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Article
Plastics in Freshwater Ecosystems

Microplastic concentrations at the water surface are reduced by decreasing flow velocities caused by a reservoir

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With 3 figures and 1 table

Abstract: Microplastic particles are found globally in all kinds of water bodies posing a serious threat to aquatic organisms and ecosystems. However, plastic concentrations are not homogeneously distributed and can decrease along a river course. Thus, potential sinks need to exist. Dams and reservoirs are proposed to be such potential sinks for microplastics. We investigated plastic concentrations at the water surface upstream and downstream of a reservoir inundated by a wastewater treatment plant effluent by filtering water with a net with 200 µm mesh size. We sampled at flow velocities ranging from 6 cm s^{-1} to 35 cm s^{-1}. Upstream of the reservoir significantly higher concentrations of microplastics (19.9 ± 7.3 particles per m^{-3}) than downstream (3.4 ± 2.2 particles per m^{-3}) were identified. Furthermore, the plastic concentrations increased with increasing flow velocities. Hence, reservoirs can be sinks of microplastics as decreased flow velocities may lead to an increased sedimentation or decreased erosion potential. Consequently, flow velocities are critical when identifying plastic loads. Single time or single spot measurements may not well represent plastic loads if flow velocities vary considerably in time or space.

Keywords: microplastic; sampling methods; floating microplastic; Rieselfelder; wastewater treatment plant; water column; monitoring

Introduction

The production and utility of plastic are steadily increasing and the occurrence of microplastic particles (sizes of up to 5 mm; e.g. Thompson 2015) in oceans (e.g. Eriksen et al. 2014; Peng et al. 2018), rivers (e.g. McCormick et al. 2014; Mani et al. 2015), lakes (e.g. Eriksen et al. 2013; Yonkos et al. 2014) and shorelines (e.g. Browne et al. 2011) have negative impacts on aquatic biota (e.g. Derraik 2002; Talsness et al. 2009; Cole et al. 2013; Mueller et al. 2020) and ecosystems (Ma et al. 2020).

Following the longitudinal run of rivers, it becomes evident that there must be some kind of sinks as the amount of transported microplastic does not increase proportionally to river length and can change considerably over time (e.g. Mani et al. 2015; van Emmerik et al. 2019a; Mani & Burkhardt 2020). Dams and impoundments may be among those potential sinks of floating microplastic (Zhang et al. 2015; Watkins et al. 2019). Watkins et al. (2019) give a first indication of increased sedimentation of microplastic caused by reservoirs as they found higher microplastic concentrations in the sediments in the reservoirs than upstream of the reservoirs, probably due to lower flow velocities. Furthermore, first studies point out that high flow velocities caused by floods or higher discharge can result in lower microplastic concentrations in river sediments (Hurley et al. 2018) and to higher microplastic concentrations in a Mediterranean bay (Gündoğdu et

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