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SPATIAL AND TEMPORAL DISTRIBUTION OF MICROPLASTICS IN SURFACE WATER OF BOLGODA LAKE, SRI LANKA

R. M. S. K. Rathnayake[1,2], A. S. Dikkumbura[1] and M. G. Y. L. Mahagamage[2*]

[1]Department of Chemistry, Faculty of Natural Sciences, [2]Centre for Environmental Studies & Sustainable Development, The Open University of Sri Lanka, Sri Lanka

Microplastic (MP) pollution is often referred to as the invisible threat of our era due to its minute size. Microplastics are defined as plastic particles less than 5 mm in size and can be transported across various ecosystems, including the atmosphere. They also have the potential for bioaccumulation and biomagnification within food chains. This study investigates microplastic pollution in Bolgoda Lake and examine the temporal variation of microplastics during the wet and dry seasons. Fifteen water samples were collected from randomly selected different locations across the lake during both seasons, with duplicates taken to ensure accuracy. A total of 25 liters of water were filtered using a 300 µm sieve, and the residue was collected for analysis. This residue underwent a digestion process followed by density separation. The extracted microplastics were then observed using a stereo microscope. The results indicated that the wet season exhibited a higher abundance of microplastics compared to the dry season. The concentration of microplastics in surface water was higher during the wet season (372 ± 143 MPs/m³) than in the dry season (252 ± 198 MPs/m³). In both seasons, microfibers were the predominant type of microplastic observed. Regarding color distribution, the microplastics observed during the wet season followed this order: Black > Red > Blue > Transparent > Green > Yellow > White. A similar pattern was found during the dry season, with the order being: Black > Red > Blue > Green > Transparent > Yellow > White. Results further indicated that areas near urban development recorded a higher abundance of microplastics compared to more isolated regions. This study highlights that Bolgoda Lake exhibits the highest concentration of microplastics in its surface waters. These findings provide crucial baseline data for understanding the sources, threats, and seasonal distribution of microplastic pollution in Bolgoda Lake and provide valuable insights for policymakers, researchers, and local communities.

Keywords: Bolgoda Lake, microplastics, surface water, plastic pollution

**Corresponding Author: mgyma@ou.ac.lk*

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[1]Department of Chemistry, Faculty of Natural Sciences,
The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka.
[2]Centre for Environmental Studies & Sustainable Development,
The Open University of Sri Lanka, Nawala, Nugegoda, Sri Lanka.

INTRODUCTION

Plastics have become a major environmental concern in our era due to their non-biodegradable nature and their ability to persist in ecosystems for extended periods. Through physical and chemical degradation, these materials can break down into various sizes, including macroplastics, mesoplastics, and microplastics (MP). Microplastics are defined as plastic particles smaller than 5 mm, which pose a global threat due to their widespread distribution and persistence in the environment (Rathnayake et al., 2025). MPs can take several forms, such as microbeads, pellets, filaments, fibers, and fragments, and have been detected in all ecosystems: air, aquatic, and terrestrial (Hossain et al., 2022). MPs have the capacity to adsorb harmful substances such as pesticides, microorganisms, and heavy metals onto their surfaces, effectively turning them into vectors for pollutants. Once MPs enter food chains, they can bioaccumulate and biomagnify, posing potential risks to both plant and animal health (Igalavithana et al., 2022). Aquatic ecosystems are vital to Sri Lanka's livelihoods, providing essential food and water resources. However, many rivers, lakes, and tanks across the country are heavily contaminated with plastic debris. Bolgoda lake is one of the largest freshwater lakes in the Western Province (Jayasekara & Gunawardena, 2020) which supports diverse ecosystems, including mangrove forests, freshwater habitats, and estuarine systems. Located in a densely populated area, anthropogenic activities increasingly threaten the Bolgoda Lake ecosystem and suffer from severe plastic pollution, which endangers both biodiversity and local livelihoods.

METHODOLOGY

The study was conducted at Bolgoda Lake, located in the Western Province of Sri Lanka (6.7712° N, 79.9067° E). A total of 15 sampling locations (Figure 1) were randomly selected (BL1 to BL15). Water samples were collected duplicate during two distinct seasons: the wet season and the dry season, spanning the period from October 2024 to April 2025. Samples were taken from areas with flowing water, and a total of 25 liters of surface water was filtered using a 300 µm sieve. The retained residue was rinsed with microplastic-free water and transferred into pre-cleaned, labeled glass bottles. Then samples were transported to the laboratory and stored under refrigeration. Following initial filtration, catalytic wet peroxide oxidation (Fenton's reagent) was used to oxidize organic matter (Masura et al., 2015). Density separation was then carried out using saturated sodium chloride solution (1.2 g/ml). The separated microplastics were filtered through 0.45 µm membrane filter papers and examined under a stereo microscope. Identified microplastics were categorized by color (black, white, transparent, red, and blue) and shape (irregular, round, filamentous) to determine the dominant types.

