abundance in the Houjin River in Taiwan and found MPs at higher levels (183.33±128.95 units/m^3) in the dry period, in parallel to this study. Moreover, the MP concentrations observed in this study are relatively high compared to other contaminated areas, including the bay of Marseille, Rhone River (5.79±12.71 units/m^3) (Alcaïno et al., 2024), and the Elbe River, in Germany (5.57±4.33 units/m^3) (Scherer et al., 2020). However, when the Gediz River, which is highly polluted by industrial activities, is compared with Asian rivers, similar levels for MP counts are determined. In two different rivers (Xinyi and Ashe) from Harbin (China), MPs were estimated as 37,328.4 and 22,638.8 units/m^3 in the dry season, whereas MPs were found as 50,809.9 units/m^3 and 40,183.0 units/m^3 in the wet season (Liu et al., 2024).

MPs' Morphological Characteristics

MPs are divided into four categories based on their size, and the frequencies in each category are shown in Figure 3. The 0.5-0.1 mm size range was the most frequently detected group (58.7%), and the least frequently detected size range was 1-5 mm (7.3%). Counted MP shape classes were fiber, film, fragment, foam, and pellet. Among the different shapes, fragments and fibers were predominant (47.1% and

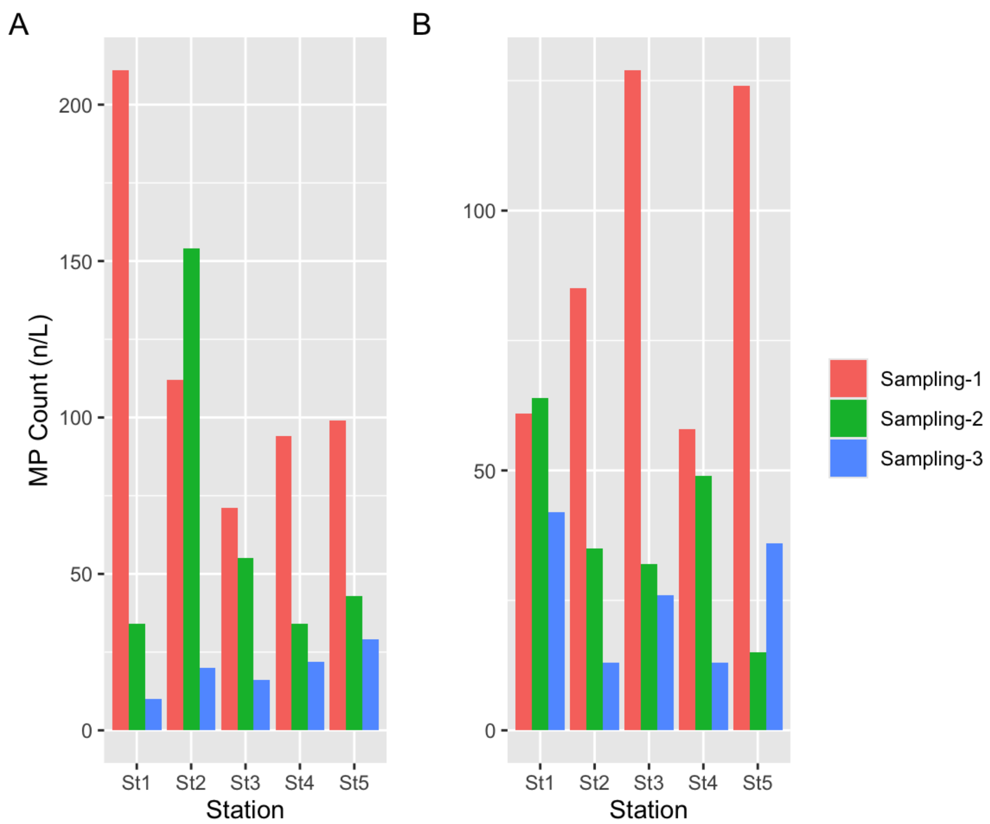

Figure 2. The abundance of MPs in dry (A) and wet (B) abundance in Gediz River.

38.5%), followed by film and pellet (9.9% and 4.4%), and foam (0.09%) was the least common type. The most observed MP colour in the present study was transparent (53.1%), followed by red (19.4%) during the dry and wet seasons. In the study conducted in the Ergene River, which is severely polluted by industrial waters just like the Gediz River, the most detected MP shape was fiber (88%), and the most MPs were counted between 1-2 mm (38%). In Ergene River study, the most common colour was found to be black (49%) (Akdogan et al., 2023). In another study conducted in Türkiye, (Ozguler et al., 2022) investigated the number of MPs in rivers flowing into Mersin Bay. They found that the dominant shape was fiber (83.5%), the dominant colour was blue (55%), and 91% of the MPs counted were <2.5 mm. In our study, the total percentage of MP counted between <0.1 mm, 0.1-0.5 mm and 0.5-1 mm was 92.7%.

