Adding depth to Microplastics

Margherita Barchiesi*[1,2], Merel Kooi[1], and Albert A. Koelmans[1]

[1]Aquatic Ecology and Water Quality Management Group, Wageningen University – 6700, DD, Wageningen, Netherlands

[2]DICEA, Department of Civil, Constructional and Environmental Engineering, Faculty of Civil and Industrial Engineering, University of Rome Sapienza – Via Eudossiana 18, 00184 Rome, Italy

Abstract

Available analytical techniques do not allow for a complete characterization of the 1 to 5000 μm Microplastic (MP) continuum. Spectroscopic techniques provide information on MP polymer identity and 2D morphological aspects but not on the third dimension: depth. Based on 2D shape characteristics and depth, particle volume can be estimated, which is crucial for accurate particle number to mass conversions and risk assessments that use ingested particle volume as an ecologically relevant metric. Depth (or height) and estimated volume usually are estimated using various approaches, which however rarely have been validated. Here we evaluate a new validation approach that uses the collective volume of environmentally relevant MP mixtures, rather than validation based on volumes of individual particles. A sample of MPs from Singapore's beach was divided into three groups: $<$ 1mm, 1-2mm and 2-5mm, as well as into primary MPs, secondary MPs, and fibers. The collective volume was measured by a Pycnometer and by a new protocol based on volume displacement. These empirically determined volumes were compared with values obtained from models that estimate volume from 2D image analysis of the particles. The best-performing model for primary and secondary MPs was the one proposed by Tanoiri et al. (2021) with an estimated volume to measured volume ratio of 0.98-1.02. The second-best model was a modified Simon (2018) model, with a volume estimate to measured volume ratio of 0.99-1.33. This model was improved by implementing a correction factor accounting for irregularities at the particle surface. Our approach to estimating the volume of environmentally relevant collective groups of particles is demonstrated to be reliable. We expect that this will promote further breakthroughs in MPs ecotoxicity analysis, environmental fate studies and risk assessment.

Keywords: Microplastics Volume Estimate

*Speaker