https://doi.org/10.65646/3cp3es20dps3a028

Assessment of Microplastic Pollution in the Kelani and Gin River Drinking Water Intake Points in Sri Lanka

K.G.Lahiru Shanaka
Department of Construction Technology
Faculty of Engineering Technology
University of Vocational Technology
Rathmalana , Sri Lanka
kglshanaka@gmail.com

D.R.S.S. Aththanayaka
Department of Construction Technology
Faculty of Engineering Technology
University of Vocational Technology
Rathmalana , Sri Lanka
supun4470@gmail.com

R.P.C.P. Siriwardana
Department of Construction Technology
Faculty of Engineering Technology
University of Vocational Technology
Rathmalana , Sri Lanka
chanikaprasadani66@gmail.com

R.S.M.Samarasekara
Department of Civil Engineering
Faculty of Engineering
University of Sri Jayawardenapura
Colombo, Sri Lanka
samarasekara@sjp.ac.lk

D.M.M.R.Dissanayake
Environmental Studies & Service Division
National Building Research Institute
Colombo 7 , Sri Lanka
manjularuwan@hotmail.com

Abstract* — Microplastic pollution has become a growing concern in freshwater systems that supply drinking water. This study used a quantitative experimental design to assess the occurrence and preliminary characteristics of microplastics in the Kelani and Gin River drinking-water intake points in Sri Lanka. Water and surface sediment samples were collected from upstream, intake, and downstream locations, then processed by filtration, density separation, and phase-contrast microscopy. The observed particles were classified into four main morphologies: fibers, fragments, films, and pellets. In the reported counts, Kelani River water contained 48 fibers, 32 fragments, 25 films, and 34 pellets, while Gin River water contained 39 fibers, 34 fragments, 21 films, and 32 pellets; sediment samples showed lower overall counts but the same dominant morphologies. XRD was used only as a preliminary structural characterization technique; definitive polymer identification requires complementary techniques such as FTIR and SEM, which were not performed in the present study. The study provides baseline evidence of suspected microplastic contamination at both drinking-water intake systems and supports continued monitoring and further polymer-specific characterization in Sri Lanka's drinking-water sources.

Keywords*— Microplastics; Drinking Water Sources; Freshwater Pollution; Kelani River; Gin River.

I. INTRODUCTION

Plastic pollution has emerged as one of the most significant global environmental challenges due to the continuous increase in plastic production, widespread consumption, and inadequate waste management practices. As larger plastic materials undergo physical, chemical, and biological weathering, they gradually fragment into microplastics (particles smaller than 5 mm), which persist in the environment for extended periods because of their resistance to natural degradation. Microplastics have now been detected in freshwater, marine environments, soils, the atmosphere, and even remote ecosystems, demonstrating their global distribution and environmental persistence.[1] Owing to their small size and large surface area, microplastics can adsorb and transport hazardous contaminants, including heavy metals, persistent organic pollutants (POPs), and pathogenic microorganisms. Aquatic organisms readily ingest these particles, facilitating bioaccumulation and trophic transfer through food webs, while humans may be exposed through drinking water, seafood, food products, and inhalation. Although the long-term health consequences are still under investigation, growing evidence suggests that microplastic exposure may contribute to oxidative stress, inflammation, cellular toxicity, and other adverse biological effects.[2] Consequently, understanding the sources, transport pathways, environmental fate, distribution, and ecological impacts of microplastics has become essential for developing effective pollution mitigation strategies, improving water resource management, and protecting ecosystem and public health.[3]

Despite increasing attention to microplastic contamination in Sri Lankan aquatic environments, evidence focused specifically on drinking-water intake locations remains limited. Existing studies have examined coastal and estuarine environments, including the Kelani River estuary [9][10], but site-specific information on microplastic occurrence and morphology at selected Kelani and Gin River drinking-water intake locations remains limited. Therefore, this study evaluates upstream, intake, and downstream locations and selected physicochemical characteristics to provide baseline information for drinking-water source management.

II. METHODOLOGY

A. Study Area

The Kelani River and Gin River were selected as study sites due to their importance as major freshwater resources and drinking water sources in Sri Lanka [9][10]. Although both rivers provide essential ecosystem services and support public water supply systems, their catchment characteristics differ considerably due to variations in land use, urban development, industrial activities, and hydrological conditions. These differences may influence the occurrence, transport, and accumulation of microplastics within the river systems. The key characteristics of the two river systems and their significance for drinking water supply are summarized in Table 1. Previous work has also documented microplastic contamination in the Kelani River estuarine environment [9][10], supporting the need for further assessment of upstream and drinking-water source locations.