Similar to the present study from Türkiye, fiber was the most common form of MP in many rivers like Manas River, China (88%) (L. Wang et al., 2021), Ganga River, India (91%) (Napper et al., 2021), and Tamil Nadu, India (78.5%). Also, Pavithra et al. (2024) found fragment shape to be dominant in the estuarine regions of the river of the Bay of Bengal, similar to our work. The primary source of fibres is plastic packing material, domestic wastewater, including laundry wastewater release, and personal care products (Di et al., 2019). Also, Gediz River has been receiving a significant number of industrial discharges for many years, and it is known that fiber MP is intensively found, especially in plastic manufacturing and textile industry wastes (Napper & Thompson, 2016).

Polymer Compositions of MPs

At monitoring St1, the furthest station from the sea, there is a significant prevalence of PP at 52.4%, followed by "Others" at 23.8% and PET at 14.3%. The category labeled "Others" in the analysis includes a variety of microplastic types such as CA, PBAN, PMMA, PVDF, PBT, LATEX, SAN and etc. This suggests that inland sources, possibly related to local industrial, agricultural, or urban activities, contribute to a diverse range of

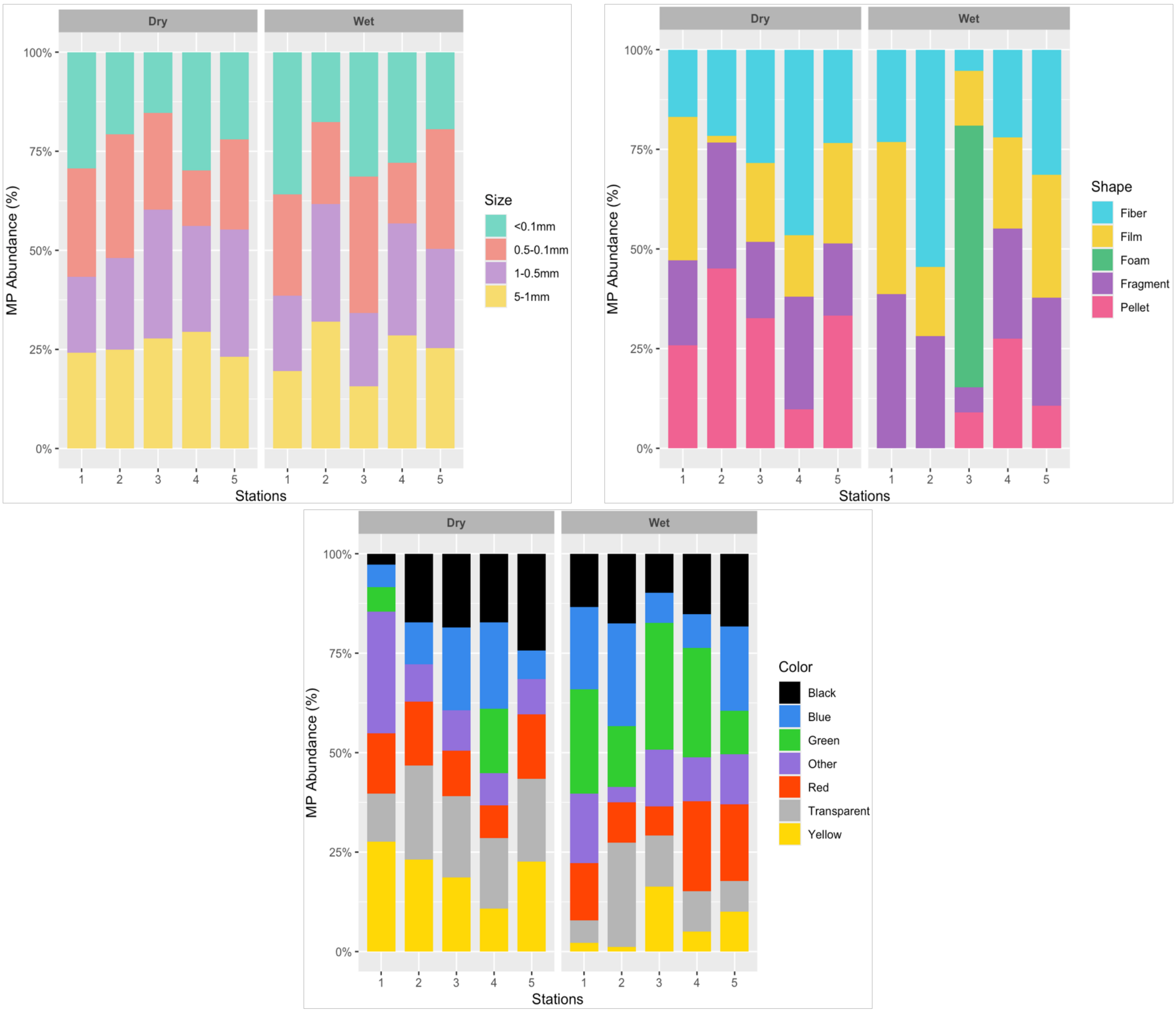

Figure 3. MPs shape, size, and color distribution in dry and wet periods for five stations.

microplastics, with PP being particularly dominant. St2, located just downstream of a bridge pillar, and St3, situated within the Menemen district's boundaries, show similarly high levels of PP. The influence of urban runoff is likely contributing to introducing and distributing various microplastic types at these sites. The high levels of PE and PET at these stations further underscore the impact on urban areas, as these plastics are widely used in the packaging and textile industries, which are known to be significant contributors to microplastic pollution in aquatic environments (Dris et al., 2017).

