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# Editorial: Early Career Scientists' Contributions to River Plastic Monitoring Across Scales

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**Editorial on the Research Topic**

**Early Career Scientists' Contributions to River Plastic Monitoring Across Scales**

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## INTRODUCTION

Plastic pollution in aquatic ecosystems (rivers, lakes, estuaries, and oceans) is of growing global concern, because of its negative impact on environmental health, and human livelihood. Rivers are assumed to be one of the main transport pathways for land-based plastics from source to sea (Meijer et al., 2021). Yet, observations and understanding of riverine plastics are scarce in comparison to the marine environment. To optimize plastic pollution prevention, mitigation and reduction strategies, as well as reliable data on plastic abundance, transport, and types are crucial. However, a lack of consistent and long-term observations limits our ability to monitor plastics in aquatic ecosystems. Recent advances in both cost-effective and high-tech measurement methods, that promote method standardization and harmonization, may be key to tackle plastic pollution (UNEP, 2020). This Research Topic bridges the gap between 1) macro- and microplastics, 2) fundamental research and development of long-term monitoring strategies, 3) *in situ* and remote sensing observations, and 4) observation-based modelling approaches to link scales and ecosystems.

## NEW INSIGHTS ON PLASTIC POLLUTION IN AQUATIC ECOSYSTEMS

The scientific contributions of the Research Topic can be summarized into five main advances, which we discuss in more detail below. Each scientific theme addresses novel insights of plastics in aquatic ecosystems, such as fundamental transport behaviour, ecological impacts, and the role of specific compartments to influence travel distances and retention times.

### Additional Observational Evidence for Short Travel Distance of River Plastics

In contrast to what is often assumed, insights from previous research suggests that most plastics leaked into the environment are not emitted into the ocean (Weiss et al., 2021; van Emmerik et al., 2022). The retention of plastics in terrestrial and riverine ecosystems is still poorly quantified and understood. Newbould et al. shed new light on macroplastic transport dynamics by combining tracker experiments and a modelling exercise. The observational evidence confirmed that travel distances were revealed to be short and variable, with plastic retention in specific trapping points strongly dependent on the degree of meandering and riparian vegetation. Other trapping mechanisms were demonstrated by other works in this Research Topic, including retention in floating vegetation Schreyers et al. and estuaries (López et al.; Osorio et al.), which will be discussed in the following sections.

### Plastics May be Retained by Floating Vegetation in Tropical Rivers

Besides riparian vegetation, floating macrophytes can also aggregate plastics in coastal, and riverine environments. Water hyacinths, an invasive macrophyte species, have been found to successfully entrap floating macroplastics. Earlier work demonstrated water hyacinths can entrap close to 80% of the total floating river plastics (Schreyers et al., 2021). In their follow-up study, Schreyers et al. presented a suite of methods to detect and quantify macroplastic entrapment in water hyacinths. These methods range from physical sampling of vegetation patches, to visual counting from bridges, the use of drone imagery, and space-borne satellite observations. To better understand the retention and release dynamics of macroplastics in floating vegetation, both local fundamental experiments, and large-scale data collection applying the presented methods are necessary. As Newbould et al.; Schreyers et al. both show that different vegetation types trap plastics, future work should focus on developing a more comprehensive understanding of floating and riparian vegetation types on plastic retention in rivers.

### Estuaries can Limit Plastic Emissions From Rivers Into the Ocean

Estuaries are the crucial link for plastic emissions between freshwater and the open ocean. These complex systems are influenced by both river and tidal dynamics, and the transport behaviour of plastics in estuaries is therefore largely unresolved. López et al. investigated the transport and fate of microplastics in an estuary, and found that most plastics do not make it into the ocean. Instead, the majority (94%) is beached rather than exported. These findings may explain the high abundance of plastics in river mouths, as also found by Osorio et al.. During periods with low freshwater discharge, plastics that reach the estuarine zone are retained. It is yet unclear what happens during periods of increased discharge or flood events. Both studies emphasize the need for further research on the fundamental transport dynamics in estuaries, to better understand what factors control the retention and its timescale of plastics in these systems.

### Macroplastics and Microplastics Affect Aquatic Life and Ecosystems

The studies by Giles et al. and Hoellein et al. focused on the impact of plastics on aquatic life and ecosystem health. Hoellein et al. investigated microplastic abundance in mussels in the North American Great Lakes, and showed that although they do not serve as bioindicators of microplastic pollution, they are important for understanding the spatial distribution and budget of plastics in aquatic systems. Plastics also affect ecosystems on larger scales, and recently it has been shown that coastal mangrove forests are sinks of plastics. Giles et al. found that macroplastics are ubiquitous in the Red River estuary, and ecological indices declined with increasing plastic abundance. This includes the adverse effects of plastics on mangroves, which provide important ecosystem services to the Red River delta. It is clear that pollution negatively affects aquatic life and ecosystems across spatial scales, and further work is necessary to assess its full impact.

### Missing Plastics Below the Surface Are now Detectable

Plastics are abundant in all compartments of the river systems, including below the surface. To date, only few studies have been able to quantify submerged plastics accurately, consistently, or cost-effectively. Previous work has estimated plastics below the surface using large nets deployed from ships or bridges, or through extrapolation of floating plastic observations. Such methods are often labour and cost intensive, and come with high uncertainty. Broere et al. presented a first non-invasive method to detect and monitor macroplastic items below the surface using echo sounding. A low-cost sensor that emits and receives sound waves was tested under controlled, semi-controlled, and natural conditions. It was demonstrated that a substantial share of total plastic transport may occur below the surface, emphasizing the need for further work on the vertical distribution of plastics in freshwater systems.

## TOWARDS A BETTER UNDERSTANDING OF PLASTIC POLLUTION

The findings presented in this Research Topic address some of the most pressing challenges in the field of plastic pollution research. First, the importance of improved understanding of fundamental plastic transport dynamics is highlighted. River plastics are advected less than previously assumed, a considerable share may be transported below the surface, and most plastics are trapped in the estuarine zone instead of emitted to the ocean. Second, new evidence shows additional mechanisms of plastic retention within river systems. Specifically, in tropical rivers, water hyacinths can successfully entrap the majority of the floating plastics, depending on the growing season of these plants. Finally, both macroplastics and microplastics have clear negative impacts on species and ecosystem health, emphasizing the need for science-based prevention, mitigation, and reduction strategies. The studies within this Research Topic provide a wide range of observational and modelling tools which can be used for similar studies in other systems and at other spatial scales.

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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