The Biobrio ISSN : 2393-9508 e-ISSN: 2582-4902
An International Quarterly Journal of Life Sciences
Website: www.thebiobrio.in SJIF 2023:8.16
10 (3&4): 1023-1026, 2023

# Dispersal and transport of microplastics in river sediments: A review

**Abhishek Kumar Sharma & Ram Deepak**
Department of Environmental Science,D.S.P.M. University, Ranchi, Jharkhand, India.

*Received : 12th July, 2023 ; Accepted : 13th August, 2023*

## ABSTRACT

Rivers are viewed as major pathways of microplastic transport from terrestrial areas to marine ecosystems. However, there is paucity of knowledge on the dispersal pattern and transport of microplastics in river sediments. In this study, a three dimensional hydrodynamic and particle transport modelling framework was created to investigate the dispersal and transport processes of microplastic particles commonly present in the environment, namely, polyethylene (PE), polypropylene (PP), polyamide (PA), and polyethylene terephthalate (PET) in river sediments. The study outcomes confirmed that sedimental microplastics with lower density would have higher mobility. PE and PP are likely to be transported for a relatively longer distance, while PA and PET would likely accumulate close to source points. High water flow would transport more microplastics from source points, and high flow velocity in bottom water layer are suggested to facilitate the transport of sedimental microplastics. Considering the limited dispersal and transport, the study outcomes indicated that river sediments would act as a sink for microplastic pollutants instead of being a transport pathway. The patchiness associated with the hotspots of different plastic types is expected to provide valuable information for microplastic source tracking.

**Key Words -** microplastic, polyethylene, polypropylene, polyamide, polyethylene terephthalate,

***Corresponding author :** @gmail.com

## INTRODUCTION

Microplastics, which are microscopic fragments of plastic that are 5mm in size or less, can be found in a variety of places, including abandoned packaging, cosmetics, and laundry detergent. Microplastics have been present in the environment for decades. Study has shown that they can be found in freshwater, soil, air, and oceans. The discovery of microplastics in river sediments in more recent studies has highlighted the need for additional study on the dispersal of microplastics in the environment. An overview of microplastics in river sediment, their sources and routes to rivers, their impacts on the environment, and prospective management solutions are provided in this review study.

The presence of microplastic pollutants in various aquatic ecosystems has received attention as a significant environmental issue. Their sources, abundance, physical characteristics such as type, size, shape, spatial and temporal distribution patterns, and adverse impacts on aquatic organisms, ecosystems, and human health have been well studied from an environmental perspective. However, the dispersal and behaviour of different microplastic particles in aquatic sediments has not received due attention.

As an emerging pollutant in aquatic environments, microplastics are known to originate from terrestrial sources and primarily transported by creeks and rivers to other freshwater systems and oceans.

Due to the low density, microplastic particles initially float in the water column after entering a waterbody, and are subsequently transported by water flows or sink into sediments due to increased density caused by additional factors such as biofilm accumulation or interaction with suspended clay particles. If there is an increase in the flow velocity, previously settled microplastics are likely to re-mobilize along with sediment clays. River sediments, thus, function as sinks for microplastic pollutants and acts as a source of further mobilization.

Based on past investigations of plastic pollutant abundance in inland aquatic ecosystems, recent modelling studies have estimated that globally, rivers discharge annually about 1.2-2.4 MT of floating plastic pollutants from inland areas to oceans. However, plastics not only float in water and transported by water flows from rivers to oceans, but also sink and accumulate in the river bed. Considerable loads of microplastics have been recorded in river sediments worldwide, indicating that a large proportion of plastic pollutants settle and accumulate in the riverbed. Under the influence of changed flow rates, and the interaction with sediment clays, such settled plastic debris can be either remobilized by water flow or remain where they settle. Therefore, the movement behaviour of sediment microplastics would be different to floating debris under the same hydrodynamic conditions. However, detailed studies on the dispersal and transport of different microplastic types in river sediments are scarce.

Considering the above knowledge gaps, and the impacts of different microplastics on sediment quality, it is important to derive an in-depth knowledge on settled microplastics dispersal and transport processes. Accordingly, this study created a three dimensional hydrodynamic and particle transport modelling framework to predict the dispersal and transport processes of different species of sedimental microplastics. Accordingly, this study provides new knowledge on the mobility of different sedimental microplastics. The research outcomes are expected to contribute to the global modelling effort to understand and to assess the export of microplastics from riverine systems.

**Microplastics' Sources and Routes into Rivers**

Various industrial operations, urban runoff and wastewater, as well as the direct disposal of plastic debris, are some of the sources of microplastics in rivers.

Industrial sources include emissions from the production of plastic products, plastic packaging, and packaging materials. Sewage treatment facilities and land-based activities, such as stormwater runoff from metropolitan areas, are sources of wastewater. Plastic waste can also be directly disposal or throwing of it into rivers and streams. As per the research, untreated water and runoff from urban areas act as the main sources of land-based microplastic pollution in to the rivers.

Microplastics enter rivers through a vivid route, including direct inputs, deposition from air, and runoff from surface. When plastic garbage from land surfaces is carried into rivers and streams by rain or snowmelt, this is called surface runoff. Microplastics are carried in the air and deposited into rivers and streams as a result of air deposition. Plastic garbage entering rivers and streams directly is known as a direct input.

In fact rivers are viewed as chief pathways of microplastic transfer from habitat to marine ecosystems. But, there is scarcity of knowledge on the dispersal pattern and transport of microplastics in river sediments. The microplastic particles commonly present in the environment, namely, polyethylene (PE), polypropylene (PP), polyamide (PA), and polyethylene terephthalate (PET) in river sediments. The sedimental microplastics with lower density would have higher mobility. PE and PP are likely to be transported for a relatively longer distance, while PA and PET would likely accumulate close to source points. High water flow would

transport more microplastics from source points, and high flow velocity in bottom water layer are suggested to facilitate the transport of sedimental microplastics.