St4 and St5, on the other hand, are located in regions far from urban settlements, characterized by extensive agricultural activities. St4 stands out with an overwhelming 88.9% of PP, surpassing other microplastic types. The dominance of PP in this area suggests a strong influence from agricultural practices, possibly due to the use of plastic-based materials like mulching films and irrigation pipes, which can fragment and enter the river system (Steinmetz et al., 2016). St5 presents a different scenario as it is closest to the sea and functions as a transitional zone between fresh and saline waters. Here, both PP and "Others" account for 46.7% each, reflecting the complex interactions between marine and terrestrial influences in this region, where microplastics from both sources mix.

The specific distribution patterns and concentrations at each station, as detailed in Figure 4, emphasize the importance of geographical, infrastructural, and environmental characteristics when analyzing microplastic pollution. The statistical analyses reveal significant differences in microplastic composition between different microplastic types ($P<0.05$), while no significant differences were observed between stations.

These results suggest that while the type of microplastic is significantly related to their concentrations, the specific locations (stations) do not show statistically significant variation within this dataset. However, the patterns observed in microplastic distribution across stations may still reflect underlying environmental and anthropogenic factors such as proximity to urban areas and agricultural activities. Urban sources such as the packaging, textile, and automotive industries are likely key contributors to the presence of PE, PET, and PP in these regions (Dris et al., 2017; Kole et al., 2017).

Ecological Risk of MPs

The ecological risk posed by microplastics in freshwater environments is a significant concern due to their persistence, potential toxicity, and ability to act as vectors for other pollutants. The data analysis performed on the Gediz River, utilizing both Pollution Load Index (PLI) and Polymer Hazard Index (PHI), provides insights into MPs' seasonal and spatial distribution and the associated ecological risks.

