Spatio-temporal patterns in microplastic pollution of surface waters and sediments within the R. Thames (UK) and its tributaries

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It is currently predicted that rivers deliver as much as 80% of plastic waste into the marine environment, including microplastics (MP) <5 mm in size. Yet, the transfer mechanisms of MP in river systems remain poorly understood. While high flow events are thought to flush more microplastics into marine waters, their overall load may depend on factors such as river morphology, land-use, or local MP sources.

Microplastic concentrations were monitored on a seasonal basis (summer 2019 - winter 2020/2021) across 13 sites located across the R. Thames catchment, UK. Sites were selected to include rural, urban and industrial locations with different hydrological characteristics and proximities to potential MP inputs (e.g. sewage or industrial effluents). At each site, bed sediment samples were manually extracted (n=55 samples), and surface water samples collected in 5 L clean polyethylene bottles (n=22 samples) and using a 500-µm plankton net (n=12 samples). Microplastics were extracted from sediment and plankton net samples using density flotation, whilst bulk water samples were filtered with no prior extraction steps. All samples were visually inspected under a stereomicroscope and their morphology recorded. The chemical composition is to be further investigated using µFTIR as part of future research.

Sediment and water samples likely contained MP from different sources (e.g. in-situ breakdown of plastic litter, sewage effluent), which was reflected in the varying MP shapes and loads observed at the study sites. Microplastic levels ranged from <LoD (limit of detection) to 381 MP·100 g⁻¹ in sediments, <LoD to 16 MP ·L⁻¹ in bulk water samples and <LoD to 2 MP·m⁻³ in plankton net samples and were highest at sites downstream of known sewage inputs. There was also a clear variation in particle shapes and levels with respect to site, with fibres and fragments representing the dominant MP type present along urban river stretches, and microbeads most abundant near industrial locations.

Microplastic levels varied on a temporal basis in both surface waters and sediments. Increasing river discharge generally had a diluting effect on MP levels observed in the water column (mean levels of 5 MP·L⁻¹ and 2 MP·L⁻¹ in summer 2019 and winter 2020, respectively). Mean microplastic levels in sediments also decreased from 15.1 MP·100 g⁻¹ in the summer to 9.4 MP·100 g⁻¹ in the winter, although some local increases in microplastic pollution were observed during high flow
period, particularly at sites situated in close proximity to reported sewage discharges (e.g. from Combined Sewer Overflows).

This study is one of the first few to report spatio-temporal variations in microplastic contamination of both river water and sediments. Our early findings suggest that variability in MP levels and composition in both media may correspond to local pollution sources, and plastic particles could be released from surface sediments during periods of increased precipitation, even in the absence of flooding. Understanding such patterns in MP flux will be crucial to accurately model plastic loads from terrestrial to marine environment and implement effective mitigation measures.