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Study and analysis of microplastic pollution in water sediments with contamination control method at various lakes

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ABSTRACT - Environmental pollution is the most horrible ecological crisis to which we are subjected today. It is due to the rapid urban-industrial technological revolution and the rapid exploitation of natural resources by man, that the population explosion. Today the environment has become filthy, contaminated, undesirable and, therefore, harmful to the health of living organisms, including man. Information on the presence of microplastics can be crucial to preventing further pollution and developing management interventions. This research presents the first reports of microplastic pollution in the coastal sediments of different lakes and emphasizes the need for further research on microplastic pollution.

Keywords: Microplastics; contamination control method; Pollution; weathering.

1. INTRODUCTION

Laboratory contamination was minimized by rinsing the beakers several times with distilled water before use and keeping the samples covered. White cotton lab coats and nitrile gloves were worn at all times when handling and transferring samples to reduce and standardize any contamination from processing. To measure any contamination introduced by the laboratory air, three filter papers were left exposed for 24 h near the sites used for filtration, oxidation processing steps, and counting.

According to Lebreton and Andrady (2019) rivers are the main transport channels for poorly managed plastic waste to the ocean. The number of studies on microplastic pollution in rivers around the world is growing, but it is still limited and should receive more scientific attention (Blettler et al., 2018; Koelmans et al., 2019). The global model of river entry of plastics into the ocean estimates that 1.15 to 2.41 million tonnes of plastic waste enter the ocean annually through rivers, and the top 20 population rivers were mainly located in Asia (Lebreton et al., 2017). However, there remains a huge lack of field studies on microplastics in rivers in Asian countries (Mai et al., 2019).

Rapid urbanization, industrialization and population growth in India undoubtedly lead to a significant increase in waste. According to the Central Pollution Control Board (CPCB), 3.3 million metric tons of total plastic waste was generated in India from the year 2018–2019 (Centre for Science and Environment, 2020). Inefficient waste management, such as disposing of plastic waste in an open-air landfill, is a common method in India (Joshi and Ahmed, 2016; Sharma and Jain, 2019).

Thus, secondary microplastics will be widely accumulated in different parts of the environment. With global warming, rapid melting of glaciers and wind disturbance, intense precipitation leads to an increasing amount of microplastics, terrigenous nutrients and other contaminants entering water bodies (Zhang et al., 2020; Wong et al. ., 2020). Therefore, glaciers, lakes and rivers in India are important places to assess microplastic pollution.

Until now, microplastics studies in India have mainly been carried out on the east coast and west coast, such as in beach sediments, and coastal waters (Dowarah and Devipriya, 2019; Robin et al., 2020; Sathish et al., 2019; Tiwari et al., 2019) and in the biota (Maharana et al., 2020; Naidu, 2019; Patterson et al., 2019). Therefore, close attention to microplastic pollution in India's freshwater sources is needed (Veerasingam et al., 2020). As far as we know, field studies on microplastics in rivers have only been studied in two rivers, the Ganga River and the Nethravati River, with sizes ranging from 0.063 to 5 mm and 0.3 to 5 mm, respectively (Amrutha and Warrier, 2020; Sarkar et al., 2019). Focusing on smaller microplastics is necessary due to their increasing tendency to cause environmental impacts and increase relative abundance with decreasing size (Koelmans et al., 2019). It also highlights key issues to consider in future research to strengthen our understanding of microplastics in river dynamics. It is estimated that 80% of marine microplastic pollution originates from terrestrial sources (Andrady, 2011).

Along with direct inputs from coastal lands, transport along rivers is an important pathway from human-derived sources of plastic pollution to the oceans, with an estimated 1.15 to 2.41 million tonnes of plastic being transported to oceans. The magnitude of this input is supported by the high concentrations of microplastics found in estuarine environments (Browne et al., 2010; Mathalon and Hill, 2014; Yonkos et al., 2014).