Table 1: Key characteristics of the Kelani and Gin River systems

Characteristic	**Kelani River**	**Gin River**
River length	145 km	113 km
Catchment area	2,292 km²	922 km²
Origin and outlet	Originates from the central highlands and discharges into the Indian Ocean at Colombo	Originates from the Sinharaja–Deniyaya mountainous region and discharges into the Indian Ocean at Gintota, Galle
Dominant land-use characteristics	Upper catchment consists mainly of forest and agricultural areas, while the middle and lower catchments are influenced by urban development, industrial zones, settlements, and transportation activities	Predominantly forested upper catchment with agricultural areas, rural settlements, tourism-related activities, and increasing human influence towards downstream regions
Major anthropogenic influences	Urbanization, industrial activities, wastewater discharge, construction activities, solid waste disposal, and stormwater runoff	Agricultural runoff, domestic waste disposal, tourism activities, rural settlements, and land-use changes
Drinking water intake location	Ambathale Water Treatment Plant intake	Wakwella Water Treatment Plant intake
Importance for water supply	Major raw water source for Colombo Metropolitan Region and surrounding areas	Important raw water source for communities in the Southern Province
Major treatment processes	Screening, coagulation–flocculation, sedimentation, filtration, and disinfection	Screening, coagulation–flocculation, sedimentation, filtration, and disinfection

As indicated in Table 1, the Kelani River catchment is subjected to comparatively higher anthropogenic pressure due to extensive urbanization, industrial development, and population density within the lower basin [9]. These activities may introduce greater quantities of plastic waste, wastewater-derived contaminants, and urban runoff into the river system. In contrast, the Gin River represents a comparatively less urbanized catchment; however, agricultural activities, rural settlements, tourism, and downstream development may contribute to microplastic inputs [10]. Therefore, differences in catchment characteristics and human activities between these two rivers provide an important basis for evaluating spatial variations in microplastic contamination at drinking-water intake locations. Below, Figure 1 shows the selected water intake points of the Kelani and Gin rivers.



Figure 1 : Location of the Kelani and Gin River basins showing the selected drinking water intake sampling stations.

B. Sample Collection

Field Water and sediment samples were collected from twelve selected sampling locations along the Kelani River and Gin River to assess the occurrence, distribution, and accumulation of microplastics within drinking water source environments. The selected locations represented upstream, drinking water intake, and downstream sections of each river system. Detailed field sampling information, including sampling dates, time periods, sample quantities, equipment specifications, and environmental conditions during sampling, are summarized in Tables 2 and 3.

The Kelani River sampling campaign was conducted on 29 April 2026 between 10:30 a.m. to 3:30 p.m., while the Gin River sampling campaign was conducted on 24 June 2026 between 11:00 a.m. to 5:00 p.m. 45 minutes to 1 hour was required for sampling at each location, including sample collection, recording of site information, and sample handling.

A large-volume surface water sampling approach was adopted due to the relatively low concentration of microplastics commonly reported in freshwater environments. 100 L of surface water was collected from each sampling location using a manta net with a 300 µm mesh size. The net was operated against the river flow to capture suspended microplastic particles present within the water column. Following collection, the retained materials were carefully rinsed from the collection chamber using filtered distilled water and transferred into pre-cleaned 250 mL glass bottles to minimize potential contamination.

surface sediment samples were collected from the same twelve sampling locations immediately after water sampling to evaluate the accumulation of microplastics within riverbed sediments. 500 g of surface sediment was collected from each location using a stainless-steel grab sampler. Stainless-steel sampling equipment was selected to reduce the risk of introducing external plastic particles during collection. After collection, excess water was carefully removed, and sediment samples were transferred into pre-cleaned glass containers using stainless-steel tools.

All collected water and sediment samples were immediately labelled with unique identification codes containing the river name, sampling location, sample category, sample type, and collection date. The samples were transported to the laboratory under controlled conditions for subsequent filtration, density separation, microscopic identification, and polymer characterization.