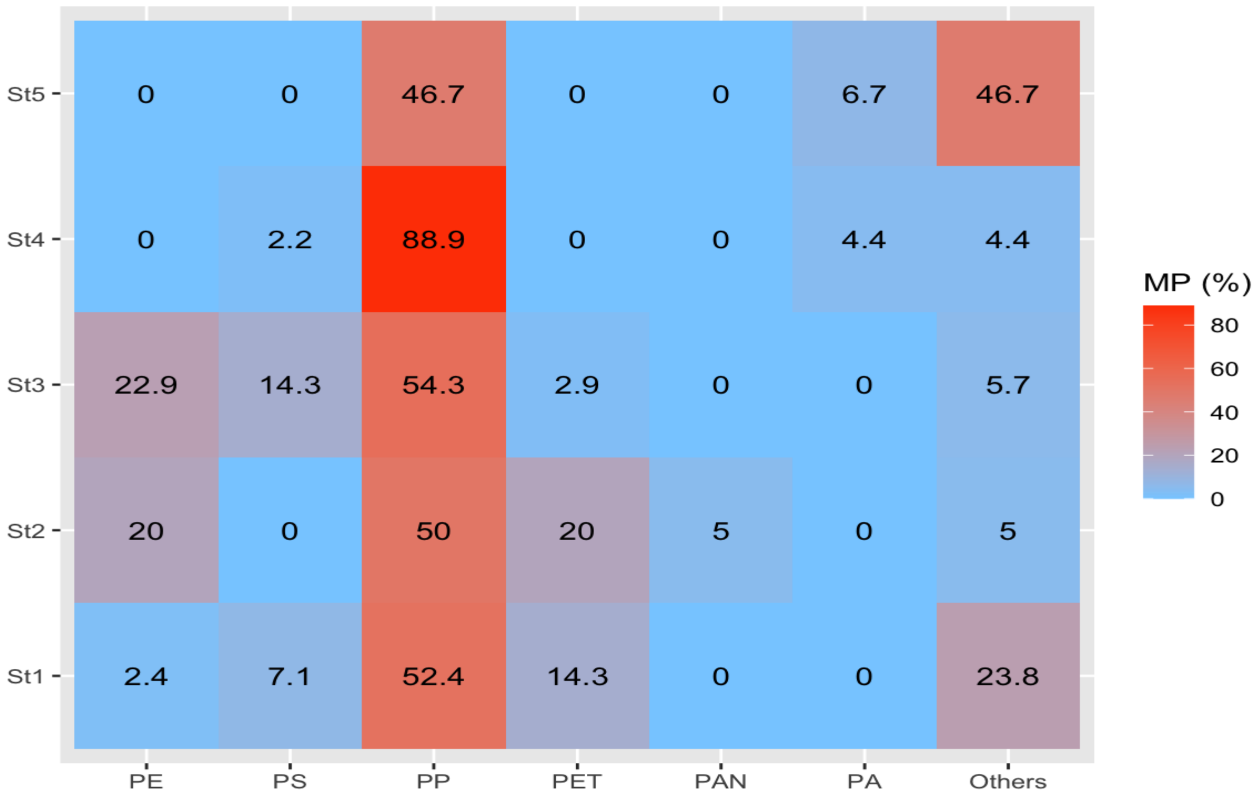

Figure 4. The distribution of microplastic types across sampling stations in the Gediz River.

The boxplot comparing the PLI values between dry and wet seasons (Figure 5) indicates a higher median PLI during the dry season compared to the wet season. According to the risk classification criteria, a PLI of less than 10, as observed here, places both seasons in Risk Category I, indicating a Minimum Risk level. The statistical analysis results show that the difference between the dry and wet periods is insignificant (P-value >0.05). Additionally, the observed higher values during the dry season indicate that ecological risks may be exacerbated when water flow is reduced, leading to higher concentrations of MPs (Whitehead et al., 2009). The statistical analysis among MP concentrations demonstrated that the mean MP concentration is higher during the dry season (mean = 67 units/L) compared to the wet season (mean = 52 units/L), though the difference is not statistically significant (P>0.05) according to the Kruskal-Wallis test (Kruskal & Wallis, 1952).

The bar chart representing the PHI across different stations (Figure 6) illustrates notable spatial variability, with PHI values ranging from approximately 4 to 8 across various stations. It is important to note that in the calculation of PHI, the "Others" category of plastics is not included. Potential PHI calculation inconsistencies were eliminated since these plastics were only present in some stations. As a result, only the more consistent polymers—PE, PP, PS, PET, PA, and PAN—are included in the calculation.

According to the risk classification for PHI, values between 1 and 10 correspond to Risk Category II, indicating a Moderate Risk level across all stations. Station 3, located in an urbanized area, exhibits the highest PHI, approaching this risk category's upper limit. This indicates a higher risk due to the predominance of hazardous polymers such as PP, which are heavily used in various industries and urban infrastructure. Stations 4 and 5, although located in areas with significant agricultural activities, also show elevated PHI values, reflecting the influence of agricultural runoff, which introduces MPs used in farming practices.

The one-way variance analysis conducted on MP types further emphasizes the significant concentration differences across polymer types, with PP showing the highest concentrations, particularly at Stations 3 and 4. The Kruskal-Wallis test confirmed these differences (P<0.05), highlighting the variable distribution of MPs depending on their source and the surrounding activities. These findings align with previous studies that have identified PP as one of the most commonly found polymers in aquatic environments, primarily due to its widespread use and lower density, which allows it to float and be easily transported by water currents (da Costa et al., 2023; Dris et al., 2016; Klein et al., 2015).

