ISSN No:-2456-2165

Analysing Microplastic Pollution of Drinking Water in Kelani River, Sri Lanka

Dassanayake H.G.D.M.[1]
Department of Zoology and Environment Management
University of Kelaniya
Kelaniya, Sri Lanka

Kalaimathy S.N.[2]
National Water Supply and Drainage Board
Western North, Sri Lanka

Najim M.M.M.[3*]
Department of Zoology and Environment Management
University of Kelaniya
Kelaniya, Sri Lanka

Abstract:- Microplastics, which are ubiquitous in the environment, have been defined as any synthetic particle or polymeric matrix; with a size less than 5 mm. Over the past few years, several studies worldwide have detected microplastics in treated tap water. This has raised concerns regarding the potential impact of Microplastic-contaminated drinking water on human health. Microplastic pollution in aquatic environments in Sri Lanka is severe, and enough precautions have not been taken so far for its prevention. This study aims to explore microplastic presence, quantities, and spatial distribution in the surface water of the Kelani River in Sri Lanka, and their removal efficiency during drinking water treatment. Seven sampling sites were chosen, and collected samples underwent wet sieving, wet peroxide oxidation, density separation, and microscopic observation. Microplastics were categorized by size, shape, and color. When comparing the findings of this study, it can be concluded that the Kelani River has a critical level of microplastics (5.01±0.34 Particles/L). The percentage removal of microplastics through water treatment may 82.4%. Among the various shapes of microplastics present in each sampling site, micro fragments were the most prevalent in raw water samples. This study enriches the database on microplastic pollution in Kelani River-Sri Lanka, aiding future preventive efforts.

Keywords:- *Microplastic; Size Category; Shape Category; Drinking Water; Water Treatment.*

I. INTRODUCTION

The use of improved analytical techniques to find and measure these microplastic (MP) loads in drinking water can only be made possible to minimize the fatalities and subsequent human life losses with more awareness. Surface run-off and wastewater effluent are considered the main sources of MPs in water. In aquatic environments, the fragmentation of plastic is catalyzed by photodegradation, biodegradation, thermos oxidative reactions, and hydrolytic reactions [1]. It is very difficult to track down the multiple sources and transport routes of MPs into the aquatic systems. Surface inland waters of urban areas in Sri Lanka are polluted from MPs heavily with domestic sewage and industrial effluents and in rural areas with agricultural runoff. Kelani River is a major water supplier for most of the parts of the Colombo district which is the commercial heart of Sri Lanka and a few other districts. The main objective of this study was to investigate the presence of MPs in the drinking water in Kelani River and estimate MP removal efficiency through water treatment, and further objectives were to examine the size, shape and color of MPs.

The MP pollution at seven National Water Supply and Drainage Board [NWS&DB] intake points such as Ruwanwella Intake, Awissawella Intake, Pugoda Intake, Kosgama Intake, Kelani River Basin (KRB) Intake, Chico Intake and Ambatale Intake were assessed as the study area in this investigation. Biyagama Water Treatment Plant (BWTP) was taken to investigate the removal efficiency of MPs through water treatment.

II. LITERATURE REVIEW

Analyzing peer-reviewed investigations up to 2021, the examination of MP pollution in drinking water was conducted in only 24 countries [2]. However, information regarding MP pollution in rivers remains limited. Microplastics (MPs) interact with biota, including microorganisms in aquatic habitats, raising concerns about their ecological impact. MPs have the potential to release toxic substances such as polychlorinated biphenyls (PCBs) and nonylphenols, posing a threat to overall water quality and organisms that ingest plastic.

The evaluation of the efficiency of removing MPs from the environment and the traceability analysis of MPs are both crucial [3]. Concerns over these MP particles have led to a growing literature attempting to quantify MPs in the environment and their effects on organisms. However, the lack of universal and validated methods has led to a wide range of analytical approaches, hindering a comprehensive interpretation of current findings. MPs are distributed in the water column based on their properties, such as density, shape, particle size, chemical adsorption, and biofouling, along with environmental conditions such as water density, wind currents, and waves. Consequently, the quantity and quality of recovered MPs heavily depend on the sampling location and depth. The sampling and processing methods are comparable for both freshwater and saltwater samples. MPs can cause issues due to their ubiquity, bioavailability, and transportability of toxins. Fibers were identified as the most prevalent type of MPs, followed by films. In coastal waters, blue-colored and transparent microplastics constituted the majority of plastic items. Fibers were the most common MPs followed by films. Blue-colored and Transparent MPs were the majority of plastic items in coastal water. Previous studies have indicated that the presence of MPs in drinking water exhibits discrepancies across various research endeavors, probably due to spatial variations, emphasizing the reliance on specific sampling locations.

