Controls of bio-modulated flocculation on the fate of microplastic pollution in river-estuary transition zones

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Plastic fragments floating on the surface of oceans represent less than 1% of plastic pollution entering these environments annually, with the fate of the remaining plastics largely unknown. There are several removal mechanisms that have been suggested for microplastics (<5mm) including ingestion by biota, biofouling and/or aggregation with organic material leading to flocculation and a change in particle density that can impact trajectory and fate of the material. Furthermore, despite the widespread recognition that rivers dominate the global flux of plastics to the ocean, there is a key knowledge gap regarding the behaviour of microplastics in transport and its pathways from rivers into the coastal zone, especially in regards to how biofilm formation and aggregation influence particle fate. This prevents progress in understanding microplastic dynamics and identifying zones of high accumulation, as well as curtailing the evolution of effective mitigation and policy measures. To predict transport, fate and biological interactions of microplastics in aquatic environments at a global scale, the factors that control these processes must be identified and understood.

A laboratory settling experiment was therefore conducted to recognise how different factors, including salinity, suspended sediment and biofilm formation influence microplastic particle settling velocities, and thus transport. The results presented herein explore the role of biofilms on the generation of microplastic flocs and the impact on buoyancy and settling velocities. Six different polymers were tested and compared including fragments and fibres. Settling velocities were then combined with field flow data from the Mekong River, one of the top global contributors to marine plastic pollution, allowing predictions of areas of microplastic fallout and hotspots. The results also highlight potential areas of ecological risk related to the dispersal and distribution of microplastics across the river-delta-coast system including the ecologically important Tonle Sap Lake. Future work involves further aligned fieldwork within the Mekong River that details the particulate flux and transport of microplastics throughout the vertical velocity profile.