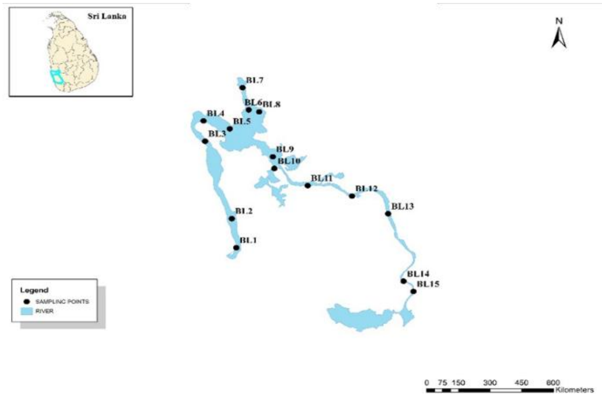

Figure 1. Sampling locations of the Bolgoda Lake.

RESULTS AND DISCUSSION

Microplastics in Surface Water

Data indicates that among the five types of microplastics analyzed, microfibers and fragments were the most abundant. The highest concentrations were observed at locations BL6 and BL14, both situated in the northern part of Bolgoda Lake. The dense growth of water hyacinth may impede water flow, potentially acting as a barrier that traps microplastics in the surface water. Bolgoda Lake is also in close proximity to major rivers such as the Kalu and Kelani Rivers, both of which have been reported to experience high levels of microplastic pollution (Dassanayake et al., 2023). During the dry season, the highest microplastic concentration was recorded at the river mouth (BL1), reaching 820 ± 299 MPs/m³. In contrast, the lowest concentrations were observed at BL4 and BL13, with 100 ± 30 MPs/m³ and 100 ± 38 MPs/m³, respectively. The average concentration for the dry season was 252 ± 198 MPs/m³. These findings reveal a concerning level of microfiber pollution in Bolgoda Lake. Major sources of microfibers include tire wear, laundry discharge, and the release of untreated household wastewater (Andrady, 2011). As shown in Figure 2, various types of microplastics were identified in Bolgoda Lake.

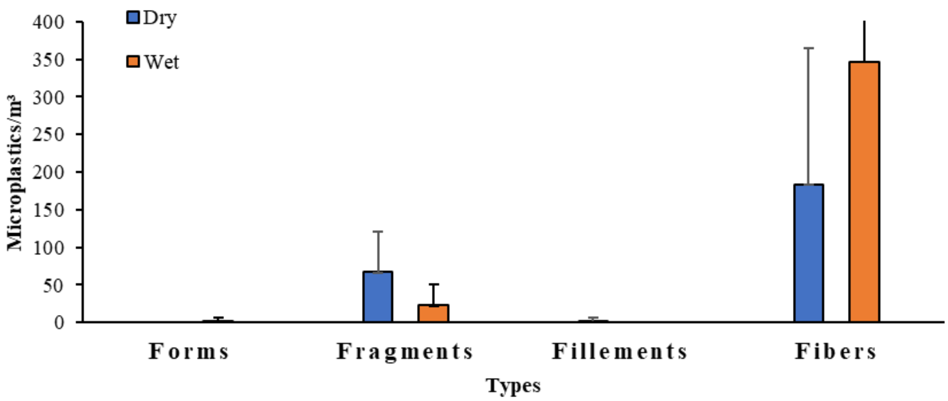

Figure 2. Types of MPs during the wet and dry seasons in Bolgoda Lake.

During the wet season, filament-shaped microplastics dominated, accounting for 94% of the total samples, while irregularly shaped particles comprised only 6% as shown in Figure 3. However, in the dry season, this distribution changed significantly: filament-shaped microplastics made up 60%, while irregular shapes increased to 40%. Fillemet shape microplastics like micro fibers mainly originate from land-based sources such as laundry wastewater, household wastewater, tires and textile wastewater (Ahmad & Almalki, 2025) .