Although specific sources and sinks of microplastics have not yet been identified, evidence suggests that microplastic concentrations in rivers vary spatially (McCormick et al., 2016). Nearby land use is a frequently mentioned source of spatial variability, with higher concentrations of plastics being found in watersheds with a high percentage of urban land use, as well as proximity to urban centers is highly correlated with higher concentrations of microplastics in urban areas. surface waters (Baldwin et al., 2016; Mani et al., 2015). In-stream barriers, however, have not yet been adequately investigated as additional sources of spatial variability, although they have been mentioned as likely sinks for light plastic particles (Lebreton et al., 2017; Mani et al., 2015). Sedimentation is likely facilitated by decreased buoyancy due to biofilm accumulation on plastic surfaces, as evidenced in wastewater treatment plants (Carr et al., 2016) and experimentation (Kaiser et al., 2017; Lobelle and Cunliffe, 2017; Lobelle and Cunliffe, 2016). 2011;

Moret-Ferguson et al., 2010). The presence of microplastics in sediments worldwide supports fixation as a destination for microplastics, but the presence of microplastics in sediments found behind dams has not yet been directly investigated (Castañeda et al., 2014; Di and Wang, 2018; Horton et al., 2017; Klein et al., 2015; Rodrigues et al., 2018; Zhang et al., 2017).

2. SAMPLING METHOD

Four samples were collected at random points 1 to 2 meters along the lake shore of each site. Stainless steel spoons and containers were used to collect sediment from an area of approximately 30 cm^2 and approximately 5 cm in depth. Subsequently, sediment samples collected from each point were mixed into a pooled sample and 1 kg of sediment from pooled samples was separated as a final sample.

Overall, four of these samples were collected at four different locations, and the collected samples were taken to the laboratory and oven dried at 45°C for 72 hours before pretreatment.

3. PRE-TREATMENT

For pre-treatment, 50g of dry samples from each of the samples were taken and subjected to densimetric separation using $ZnCl_2$ solution. $ZnCl_2$ has a density of 1.7 g/cm^3 and the density of plastics varies in a range between 0.8 and 1.4 g/cm3, specifically for polyethylene (0.92-0.97 g/cm3), polypropylene (0.85-0.94 g/cm^3), polystyrene (0.05-1 g/cm^3) and others are also in the same range. After density separation, the floating particles were separated by filtering the supernatant using a 20-micrometer sieve. Subsequently, the oxidation of the organic material was carried out using a 35% H_2O_2 solution in a borosilicate glass beaker for 24 hours.

Then, the sample was filtered through the same 20-micrometer sieve. Finally, vacuum filtration was performed on cellulose filter paper (diameter 47 mm, pore size 5 mm) using a configuration consisting of a vacuum pump, a well-washed Buchner flask and a porcelain Buchner funnel. The pre-treatment method used in this study has possible flaws that can cause an overestimation and underestimation of microplastics in lakes. For example, microplastics attached to biofilms may have been discarded during density separation, or microplastics may have been introduced into samples during the sampling campaign, sample pretreatment, and analysis, despite stringent contamination control procedures along the way. study.

4. CONTAMINATION CONTROL

Sediments were collected in stainless steel containers using stainless steel spoons from the sites. When performing the densimetric separation and oxidation of the organic matter, a borosilicate glass apparatus was used, except for the washing bottles, which were made of plastic. The borosilicate glassware was washed twice with distilled water before being used for pretreatment. The filtration setup with a porcelain Buchner funnel was carefully rinsed with distilled water several times to avoid contamination. Fresh filter papers were used for filtration with a 250ml test of distilled water. The filtered samples were then stored in borosilicate glass Petri dishes. The procedure was performed in a dedicated, clean laboratory with limited access. Glassware was strictly used throughout the sample pretreatment, except plastic wash bottles (PE body and PP cap/cap). Cotton lab coats and nitride gloves were worn throughout pretreatment and analysis. The cups were washed with soap and rinsed three times with ultrapure water before being used for pretreatment.

The $Na_2WO_4.2H_2O$ and H_2O_2 solutions for pretreatment were filtered through a glass fiber filter (VWR, Grade GF/F, porosity 0.7 µm). However, a pre-checked clean filter (VWR, Grade GF/C, porosity 1.2 µm) was maintained throughout the pretreatment process in the hood to monitor atrial contamination. The final filtration step on the silver-coated membrane was performed in a laminar flow hood and all microplastic analyzes were performed in a semi-clean laboratory.