Table 2 : Summary of Field Sampling Information

River	Sampling Category		Number of	Sampling Date	Sampling Time	Sample Type	Sample Quantity
Kelani River	Upstream	USP 01 USP 02	2	29 April 2026	10:30 a.m. 3:30 p.m.	Surface water and sediment	100 L water and 500 g sediment per location
Kelani River	Intake Point	MP 01 MP 02	2	29 April 2026	10:30 a.m. 3:30 p.m.	Surface water and sediment	100 L water and 500 g sediment per location
Kelani River	Downstream	DSP 01 DSP 02	2	29 April 2026	10:30 a.m. 3:30 p.m.	Surface water and sediment	100 L water and 500 g sediment per location
Gin River	Upstream	USP 01 USP 02	2	24 June 2026	11:00 a.m. 5:00 p.m.	Surface water and sediment	100 L water and 500 g sediment per location
Gin River	Intake Point	MP 01 MP 02	2	24 June 2026	11:00 a.m. 5:00 p.m.	Surface water and sediment	100 L water and 500 g sediment per location

Gin River	Downstream	DSP 01 DSP 02	2	24 June 2026	11:00 a.m. 5:00 p.m.	Surface water and sediment	100 L water and 500 g sediment per location

Rainfall before sampling (24–48 h)	Light rainfall recorded	Moderate rainfall recorded
Wind speed	Low (approximately 2–5 m s^{-1})	Moderate (approximately 4–7 m s^{-1})
Wind direction	South-west	South-west
Air temperature (°C)	28–30	31–33
Water condition	Slightly turbid	Slightly turbid
River flow condition	Moderate flow	Moderate to high flow
Tide condition (where applicable)	Low tide during sampling	Low tide during sampling
Additional field observations	Floating vegetation and minor plastic debris observed near riverbanks. No significant anthropogenic disturbances were observed during sampling.	Floating debris, plastic litter, and increased human activities observed near the intake area and adjacent riverbanks.

C. Microplastic Extraction and Processing

Microplastic isolation from sediment and surface-water samples was performed using density separation and vacuum filtration based on established methodologies [4][5]

1) Processing of Surface Water Samples

Concentrated surface-water samples collected via a Manta trawl with a 300 µm mesh size were processed directly through a vacuum filtration unit to isolate suspended anthropogenic microparticles [5]. The apparatus comprised a glass Büchner funnel attached to a vacuum receiving flask driven by an oil-free

Table 3 : Environment condition during sampling

Parameter	**Gin River Sampling (24 June 2026)**	**Kelani River Sampling (29 April 2026)**
Weather condition	Cloudy with intermittent sunshine	Partly cloudy with sunny conditions
Rainfall during sampling	No rainfall observed	No rainfall observed

diaphragm pump under controlled negative pressure (ΔP≈20–30 kPa). Sample volumes were drawn through 0.45 µm nitrocellulose membrane filters to retain synthetic fibers and rigid fragments while eliminating excess aqueous matrix. Retained membranes were thoroughly rinsed with ultrapure water (18.2 MΩ·cm) to prevent inorganic scaling, transferred into clean glass Petri dishes, and dried to constant weight at 40 °C prior to stereomicroscopic and XRD evaluation.

2) Extraction from Sediment Samples

To isolate synthetic polymers bound within dense mineral bed sediments (ρ≈2.65 g cm^{-3}), samples underwent gravimetric density separation prior to filtration [4]. Sediments were mixed with a saturated sodium chloride (NaCl) brine solution (ρ≈1.20 g cm^{-3}) and subjected to active mechanical agitation to fluidize the sediment bed and unbind microplastics adhering to mineral grains. Following a quiescent settling period under standard gravity, low-density polymers including polyethylene (0.91–0.97 gcm^{-3}) and polypropylene (0.90–0.91 gcm^{-3}) buoyantly migrated into the supernatant phase while heavy silicate minerals settled to the bottom [6]. The floating, polymer-rich supernatant was carefully decanted and subsequently passed through the same 0.45 µm nitrocellulose vacuum filtration assembly for particle collection, salt rinsing, and thermal drying

D. Microscopic Identification and Morphological Characterization

Retained particulates were examined under phase-contrast optical microscopy to screen and classify microplastic candidates according to standardized physical criteria, including geometric morphology, dimensions, color, and surface degradation [4]. Microplastics were categorized into four predominant morphological types: continuous unidimensional filaments (fibers), irregular planar sheets (films), angular non-uniform particles (fragments), and spherical/spheroidal beads (pellets). Visual sorting served as a preliminary, high-throughput screening phase to distinguish anthropogenic synthetic polymers

from natural organic debris and mineral matrix artifacts. Because FTIR and SEM analyses were not performed in this study, morphological and XRD observations are interpreted as preliminary characterization rather than definitive polymer identification.