III. METHODOLOGY

A. Materials and Sample Preparation

Water samples from a total of seven intakes of Kelani River were collected from April to July using a neuston-type net. The samples were poured through a stacked arrangement of 5.6 mm (No. 3.5), 0.3 mm (No. 50), and 0.15 mm (No. 100) filter sieves made of stainless-steel mesh. The Wet Peroxide Oxidation (WPO) method was followed and organic matter in the samples was digested using an Aqueous Fe (II) solution (0.05 M, 20.00 mL) and Hydrogen peroxide (30%, 20.00 mL) by following the laboratory safety practices and policies. The mixture was heated to 75 °C on a hotplate. The process was repeated until organic matter is no longer visible. Approximately 6 g of salt (NaCl) per 20.00 mL of sample was added to increase the density of the aqueous solution (~5 M NaCl). The mixture was heated to 75 °C until the salt dissolved. The WPO solution was transferred to the density separator and the solids were allowed to settle overnight. The floating solids in the upper layer were vacuum filtered by using GF/C Whatman glass microfiber filter papers (47 mm). Filters were examined under the high-powered BOECO ZOOM stereo microscope model BST- 606 with a 3.1 MP B-CAM 3 digital camera and MPs were quantified manually. MPs were identified in water samples obtained from both the intake and treated waters.

B. Qualitative and Quantitative Analysis

MPs were categorized according to size, shape, and color. When categorizing according to the size, two size categories as 0.31-5.00 mm and 0.15-0.3 mm were selected. Also detected MPs were categorized into five different shape categories micro filament/ fiber, micro fragments, micro thin films, micro granules, and micro nets/ foams. Further, this was again categorized into 10 colors blue, yellow, purple, black, orange, ash, green, transparent, red, and multi-color.

IV. RESULTS

A. Average MP Abundance of Intake Water in Kelani River

In this study, elevated levels of MPs were detected in the raw water samples collected at all sampling sites in comparison to the treated water samples.

The average MP concentrations of intake water in Kelani River can be mentioned according to two size categories, 5.63±0.34 particles/L under the 0.31-5.00 mm size range and 4.4±0.49 particles/L under the 0.15-0.3mm size range (mean ± SE). The results of the mean abundance of MPs and their removal efficiency through water treatment are presented in Table 1 and Table 2.

Table 1: Average MPs abundancy (mean ± SE) in surface water (MPs count/L) at each Intake water sample in Kelani River

Intake	MPs count/L Range 01 (0.31-5.00mm)	MPs count/L Range 02 (0.15-0.3mm)
Ruwanwella	5.33±0.52	5.58±1.06
Awissawella	4.5±1.55	4.38±1.43
Pugoda	7.28±0.46	5.83±1.91
Kosgama	4.68±0.42	3.53±1.02
Chico	4.33±0.69	3.65±1.33
KRB	6.98±0.43	4.78±1.41
Ambathale	6.3±0.62	3.08±1.19

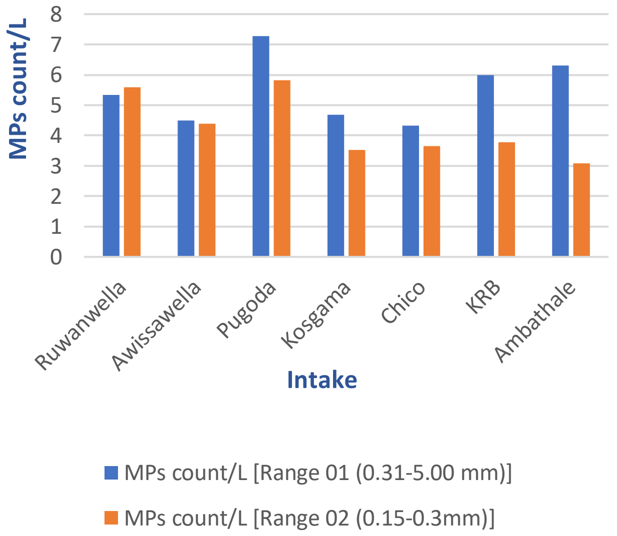

Fig 1 - MP Abundance of Intake Water in Kelani River

B. MP removal efficiency through water treatment

Table 02 - MPs in Raw water, MPs in each stage of water treatment, and MP removal efficiencies at a conventional water treatment plant

	MPs count/L Range 01 (0.31-5.00mm)	MPs count/L Range 02 (0.15-0.3mm)
Raw Water	6.98	4.78
After flocculation	3	2
After Sedimentation	2	2
After Filtration	1	1
Disinfection	1	1
% Removal Efficiency	85.7	79.1