Table 1 Composition of different lakes with different parameters

Sl.No.	Different lakes	Sampling depth (cm)	Microplastics extraction	Microplastics size	Microplastics abundance
1	Adhartal Lake (L1),	0–2 or 0–3	$Na_2WO_4.2H_20$; 30% H2O2	20–150 µm	531–3485 MP/kg dw
2	Madhotal Lake (L2)	0–2 or 0–3	$Na_2WO_4.2H_20$; 30% $H2O_2$	150–5000 µm	525–1752 MP/kg dw
3	Ranital Lake (L3)	0–10 or 0–15	$ZnCl_2$; 30% H2O2	63–5000 µm	108–410 MP/kg
4	Gulaua Lake (L4)	0–5	$ZnCl_2$; 30% H_2O_2 with solution	300–5000 µm	9–253 MP/kg

5. RESULT AND DISCUSSION

Microplastics were classified into five main color groups dark (including brown, wine red, blue, plum, lilac and black), transparent, multicolored, white (cream, grey, white) and red (including light red, pink, yellow, orange). In this study, more than 8,000 particles of lake sediment were analyzed and of these 143 particles were detected as polymers, the main types of polymers being PP, PE, PA, Polyester, PVC and others.

The sample is collected in different lakes such as Adhartal Lake (L1), Madhotal Lake (L2), Ranital Lake (L3) and Gulaua Lake (L4)

Table 2 Composition of microplastics in percentage without pretreatment of different Polymer types in L1

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	39
2	PE	43
3	PA	8
4	Polyester	4
5	PVC	3

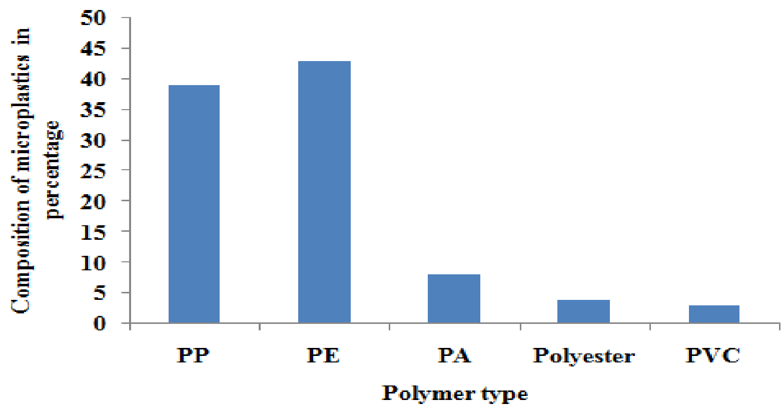

Figure 1 Composition of microplastics in percentage without pretreatment of different Polymer types in L1

Table 3 Composition of microplastics in percentage without pretreatment of different Polymer types in L2

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	42
2	PE	34
3	PA	4
4	Polyester	7
5	PVC	4

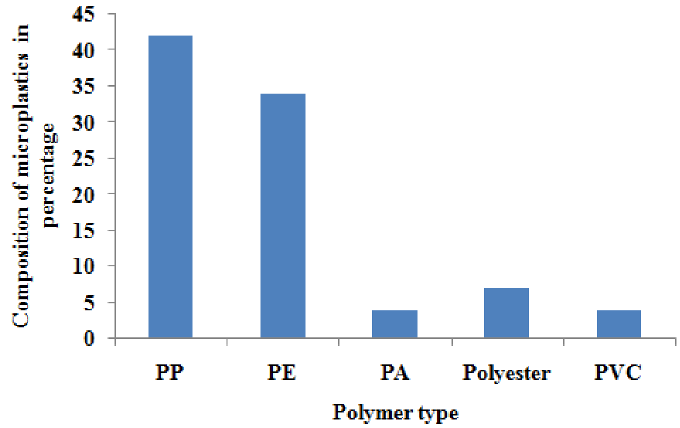

Figure 2 Composition of microplastics in percentage without pretreatment of different Polymer types in L2

Table 4 Composition of microplastics in percentage without pretreatment of different Polymer types in L3

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	40
2	PE	35
3	PA	6
4	Polyester	5
5	PVC	2