E. Polymer Characterization

Selected suspected microplastic particles were characterized by X-ray diffraction (XRD) using Cu-Kα radiation (λ = 1.5418 Å) over a 2θ range of 10–80° with a 0.02° step size. The diffraction patterns were evaluated from peak position and intensity and compared with the ICDD PDF database to assess crystalline and semi-crystalline structural features. Interplanar spacing was determined using Bragg's law ($n\lambda = 2d \sin\theta$). XRD results, combined with microscopic observations, were used as preliminary structural evidence for microplastic-like particles in accordance with the analytical principles of ISO 24187:2023 [7]. No FTIR or SEM analysis was conducted in this study; therefore, XRD results are not treated as definitive polymer identification.

III. RESULTS AND DISCUSSION

The occurrence, distribution, and physicochemical characteristics of microplastic-like particles at primary drinking-water intake points along the Kelani and Gin Rivers were systematically evaluated. The integrated results combine baseline water-quality parameters, morphological microplastic classification, preliminary XRD structural characterization, and comparison with regional freshwater literature.

A. Physicochemical Characteristics of Intake Water Samples

The measured physicochemical parameters provide an empirical baseline of the ambient hydraulic and hydrochemical regime at the drinking water intake locations.

Table 4 : Physicochemical Parameters of Intake Water Samples vs. SLS 614: 2013 Potable Water Standards[8]

Parameter	Kelani River Intake (Mean ± SD)	Gin River Intake (Mean ± SD)	SLS 614: 2013 Standard Limit*
pH	7.84±0.36	8.01±0.75	6.5–8.5
Electrical Conductivity (µS/cm)	58.3±25.4	65.22±10.0	—
Turbidity (NTU)	8.28±2.43	9.89±0.32	≤2
Total Hardness (mg/L CaCO 3)	20±22	30±8	≤250

The measured pH values (7.84±0.36 for Kelani River and 8.01±0.75 for Gin River) were within the SLS 614:2013 potable-water pH range of 6.5–8.5 [8]. Because the samples in this study represent raw water at treatment-plant intake locations rather than finished potable water, the SLS values are used here as a reference for treatment-relevant water quality rather than as evidence of potable-water compliance. Total hardness values (20±22 mg/L CaCO3 and 30±8 mg/L CaCO3) indicate relatively soft water at the sampled intake locations.

B. Hydrodynamic and Interfacial Mechanisms of EC and Turbidity

Electrical conductivity (EC) provides an indication of the ionic condition of the water surrounding suspended particles.

The low EC values observed (58.3±25.4 µS/cm and 65.22±10.0 µS/cm) indicate dilute surface-water conditions at the sampled intake locations. According to Derjaguin-Landau-Verwey-Overbeek (DLVO) theory, low ionic strength can maintain a broader electrical double layer (EDL) around suspended particles, enhancing electrostatic repulsion and suppressing homo-aggregation.

Concurrently, turbidity levels (8.28±2.43 NTU in Kelani and 9.89±0.32 NTU in Gin) were above the SLS 614:2013 reference value of ≤2 NTU for potable water [8]. Since these measurements were obtained from raw intake water, the exceedance indicates that treatment is required before potable use and highlights the importance of treatment processes such as coagulation, sedimentation, filtration, and disinfection. Elevated suspended material may also provide surfaces for microplastic attachment and transport. Therefore, the observed turbidity should be considered when interpreting the occurrence and transport of microplastic-like particles at the intake locations.

C. Regional and International Literature Comparison

The recorded pH (7.84–8.01) and low total hardness (20–30 mg/L CaCO3) provide a baseline for the sampled intake waters. The EC values (58–65 µS/cm) are lower than downstream estuarine readings reported in coastal studies (144–2,500 µS/cm) [9], consistent with the freshwater character of the selected intake locations. The elevated turbidity levels (8.28–9.89 NTU) are relevant to treatment-intake conditions because suspended particulate loads can influence the transport and retention of microplastic-like particles.

