frontiers | Frontiers in Environmental Science

TYPE Editorial
PUBLISHED 14 October 2022
DOI 10.3389/fenvs.2022.1034777

OPEN ACCESS

EDITED AND REVIEWED BY
Angela Helen Arthington,
Griffith University, Australia

*CORRESPONDENCE
Tanveer M. Adyel,
t.adyel@deakin.edu.au

SPECIALTY SECTION
This article was submitted to Freshwater Science,
a section of the journal
Frontiers in Environmental Science

RECEIVED 02 September 2022
ACCEPTED 16 September 2022
PUBLISHED 14 October 2022

CITATION
Waldschläger K, Miao L and Adyel TM (2022), Editorial: Plastics in aquatic systems: From transport and fate to impacts and management perspectives. *Front. Environ. Sci.* 10:1034777.
doi: 10.3389/fenvs.2022.1034777

Editorial: Plastics in aquatic systems: From transport and fate to impacts and management perspectives

Kryss Waldschläger[1], Lingzhan Miao[2] and Tanveer M. Adyel[3]*

[1]Hydrology and Quantitative Water Management Group, Wageningen University, Wageningen, Netherlands, [2]Key Laboratory of Integrated Regulation and Resources Development on Shallow Lakes, Ministry of Education, College of Environment, Hohai University, Nanjing, China, [3]Centre for Integrative Ecology, School of Life and Environmental Sciences, Deakin University, Burwood, VIC, Australia

KEYWORDS

plastic, microplastics, biofilm, beach, river, fishing activities, fluvial environment, wastewater

Editorial on the Research Topic
Plastics in aquatic systems: From transport and fate to impacts and management perspectives

Introduction

Plastic is an outstanding material that has become an indispensable part of our daily lives, especially in the current pandemic situation (Noman et al.). However, its ubiquitous application in various fields also leads to significant emissions into the environment, resulting in numerous, mainly negative consequences for biodiverity and ecosystems. This Research Topic takes a closer look at overlooked sources and emissions of plastics into the environment (Folbert et al.), continues with the measurement of environmental concentrations of plastics (Laermanns et al.; Emmerik et al.; Banik et al.; Steele and Miller; Pradit et al.) and discusses the impact of plastics on the environment (Noman et al.; Benson et al.; Mohsen et al.; Merbt et al.; Pradit et al.). We conclude this research topic with a critical assessment of the state of data availability in plastics research (Jenkins et al.). The following sections highlight the most important new findings of this Research Topic.

Overlooked sources of plastics in the environment

Due to the recent pandemic, the use of plastic-made personal protective equipment (PPE) like face masks has increased exponentially. Unfortunately, careless and mismanaged waste disposal of these useful items has led to a significant increase of plastics introduced into the environment. In their review paper, Noman et al. highlight the poorly studied plastic emission from PPEs into the environment and discuss the possibility of PPEs being disease routes or vectors of pathogens like SARS-CoV-2. Another, less obvious and poorly studied emitters of plastics are sea-based sources such as cruise ships, as found by Folbert et al.. These authors highlight that cruise ship wastewater is highly polluted with personal care items, cosmetics and cleaning products as well as synthetic microfibers from washing machines, with untreated greywater and overboard discharge of biosludge being main introduction pathways of microplastics into marine surroundings. Being the first to look into this source, they also name possible ways for reducing microplastic emissions from cruise ships in the future.

Towards a better understanding of the environmental distribution of plastics

Although long overlooked, rivers are now known to be a main transport pathway and possible sink for plastics. However, the influence of hydrology and river characteristics on local plastic distributions and downstream transport is still poorly understood. Laermanns et al. examine microplastic distribution in water and sediment at the confluence of two rivers in Germany (Elbe and Mulde) to identify the impact of the highly industrialized Mulde river catchment on the microplastic load in the Elbe. Their study indicates that the Mulde contributes to a substantial amount of microplastics in the Elbe River while further identification of possible source areas within the catchment needs further study. Traveling further downstream in the aquatic environment, Banik et al. and Steele and Miller focus on plastics at beaches at Kuakata, Bangladesh and at the California Channel Islands, respectively. Banik et al. study a major tourist beach in Bangladesh and the associated ecological risk of high plastic emissions by tourist activities. At their study site, local tides and currents led to the accumulation of fine sand, and Banik et al. find a correlation between smaller sediment grain sizes and higher microplastic concentrations on the beach. Moving from Bangladesh to the U.S., Steele and Miller report the temporal variation (2016–2020) of plastic pollution on remote beaches of the California Channel Islands and on the adjacent mainland. Steele and Miller find higher accumulation rates for plastic on the remote islands than on the mainland, as well as higher plastic accumulation rates in fall and winter, which might be influenced by tidal height, wind speed and direction, extreme events and anthropogenic sea-based activities. Although fishery-related macroplastic waste made up a high percentage of the found debris, it declined over the course of the 4-year study, possibly due to new regulations leading to lower fishing activities.