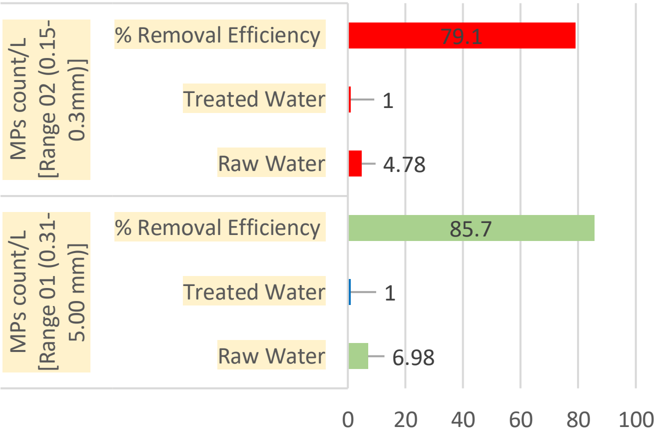

Fig 2 - MP removal efficiency at BWTP

C. Identified MP count according to different Color Categories

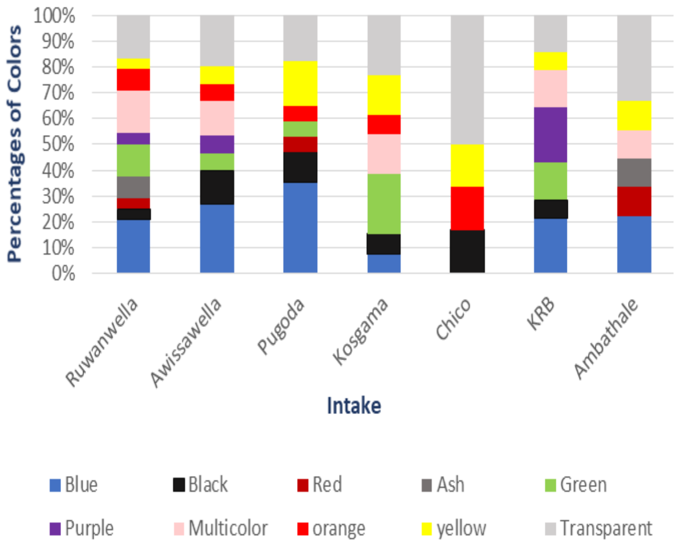

Fig 3 - Identified color categories of MPs at each sampling site

D. The geometry of MPs identified at the seven Intakes

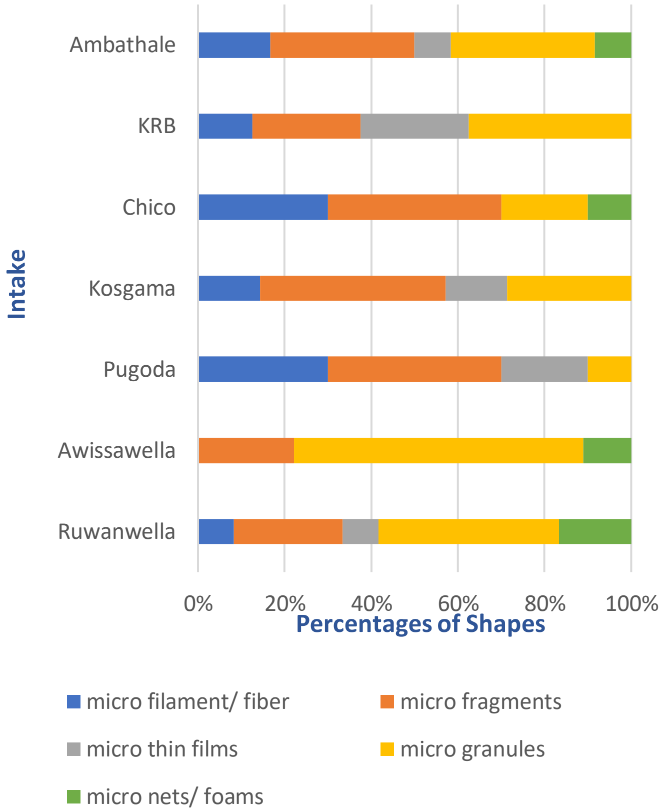

Fig 4 - Identified total MP percentages by their shape

E. Monthly variation of MPs identified at the seven Intakes

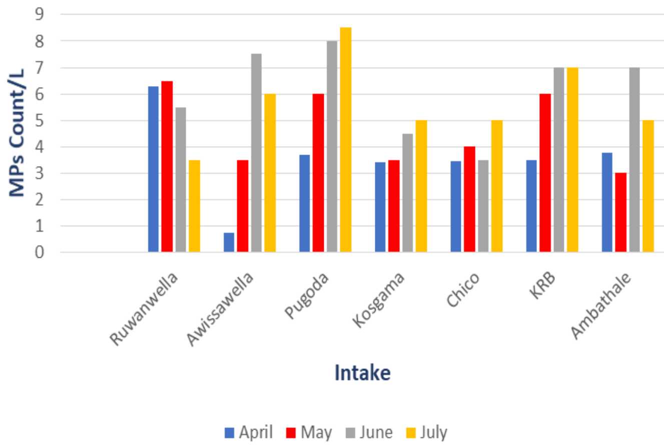

Fig 5 – Comparison of monthly MP count at each sampling site

ISSN No:-2456-2165

V. DISCUSSION

The findings of this study provide valuable insights into the presence and distribution of MPs in the Kelani River. It confirms the ubiquity of MPs in the Kelani River, with detectable concentrations found throughout the water column.

