IAHS2022-442
IAHS-AISH Scientific Assembly 2022

What can we learn from flume experiments about the transport of polyamide microplastics in streams?

Uwe Schneidewind, Holly Nel, Jennifer Drummond, Anna Kukkola, Iseult Lynch, Greg Sambrook-Smith, and Stefan Krause
University of Birmingham, School of Geography, Earth and Environmental Sciences, Birmingham, United Kingdom of Great Britain – England, Scotland, Wales (u.schneidewind@bham.ac.uk)

Microplastics have been found to be an emerging contaminant of concern in many ecosystems worldwide. While microplastics have been around for many decades, only recently have studies started to improve understanding of their transport and fate in riverine environments, toxicity to aquatic organisms and distribution throughout riverine food chains. Microplastics of various size, shapes and polymer types have been identified in water and sediment samples in streams and rivers on a global scale with the potential to accumulate in river sediments for extended periods of time. As this accumulation often occurs and increases downstream from where microplastics enter a stream, they can well be considered legacy pollutants.

While earlier studies assumed that microplastics deposit on the streambed mostly by gravitational settling, recent research indicates that turbulent flow processes near the sediment-water interface and groundwater-surface water interactions can greatly influence particle deposition patterns and retention times. In order to directly assess the deposition, accumulation and resuspension of polyamide (PA) particles in a more controlled setting we conducted experiments in mesocosms (recirculating flumes with dimensions of 200 x 42 x 15 cm).

Flumes were filled with either gravel (10-20 mm) or mixed sediment (ranging from silt to fine gravel) and freshwater and were spiked with PA fibres (500 µm length, 14 µm diameter), pre-crushed fragments (size ranges: 150-250 µm and 400-600 µm, pre-stained with Nile Red) or both. Sampling over 24 hours at three locations in each flume allowed us to study the deposition behaviour and we found that due to turbulent flow especially fibres remained in the water column much longer than would be the case for gravitational settling. Deposition rates and retention times of deposited particles were estimated by fitting flume data to a mobile-immobile model that provide insight into the differential transport between polymer types, sizes, and sediment grain size distribution. Subsequent resuspension experiments with variable flow velocities achieved by using one or several pumps per flume indicated significant differences in resuspension with respect to polymer shape and sediment type in the flume. Results will help us better understand and predict microplastic fate in streams and improve current models.