When examining the literature, (Sabilillah et al., 2023) demonstrated that Indonesia's Code and Gajahwong Streams exhibited Level II with average PHI levels of 8.9 (n=6) and Level I with average PLI levels of

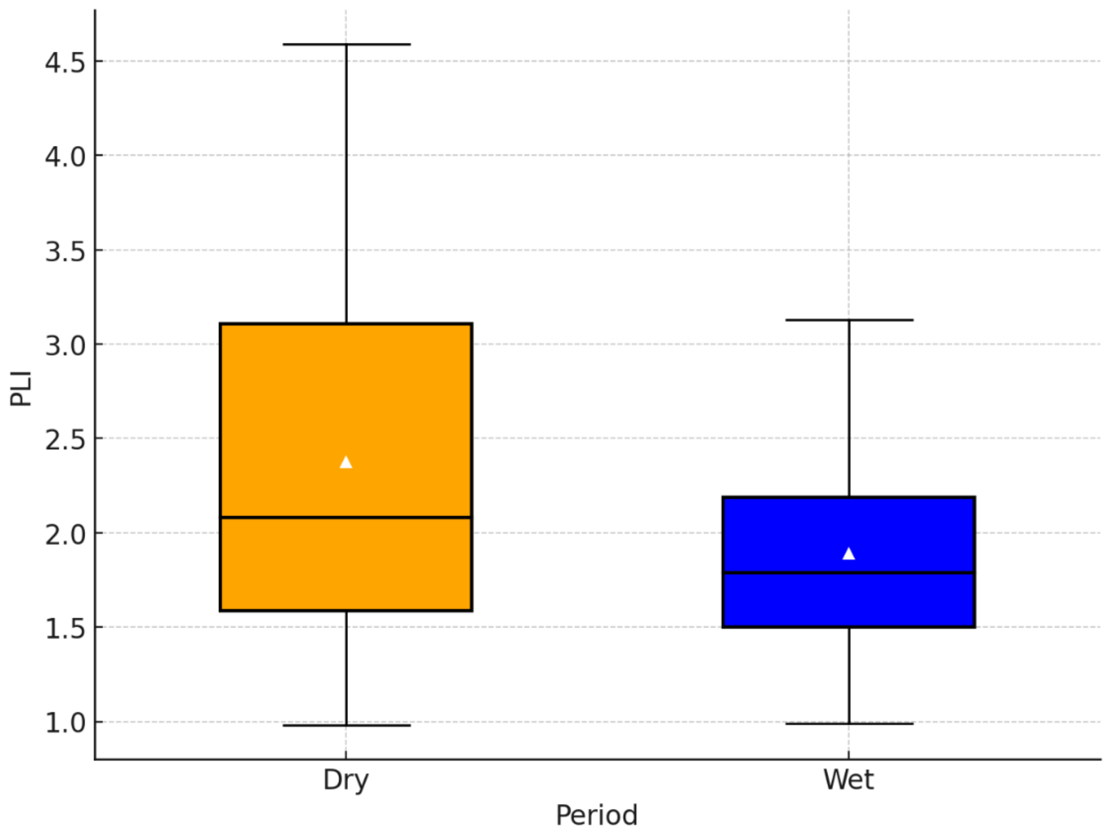

Figure 5. Seasonal comparison of Pollution Load Index (PLI) in the Gediz River.