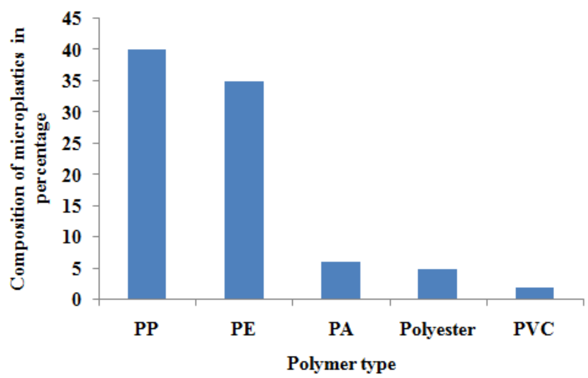

Figure 3 Composition of microplastics in percentage without pretreatment of different Polymer types in L3

Table 5 Composition of microplastics in percentage without pretreatment of different Polymer types in L4

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	39
2	PE	42
3	PA	2
4	Polyester	4
5	PVC	8

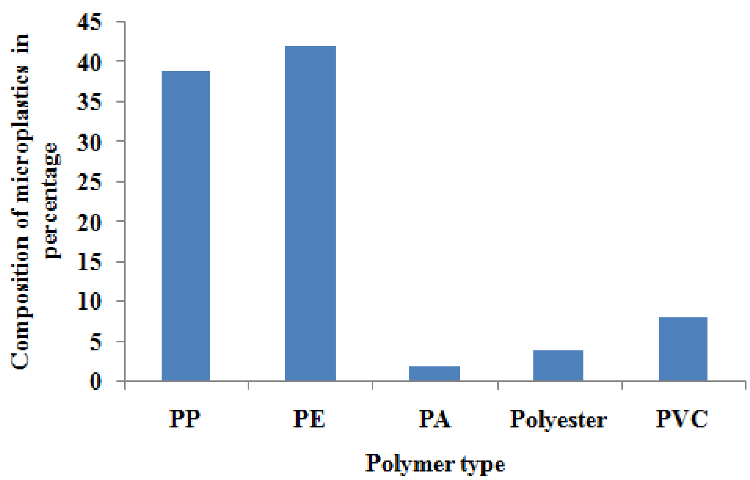

Figure 4 Composition of microplastics in percentage without pretreatment of different Polymer types in L4

Table 6 Composition of microplastics in percentage with pretreatment of different Polymer type in L1

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	31
2	PE	34
3	PA	5
4	Polyester	3
5	PVC	2

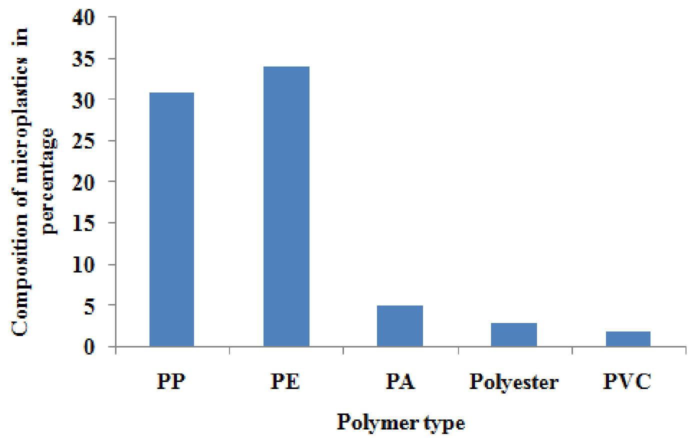

Figure 5 Composition of microplastics in percentage with pretreatment of different Polymer type in L1

Table 7 Composition of microplastics in percentage with pretreatment of different Polymer type in L2

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	30
2	PE	21
3	PA	3
4	Polyester	4
5	PVC	2

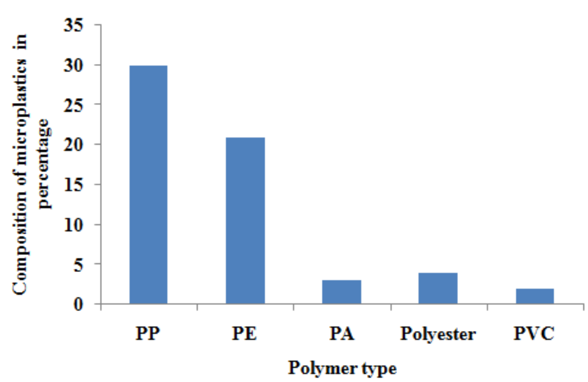

Figure 6 Composition of microplastics in percentage with pretreatment of different Polymer types in L2