D. Microplastic Classification and Morphological Distribution

Microplastic particles observed in the raw-water samples were predominantly within the reported size range of 0.05–5.0 mm. For the analyzed 100-L surface-water samples, the reported counts were 48 fibers, 32 fragments, 25 films, and 34 pellets for the Kelani River, and 39 fibers, 34 fragments, 21 films, and 32 pellets for the Gin River. Reporting the observations on a 100-L sample basis clarifies the sample volume associated with the reported counts. Fibrous particles were visually prominent, and blue was the dominant reported color among fibrous particles (>60%). Potential sources discussed in relation to the observed morphologies include wastewater inputs, atmospheric deposition, domestic laundry discharge, and physical fragmentation of larger plastic items. These pathways are considered plausible sources rather than direct source attribution.

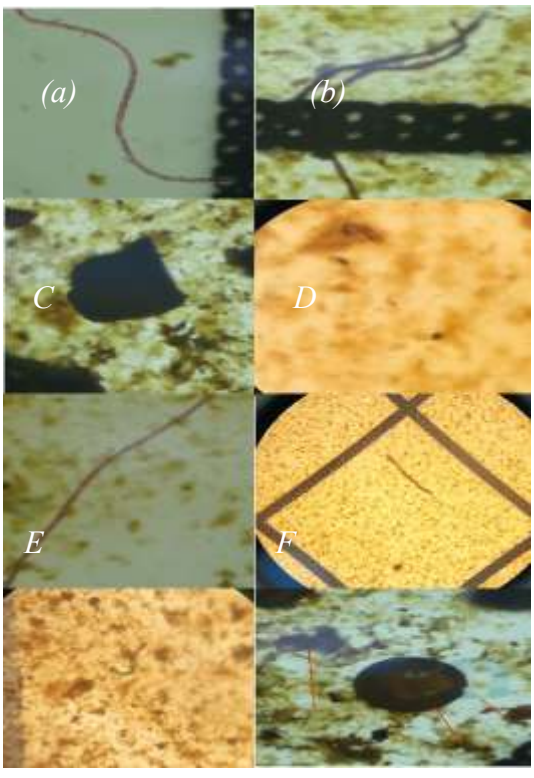


Figure 3 : Different shapes and color of MP Particles that find using Microscope a) Red Color fiber , b) Filaments , c) fiber ,d)pellets, e)rectangular shape particle , f , g)) bio fouled fibers , g) green color fragment

E. Polymer Characterization and Water Safety Implications

XRD analysis was used as a preliminary structural characterization of selected retained particles. The diffraction patterns showed a broad hump between 2θ ≈ 18–25°, together with crystalline peaks near 2θ ≈ 26.6° that were attributed to quartz from co-retained sediment. A recurring peak pair near 2θ ≈ 43.3° and 50.4° was observed across the samples and was attributed to the sample holder or mounting system; this should be verified using an appropriate blank-filter run. The present study did not perform FTIR or SEM analysis; therefore, specific polymer identities such as PE, PP, PET, and PS cannot be reported as definitively confirmed from the present dataset. Further work using FTIR and/or other validated polymer-identification techniques is recommended. The possible transport of microplastics through raw-water treatment systems therefore justifies continued monitoring and polymer-specific characterization.

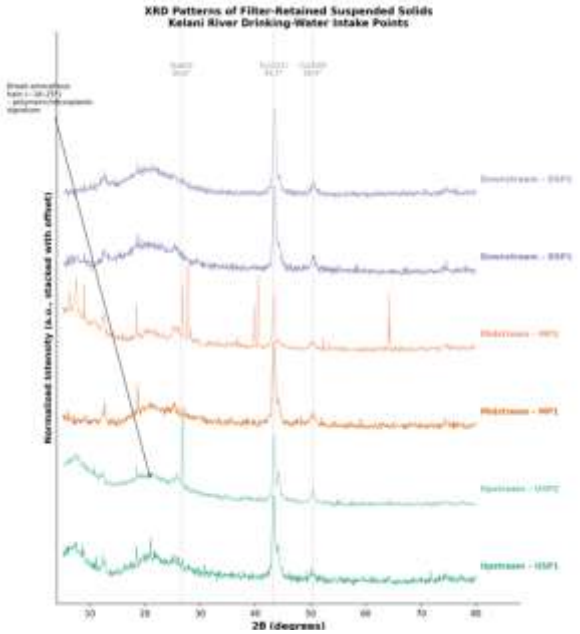


Figure 4 : XRD graph image take from Kelani River 6 water samples

IV. Conclusion

This study assessed the occurrence of suspected microplastic pollution at selected drinking-water intake points along the Kelani and Gin Rivers in Sri Lanka using physicochemical water-quality analysis,