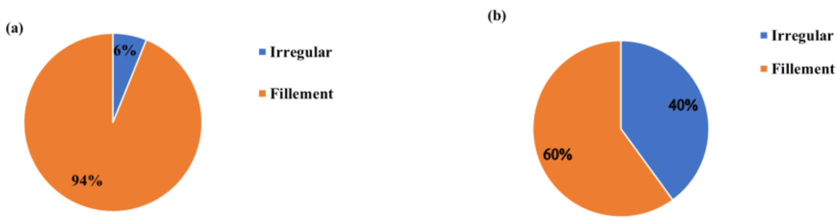

Figure 3. Shapes of MPs during the wet (a) and dry (b) seasons in Bolgoda Lake.

The morphology of microplastics is a key factor influencing their settling rates and movement within aquatic environments. Microplastics can be categorized by shape into several forms: spherical (round), filamentous, square, and irregular. Most filamentous, square, and irregular microplastics are considered secondary microplastics, formed through the degradation of larger plastic debris (Talbot et al., 2022). In contrast, spherical microplastics typically originate from primary sources, often linked to industrial processes. Filamentous microplastics which are characterized as long, thin, thread-like particles mainly originate from synthetic fibers found in textiles (D'Hont et al., 2021). Other forms, such as porous or sponge-like microplastics, commonly arise from packaging materials or aquaculture-related activities (Lozano et al., 2021). Understanding the various shapes and origins of microplastics is essential for identifying their sources and implementing effective regulations to mitigate environmental impacts (Vermaire et al., 2017).

Color of Microplastics in Surface Water

The color patterns of microplastics recorded during the wet season followed the order: Black > Red > Blue > Transparent > Green > Yellow > White. A similar pattern was observed in the dry season, with the order: Black > Red > Blue > Green > Transparent > Yellow > White. The color of microplastics plays a significant role in the aquatic environment, as it can influence their environmental behavior and interactions with biota. Certain colors may leach harmful chemical compounds into the surrounding water, posing risks to aquatic organisms (Bodzek et al., 2024). Many of these colored microplastics contain additives and dyes that can contribute to physiological and toxicological impacts in aquatic fauna (Chen et al., 2020). The color distribution of microplastics in Bolgoda Lake is presented in Figure 4.

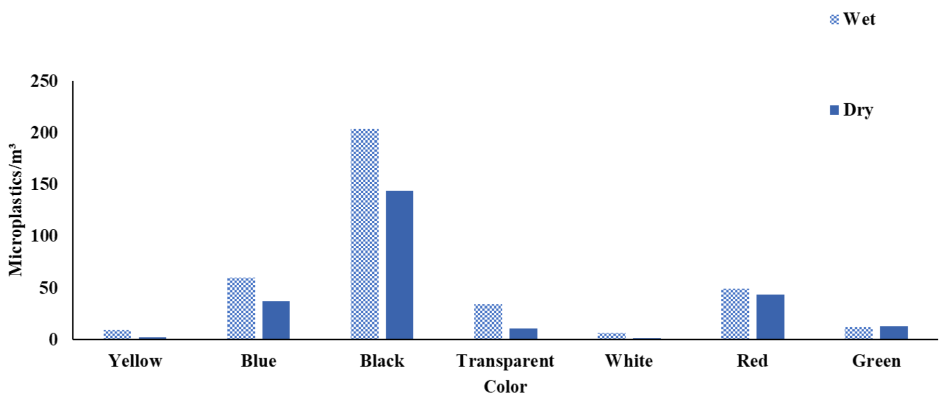

Figure 4. Color distribution of MPs in wet and dry seasons in Bolgoda Lake.

The results indicate that Bolgoda Lake is heavily contaminated with microplastics, including a considerable proportion of microfibers. These microplastics appear in a range of colors, including white, blue, black, red, green, and yellow, and each color potentially represents different sources or stages of degradation. For instance, clear and white microplastics often originate from packaging materials and fishing lines, while blue particles are commonly associated with synthetic textiles and marine ropes. Black microplastics are frequently linked to tire wear or degraded industrial plastics (Lehmann et al., 2021). Moreover, the color of microplastics can influence their interaction with aquatic organisms, as brightly colored particles are more likely to be mistaken for food by fish and other marine species.

CONCLUSION

The lake is currently facing a significant environmental threat due to plastic pollution. Our study revealed that microplastic contamination was higher during the wet season compared to the dry season. Microfibers were identified as the predominant type of microplastic in both seasons, followed by fragments as the second most common. Additionally, the findings indicated that sampling sites located near urban areas exhibited higher levels of microplastic pollution compared to more remote, less populated regions. In terms of color distribution, black microplastics were the most prevalent, followed by blue, red, transparent, green, and white particles.

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