A multi-method analysis of microplastic abundance in Rhine floodplains as a function of their local topography and flood frequencies

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Abstract

Rivers are major pathways for microplastic transport towards the ocean, but serve also as potential microplastic sinks. Microplastics can be deposited in or re-mobilized from the river bed sediments and the adjacent floodplains. In particular, river floods enhance the processes of re-mobilization and deposition at the interface of fluvial and terrestrial ecosystems. Through erosion and deposition processes, floods also have an impact on floodplain morphology and result in relatively flat topographies. Hence, local topography and flood frequency influence microplastics deposition in floodplains. In microplastic research, the aspect of the interplay between flood frequency and topography has not been fully considered yet. Therefore, we used a time series analysis of Rhine water level and a hydrodynamic flood model to study the flood frequency of three different Rhine floodplains. All sites are nature reserves or conservation areas with restricted agricultural use. We sampled soil in a depth of 5-20 cm in each Rhine floodplain along three parallel transects in varying heights and distances to the Rhine. We analysed the samples for their microplastic abundance with pyr-GC/MS, FTIR and measured the metal concentrations by X-ray fluorescence. In our preliminary results, we found the highest abundance of microplastics in the farthest transects from the Rhine with the lowest flood frequencies and the highest flood water levels, depending on their local topography. These results indicate that: (i) the microplastic abundance in the Rhine floodplains underpin that their distribution is related to flood frequency, local topography and distribution of heavy metals; (ii) In comparison to other Rhine floodplains, the floodplain 'Langel-Merkenich' seems to be highly contaminated potentially by nearby microplastic sources; (iii) The combination of sampling and hydrodynamic modelling helps to identify microplastic hotspots. This information is essential for ecological risk assessments at the interface of freshwater and terrestrial ecosystems.

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