Table 8 Composition of microplastics in percentage with pretreatment of different Polymer types in L3

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	35
2	PE	29
3	PA	5
4	Polyester	1
5	PVC	2

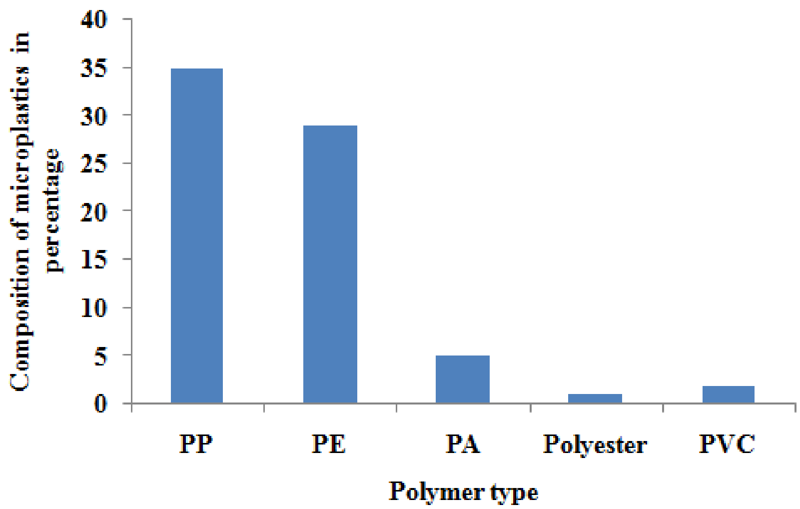

Figure 7 Composition of microplastics in percentage with pretreatment of different Polymer types in L3

Table 9 Composition of microplastics in percentage with pretreatment of different Polymer types in L4

Sl. No.	Polymer type	Composition of microplastics in percentage
1	PP	25
2	PE	26
3	PA	1
4	Polyester	2
5	PVC	3

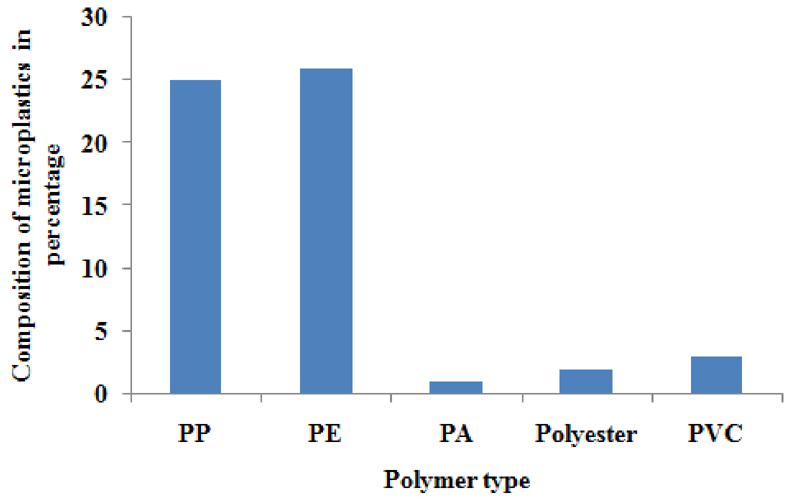

Figure 8 Composition of microplastics in percentage with pretreatment of different Polymer types in L4

6. CONCLUSION

This study concludes that sediments along the shores of lakes act as a sink for microplastic deposition. The higher number of particles in the 30 to 1,000-micrometer size range suggests that as the size of microplastics decreases, the abundance increases. This study concludes that the sediments along the different lakes act as sinks for the deposition of microplastics. Secondary microplastics were abundant among all samples, confirming that most microplastics originated from the fragmentation and weathering of older and poorly managed plastic waste. The higher number of particles in the size range from 20 to 1,000 micrometer suggests that as the size of microplastics decreased, the abundance increased. However, the microplastic concentration in L2 was shown to be the maximum filtration of PE and PP compared to others.

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