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Nanoplastics stability and aggregation behaviour in natural aqueous matrices

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Plastic has crept exponentially into our contemporary life and inadvertently a huge amount is disposed of in the environment. The relentless addition and disposal of plastic debris in the environmental matrix are highly hazardous to ecosystem functioning and a threat to global sustainable goals. Environmental plastics are dynamic contaminants found in different size ranges including microplastics (<5 mm) and nanoplastics (<1 µm). Understanding the natural attenuation and transformation of micro/nanoplastics is of high relevance to evaluating their mobility and exposure mechanism to the biota. The influence of physicochemical properties on nanoplastics fate and transport in a realistic environment is not very well investigated. Therefore, this study delineates nanoplastics stability under the influence of different types of complex natural matrices.

Natural aqueous media under the investigation included samples from different water bodies (rainwater, river water, lake water, seawater, effluent of wastewater treatment plant) and soil solutions prepared from soil collected from four different parts of Japan. Three types of nanoplastics with varying surface functionality (approx. 100 nm; amine, carboxylate, and sulfate) were used to study their continuous interaction in the ambient environment. Nanoplastics samples were dispersed in these natural aqueous media and change in the size of particle aggregates, electrophoretic mobility, and rate of sedimentation was analyzed.

Overall, the solution chemistry of the ambient matrices played a vital role in the aggregation and sedimentation of nanoplastics. This include dissolved organic matter, pH, and ionic concentration. Further, the stability of nanoplastics was correlated with their residence time and surface properties. Carboxylate-modified nanoplastics were found to be highly stable in most of the natural matrices. Irrespective of their surface functionality, unstable and aggregating nanoplastics were notable in seawater. The results imply that nanoplastics properties as well as environmental factors govern their behaviour in an ambient environment. The results of the study fill knowledge gaps to interpret the fate, transport, and ecotoxicity of nanoplastics in the environment.