Shape - and Polymer - Considered Simulation to Unravel the Estuarine Microplastics Fate

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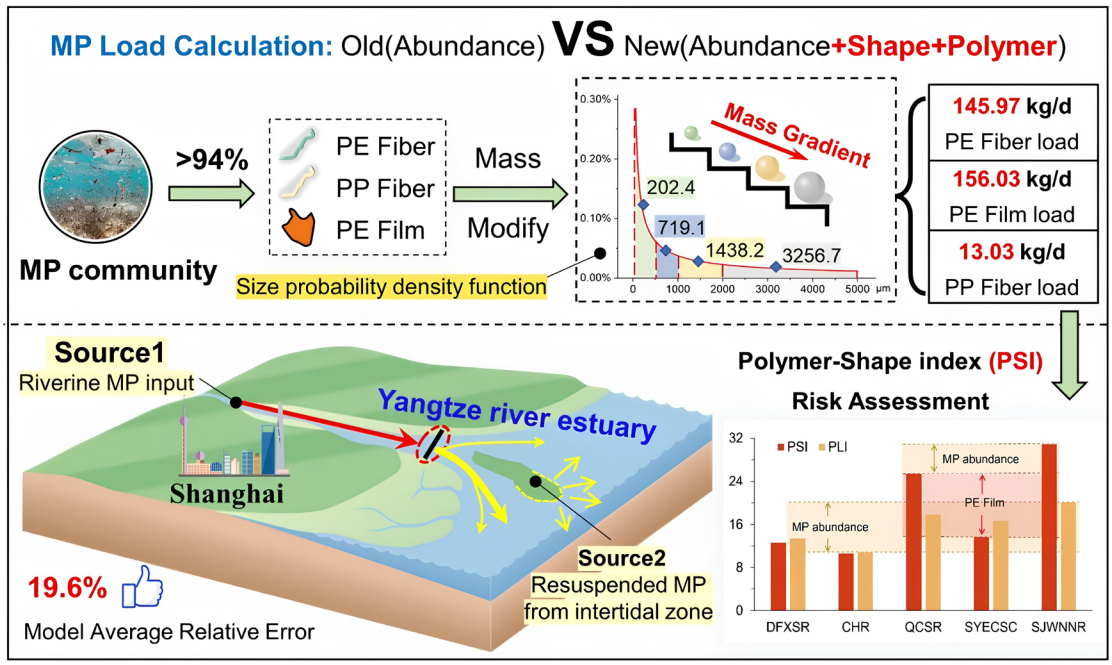
Abstract

Estuarine systems are crucial in regulating fluvial microplastic (MP) transport to the ocean, yet traditional models often oversimplify MP properties. This study develops an advanced simulation framework for the Yangtze River Estuary, incorporating particle mass gradients based on size distribution and shape factors to improve MP load quantification and trajectory prediction. By classifying MPs into dominant types (PE fibers, PE films, and PP fibers) and accounting for seasonal resuspension, the model achieved a 19.6% average error in simulating surface MP distribution. Results show that using an empirical average particle mass (33 μg) overestimates MP loads by 821 kg/month during high-flow seasons. The model identifies accumulation hotspots near estuarine fronts and highlights influences of shape and polymer type on transport behavior. A novel risk index (PSI), incorporating abundance, shape, and polymer type, demonstrates higher sensitivity than conventional indices. This framework offers a refined tool for tracking MP fate and supports targeted mitigation strategies against marine plastic pollution.



Keywords

Microplastic fate, classified simulation, size probability density function, particle shape, polymer type, Yangtze River Estuary.