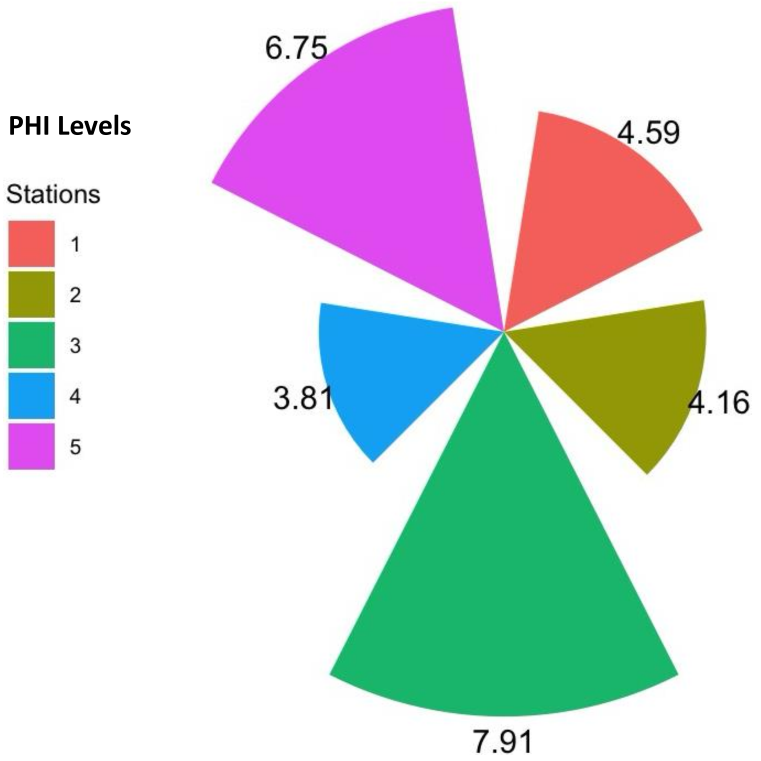

Figure 6. Pollution Hazard Index (PHI) Levels for all stations.

5.2 (n=6), reflecting a moderate risk category. The Pollution Level Index (PLI) indicated a moderate pollution risk for sites near wastewater treatment plants, with PLI values of 51.92 and 63.75. Additionally, a low pollution risk was noted at the estuary, with a PLI value of 41.99, in the study conducted on the Qinhuai River in China. This suggests that microplastic pollution poses a moderate ecological risk to the riverine environment and its associated wildlife (Yan et al., 2021). Finally, (Shekoohiyan & Akbarzadeh, 2022) their study revealed that the PHI values ranged from 17.4 to 22.6 in water and from 20.1 to 24.4 in wastewater, indicating a hazard level III. The PLI values were below 10 for water and wastewater, suggesting a minor risk level for microplastic pollution. This underscores the necessity for improved management strategies to mitigate environmental risks.

Conclusions

The findings of this study highlight the complex and multifaceted nature of microplastic pollution in the Gediz River. The analysis of polymer compositions across different stations reveals significant spatial variability, with polypropylene (PP) as the dominant polymer type, particularly at inland stations such as St1, St2, and St3. These stations, influenced by urban runoff and infrastructure, demonstrate high levels of PP, reflecting the contributions of local industrial and urban activities. The presence of diverse microplastics, categorized as "Others" further emphasizes the various sources of pollution, ranging from urban areas to agricultural regions. Notably, the overwhelming prevalence of PP at St4, an area characterized by extensive agricultural activity, suggests that agricultural practices, such as the use of plastic mulching and irrigation materials, play a critical role in contributing to MP pollution in these regions.

The ecological risk assessment, as indicated by the Pollution Load Index (PLI) and Polymer Hazard Index (PHI), provides additional insights into MPs' temporal and spatial distribution and their associated risks. The higher PLI values observed during the dry season suggest that reduced water flow leads to a concentration of pollutants, elevating the risk level. However, according to the classification criteria, it remains within the "Minimum Risk" category. This seasonal variation highlights the need for targeted management strategies for temporal changes in water flow and pollution levels. Meanwhile, the spatial variability in PHI across different stations points to a "Moderate Risk" level, particularly in urbanized and agricultural areas, where MPs such as PP, PE, and PET are more prevalent.

The statistical analyses, including one-way ANOVA and Kruskal-Wallis tests, further emphasize the significant differences in MP concentrations across polymer types. PP shows the highest concentrations at specific stations. These results align with existing literature, identifying PP as one of the most common polymers in aquatic environments due to its widespread use and buoyant nature. The findings suggest that while the specific locations of the sampling stations do not show statistically significant variation in overall MP concentrations, the type of MP significantly influences the pollution levels.

In conclusion, this study revealed the importance of considering geographical and temporal factors when assessing the ecological risks of MPs in freshwater environments. Identifying key pollution sources, such as urban runoff and agricultural practices, highlights the need for localized mitigation strategies. By addressing the specific sources of MP pollution and considering seasonal variations in water flow, it is possible to develop more effective management practices to reduce the ecological risks associated with MPs in river systems like the Gediz River. Integrating PLI and PHI into ecological risk assessments provides a valuable framework for understanding the broader environmental impact of MPs and guiding future policy and conservation efforts.

Ethical Statement

Not applicable.

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Author Contribution

Neval Baycan (Conceptualization, Methodology, Writing, Review, Editing, Supervision), Nefise Alyürük (Conceptualization, Methodology, Data Collection and Analysis, Writing), Yiğithan Kazancı (Conceptualization, Methodology, Data Collection and Analysis, Writing), Cumana Alpergün (Data Collection, Laboratory Analysis, Writing), Nursena Kara (Data collection, Laboratory Analysis, Writing), Orhan Gündüz (Conceptualization, Writing, Review and Editing).

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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