When compared to the abundance of MPs in raw water and treated water, there was an 82.4% removal of MPs through water treatment. Microplastics can also be introduced during the treatment process. For instance, they may originate from the friction within plastic pipes as water is pumped through, or from the use of polymers within the treatment procedures. Typically, these pipes are constructed from High-density polyethylene (HDPE) or Polyvinyl Chloride (PVC) materials, and the inner surfaces of reaction tanks are coated with epoxy resin to prevent corrosion.

The literature review (Table 01) provided information on the variety of plastic types that are causing pollution in the environment. Although less common polymers like Poly Vinyl Chloride and are also significant, common polymers like Poly Ethylene, Poly Propylene, Polyethylene Terephthalate, and Polystyrene predominate. Understanding these variations is vital in designing efficient approaches for reducing plastic pollution and formation of MPs.

Analyzing the color, size, and shape of MPs is essential to understanding their origins, movement, and ecological effects. Color influences photo degradation rates and helps in polymer type identification. Shape affects how sediments interact and are distributed. The fact that size affects bioaccumulation potential and accessibility to various trophic levels emphasizes the complex nature of MP study. The investigation revealed that blue and transparent were the most prevalent color categories among the MPs identified (figure 03). The reason may be many consumer products, including plastic bottles, food packaging, and personal care items, are made from transparent or blue plastics. These items can easily fragment into MPs and enter the environment. Another significant source of blue and transparent MPs may the fishing industry. These colors are commonly employed in fishing equipment, including nets and lines. Over time, the exposure of fishing gear to environmental elements can lead to the degradation of these materials, further contributing to the prevalence of blue and transparent MPs within aquatic environments.

With the increase in global plastic production, MPs may become a target pollutant for the treatment technologies of drinking water. The diverse sources of MPs identified in the Kelani River necessitate a multifaceted approach to mitigate their input. Urban runoff, industrial discharges, and agricultural activities all contribute to the contamination of the river. It is worth that the best way to reduce MPs in drinking water is to prevent them from entering the water sources. This can be achieved through measures such as reducing plastic waste, proper recycling, and improving the wastewater treatment process.

VI. CONCLUSIONS

The study reveals the presence of MPs in both raw water and treated water in Kelani River, Sri Lanka, and most of the MPs were less than 1mm in size. When considering the results of this investigation, it can be concluded that the Kelani River has a critical level of MPs (Average MPs concentration in Kelani Rive; 5.01±0.34 Particles/L). The highest MP concentration is identified from Pugoda Intake. The percentage MP removal efficiency of BWTP was 82.4%, indicating that MPs are not completely removed through water treatment. The Micro fragments were the most abundant geometric shape of MPs identified through this study. Blue and transparent were the most abundant color categories among the identified MPs. This study's results would contribute to develop the quantitative and qualitative database on MP pollution in freshwater ecosystems in Sri Lanka.

In conclusion, this investigation on MPs in the Kelani River underscores the urgency of addressing this pressing environmental concern. It is vital to implement proactive solutions to reduce the input of MPs into the Kelani River and safeguard the health of the people who depend on it.

ACKNOWLEDGMENT

Authors would like to acknowledge Department of Zoology and Environment Management, University of Kelaniya, Sri Lanka, and National Water Supply and Drainage Board, Sri Lanka.

REFERENCES

[1]. A. McCormick, T. J. Hoellein, S. A. Mason, J. Schluep, and J. J. Kelly, "Microplastic is an Abundant and Distinct Microbial Habitat in an Urban River," Environmental Science & Technology, vol. 48, no. 20, pp. 11863–11871, 2014.

[2]. I. V. Kirstein, A. Gomiero, and J. Vollertsen, "Microplastic pollution in drinking water," in Current Opinion in Toxicology, vol. 28, pp. 70–75, Elsevier B.V., 2021.

[3]. J. C. Prata, J. P. da Costa, A. C. Duarte, and T. Rocha-Santos, "Methods for sampling and detection of microplastics in water and sediment: A critical review," TrAC Trends in Analytical Chemistry, vol. 110, pp. 150–159, 2019.