microscopic examination, and preliminary XRD characterization. Microplastic-like particles were observed in both water and surface-sediment samples, with fibers reported as the dominant morphological type, followed by fragments, films, and pellets. The reported water-sample counts were 48 fibers, 32 fragments, 25 films, and 34 pellets for the Kelani River, and 39 fibers, 34 fragments, 21 films, and 32 pellets for the Gin River, based on the analyzed 100-L surface-water samples. The physicochemical results, particularly turbidity, provide important raw-water quality context for drinking-water treatment intake conditions. XRD provided preliminary structural information, but polymer-specific identification was not definitively established because FTIR and SEM analyses were not performed. Further research using validated polymer-identification techniques and repeated sampling across seasons is recommended to strengthen quantitative assessment and source characterization. The findings provide baseline information for continued monitoring and improved management of freshwater sources used for drinking-water supply.

ACKNOWLEDGMENT

This study was conducted as part of the undergraduate research of the Department of Construction Technology, University of Vocational Technology, Sri Lanka. The authors gratefully acknowledge the support, laboratory facilities, technical assistance, and valuable guidance provided by the supervisors and laboratory staff of the National Building Research Organization (NBRO), Sri Lanka, throughout the experimental work. The authors further acknowledge the support of the Department of Construction Technology, University of Vocational Technology, and all individuals who contributed to the successful completion of this research.

REFERENCES

[1] K. Bexeitova *et al.*, "Microplastics in freshwater systems: A review of classification, sources, and environmental impacts," *Chemical Engineering Journal Advances*, vol. 20, p. 100649, Nov. 2024, doi: 10.1016/J.CEJA.2024.100649.

[2] Pradeep Gajanayaka, *Microplastic have been found in human breast milk for the first time according to a research published*.

[3] P. Lalrinfela, R. Vanlalsangi, K. Lalrinzuali, and P. J. Babu, "Microplastics: Their effects on the environment, human health, and plant ecosystems," *Environmental Pollution and Management*, vol. 1, pp. 248–259, Oct. 2024, doi: 10.1016/J.EPM.2024.11.004.

[4] V. Hidalgo-Ruz, L. Gutow, R. C. Thompson, and M. Thiel, "Microplastics in the marine environment: A review of the methods used for identification and quantification," *Environ. Sci. Technol.*, vol. 46, no. 6, pp. 3060–3075, Mar. 2012, doi: 10.1021/es2031505.

[5] G. Masura et al., "Laboratory methods for the analysis of microplastics in the marine environment: Recommendations for quantifying synthetic particles in waters and sediments," NOAA Technical Memorandum NOS-OR&R-48, 2015.

[6] R. C. Thompson et al., "Lost at Sea: Where Is All the Plastic?," Science, vol. 304, no. 5672, p. 838, 2004, doi: 10.1126/science.1094559.

[7] "ISO 24187:2023." Accessed: Aug. 08, 2026. [Online]. Available: https://www.iso.org/standard/78033.html

[8] "SLS 614 Sri Lanka Standard on Potable Water Full description," 2013. Accessed: Aug. 08, 2026. [Online]. Available: https://www.scribd.com/document/290049475/SLS-614

[9] P. G. Y. W. Weerasekara *et al.*, "Sampling and Analysis of Microplastics in the Coastal Environments of Sri Lanka: Estuaries of the Kelani River to Mahaoya," *Water (Basel).*, vol. 16, no. 13, p. 1932, Jul. 2024, doi: 10.3390/w16131932.

[10] V.G.N. Thakshila, "Evidence of Microplastic Contamination in Surface Waters and Sediment of Kelani River Estuary," Proceedings of the International Forestry and Environment Symposium, 2019.