Representative monitoring of micro-as well as macroplastics in aquatic environments is still difficult to achieve, although it is essential for guiding policy, developing knowledge, managing operations, and designing and implementing mitigation strategies (Emmerik et al.). These authors develop a "Roadmap" for macroplastic monitoring in the fluvial environment regarding method development, baseline assessment and long-term monitoring that can guide national riverine macroplastic monitoring strategies in the future.

Implications of plastics in the environment

In the aquatic environment, plastics can have a variety of effects on biota, ecosystems and ecosystem services. In their review, Benson et al. compile the implications that micro- and nanoplastics have on food webs and ecotoxicological aspects in freshwater and marine settings. Regarding food web interactions, they highlight the ingestion, exposure routes and bioaccumulation of micro (nano)plastics and the probable ecotoxicological effects on aquatic biota. Additionally, Benson et al. review the adsorption and desorption potential of plastics for persistent organic pollutants, metals and chemical additives. Depending on their use, plastic items can pose additional hazards. The PPE may introduce pathogens such as SARS-CoV-2 into the environment, which could affect the plastisphere and other microbial communities (Noman et al.). Higher abundance of pathogenic bacteria on floating plastics around aquaculture areas compared to that of the surrounding water indicate the impact of anthropogenic activities (Mohsen et al.). Microbial communities (periphyton) form not only on microplastics, but also on rocks and sediments in freshwater environments, and play an essential role in the nutrient cycle (Merbt et al.). Due to the large surface area of the periphyton, it can act as a sink for microplastics (Merbt et al.). Microplastics seem to significantly impact the composition, relative abundances and mechanical properties of prokaryotic and eukaryotic communities of the periphyton, but the underlying mechanisms of these microplastic-biofilm interactions need to be studied in more detail in the future (Merbt et al.). Next to microbial communities, microplastics also change the composition of natural materials. Pradit et al. are the first to observe microplastics attached to the surfaces and pores of pumice stone, an extrusive volcanic rock, on shorelines of Thailand. The lightweight pumice stone has probably been transported to the Gulf of Thailand from the South China Sea, and thus acting as a transport mechanismand a sink for microplastics (Pradit et al.).

Still a long way to go: Open science in plastic research

As highlighted in this Research Topic, plastic pollution of our environment is not confined by geopolitical boundaries and potentially affects everyone on Earth, and should therefore be studied as comprehensively and collaboratively as possible. An important step in this process is to improve the availability of research data by following the FAIR (Findable, Accessible, Interoperable and Reusable) guidelines. However, the percentage of available data has not increased in the last 5 years in which open science has gained momentum (Jenkins et al.). Analyzing 785 randomly selected studies that were published between 1964 and 2021 on environmental microplastic sampling, Jenkins et al. highlight that only a third of their studied papers contain a data sharing statement. Even of the accessible datasets, less than 20% have descriptions amenable to use in further studies. To increase the accessibility of microplastic research data, Jenkins et al. recommend five strategies: 1) use available standards and practices to describe data; 2) share raw data—or as close to raw as possible; 3) use a trusted digital repository; 4) link datasets to publications; and 5) plan to share data from the onset of a study.

Author contributions

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

Funding

The work of KW is supported by the Investment Plan for strengthening the Technical Sciences at Wageningen University. The work of LM is supported by the Key Research and Development Project of the Tibet Autonomous Region Science and Technology Department (XZ202101ZY0016G). The work of TA is supported by an Alfred Deakin Postdoctoral Research Fellowship and a Peer-review ECR Support Scheme 2022 at Deakin University.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.