**Microplastics' Environmental Impacts**

The presence of microplastics in river silt can have a variety of negative effects on the environment, including direct toxicity to aquatic animals, physical harm to aquatic habitats, and unintended repercussions on the food chain.

Microplastics can be hazardous to aquatic organisms due to the adsorption of pollutants, ingestion of microplastics, and entanglement with microplastics. Microplastics can physically harm aquatic environments by causing sedimentation, suffocating benthic species, and habitat modification. Reduced availability of crucial resources and disturbance of food network dynamics are examples of indirect effects on the food web.

Additionally, studies have demonstrated that the environmental effects of microplastics in river sediment can continue for a very long time. For instance, microplastics can build up in river sediments, obstructing the flow of oxygen to aquatic life and resulting in anoxic conditions. In the food chain, microplastics can build up and move to higher trophic levels, where they can accumulate in top predators like birds and animals.

**Options for River Microplastics Management**

There is a need to lessen the quantity of microplastics entering rivers because of the potential environmental efects of these tiny plastic particles. Source reduction, trash management, and plastic recycling are management approaches for lowering the amount of microplastics in rivers. Source reduction entails lowering the volume of plastic trash generated, for example, by using reusable containers and eliminating plastic packaging. In order to prevent plastic debris from entering rivers and streams, waste management techniques may involve the deployment of catch basins or other containment systems. To lessen the amount of plastic entering the environment, plastic recycling entails gathering and recycling discarded plastic.

**CONCLUSION**

In conclusion, there is a worldwide issue with the presence of microplastics in river sediment that may have an effect on the environment. Microplastics can affect aquatic life and the food chain directly and indirectly, and they can enter rivers through a variety of sources and channels. Implementing management strategies including source reduction, waste management, and plastic recycling will help reduce the amount of microplastics that enter waterways. To better comprehend the sources and paths of microplastics into rivers, their impacts on the environment, and potential management approaches, more research is required.

**REFERENCES**

Bisht, V. S., & Negi, D. 2020. Microplastics in aquatic ecosystem: Sources, trophic transfer and implications. *Int. J. Fish. Aquat. Stud,* 8: 227-234.

Campanale, C., Galafassi, S., Savino, I., Massarelli, C., Ancona, V., Volta, P., & Uricchio, V. F. 2022. Microplastics pollution in the terrestrial environments: Poorly known diffuse sources and implications for plants. *Science of the Total Environment,* 805: 150431.

Carbery, M., O'Connor, W., & Palanisami, T. 2018. Trophic transfer of microplastics and mixed contaminants in the marine food web and implications for human health. *Environment international,* 115: 400-409.

Dai, Z., Zhang, H., Zhou, Q., Tian, Y., Chen, T., Tu, C., ... & Luo, Y. 2018. Occurrence of microplastics in the water column and sediment in an inland sea affected by intensive anthropogenic activities. *Environmental pollution,* 242: 1557-1565.

Frias, J. P., & Nash, R. 2019. Microplastics: Finding a consensus on the definition. *Marine pollution bulletin,* 138: 145-147.

He, B., Smith, M., Egodawatta, P., Ayoko, G. A., Rintoul, L., & Goonetilleke, A. 2021. Dispersal and transport of microplastics in river sediments. *Environmental Pollution*, 279:116884.

Kyriakopoulos, G. L., Zamparas, M. G., & Kapsalis, V. C. 2022. Investigating the human impacts and the environmental consequences of microplastics disposal into water resources. *Sustainability*, 14(2): 828.

Lebreton, L. C., Van Der Zwet, J., Damsteeg, J. W., Slat, B., Andrady, A., & Reisser, J. 2017. River plastic emissions to the world's oceans. *Nature communications,* 8(1): 15611.

Nizzetto, L., Bussi, G., Futter, M. N., Butterfield, D., & Whitehead, P. G. 2016. A theoretical assessment of microplastic transport in river catchments and their retention by soils and river sediments. *Environmental Science: Processes & Impacts*, 18(8): 1050-1059.

Van Sebille, E., Wilcox, C., Lebreton, L., Maximenko, N., Hardesty, B. D., Van Franeker, J. A., ... & Law, K. L. (2015). A global inventory of small floating plastic debris. *Environmental Research Letters,* 10(12): 124006.

Vanapalli, K. R., Dubey, B. K., Sarmah, A. K., & Bhattacharya, J. 2021. Assessment of microplastic pollution in the aquatic ecosystems-An indian perspective. *Case Studies in Chemical and Environmental Engineering,* 3: 100071.

Vo, H. C., & Pham, M. H. 2021. Ecotoxicological effects of microplastics on aquatic organisms: a review. *Environmental Science and Pollution Research,* 28: 44716-44725.

Waldschlaffger, K., & Schufftrumpf, H. 2019. Effects of particle properties on the settling and rise velocities of microplastics in freshwater under laboratory conditions. *Environmental science & technology,* 53(4): 1958-1966.

Wang, F., Wu, H., Wu, W., Wang, L., Liu, J., An, L., & Xu, Q. 2021. Microplastic characteristics in organisms of different trophic levels from Liaohe Estuary, China. *Science of The Total Environment*, 789: 148027.

Yang, L., Zhang, Y., Kang, S., Wang, Z., & Wu, C. 2021. Microplastics in freshwater sediment: a review on methods, occurrence, and sources. *Science of the Total Environment,* 754: 141948.