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The "Plastic Cycle": how ecohydromorphological processes drive the spread of microplastic pollution through rivers to the ocean

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Plastic pollution is now ubiquitous across the Earth's active zone, with recent studies finding plastics in remote parts of the Pacific Ocean, in the high Arctic and the deepest parts of the world's oceans. Of particular concern are microplastics (<5mm diameter), which can be ingested by organisms causing both chronic and acute ecological effects. Plastic pollution is increasing recognised as one of the most serious environmental issues threatening the planet, and needs to be urgently understood and addressed. The abundance and dynamics of plastic pollution in ocean currents has been documented and modelled in a number of studies, however there is increasing awareness that microplastic pollution also pervades terrestrial, atmospheric and freshwater environments. Our understanding of microplastic behaviour in these environments is incomplete and they are commonly considered independently with regards to microplastic pollution, but are in reality are closely interlinked.

We present a conceptual model of the potential terrestrial and freshwater stores of microplastic pollution and the vectors and transport pathways which deliver new plastics to these stores and transfer particles between them. We contend that interdisciplinary studies are needed to quantify the stores of microplastic material in these environments as well as the fluxes between them. By so doing we can; better constrain estimates of microplastic fluxes from specific rivers to the ocean, understand the linkages between the ultimate source of different types of plastic pollution and its presence in varied environments, and allow better assessments of the levels of exposure in different environments to better understand long-term ecological and human health implications. Ultimately, using geomorphological, hydrological and sedimentological techniques to understand the behaviour of plastic particles in the environment will be vital to effectively identify important sources of plastic pollution and design effective mitigation policies.