
Trapping of floating MP in estuaries, the importance of flocculation

Simon Nyboe Laursen^{*†1}, Mikkel Fruergaard¹, Maya S. Dodhia¹, Nicole R. Posth¹, Marianne N. Larsen¹, Dativa Joseph Shilla², Daniel Shilla³, Hellen J. Kizenga⁴, and Thorbjørn J. Andersen¹

¹Department of Geosciences and Natural Resource Management, University of Copenhagen – Øster Voldgade 10, 1350 København, Denmark

²Department of Chemistry, Dar es-Salaam University College of Education (DUCE-UDSM) – 6693+JPM, Dar es Salaam, Thailand

³Department of Aquatic Sciences and Fisheries Technology, University of Dar es Salaam – Kunduchi Beach Dar es Salaam TZ, 14122, Tanzania

⁴Institute of Marine Sciences, University of Dar es Salaam, P.O. Box 668, – P.O.Box 668. Buyu, Zanzibar, Tanzania

Abstract

Rivers and estuaries are major pathways of microplastic (MP) from terrestrial areas to marine ecosystems. Despite this, knowledge on the transport dynamics and fate of MPs in riverine and estuarine waters is limited, but crucial in order to mitigate the problem and to close the mass balance of plastic debris in the oceans.

Via *ex situ* laboratory settling experiments emulating the Msimbazi River and estuary, Dar es-Salaam, Tanzania, we demonstrate that flocculation and subsequent settling of positively buoyant MP (HDPE, 63-125 μm) and fine-grained suspended sediment ($< 20 \mu\text{m}$) are important for the environmental fate of plastic in riverine and especially estuarine waters. The study shows, that the suspension of fine-grained sediment and MPs rapidly form flocs (within an hour of incubation), across the sampling sites. However, settling velocities of the formed flocs were at least five (and up to 21) times higher in estuarine waters compared to those in rural and urban riverine waters. This increase in settling velocity is explained by the increase in ionic strength that occurs when the particles enter saline water. This confirms the classical concept of increased flocculation and settling of fine-grained particles as they are transported from freshwater to estuarine and marine waters.

The implication is that land-based sources of small positively buoyant HDPE MP transported by rivers will settle and accumulate in estuarine sediments and thereby decrease the overall load of MP delivered to the marine environment. This finding coincides with the presence of high concentrations of both high- and low-density MP in estuarine benthic sediments and demonstrates that flocculation is at least part of the explanation for estuarine trapping of large quantities of MP debris. Moreover, our results suggest that modelling the fine-grained cohesive sediment might be a good proxy for the transport of smaller MP in riverine and estuarine waters.

^{*}Speaker

[†]Corresponding author: snl@ign.ku.dk

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