Transport of polyamide microplastics at the sediment-water interface – First results from mesocosm studies

Uwe Schneidewind, Holly Nel, Anna Kukkola, Greg Sambrook Smith, Iseult Lynch, Stefan Krause

University of Birmingham, School of Geography, Earth and Environmental Sciences, Birmingham, UK

Contact: U.Schneidewind@bham.ac.uk

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Introduction

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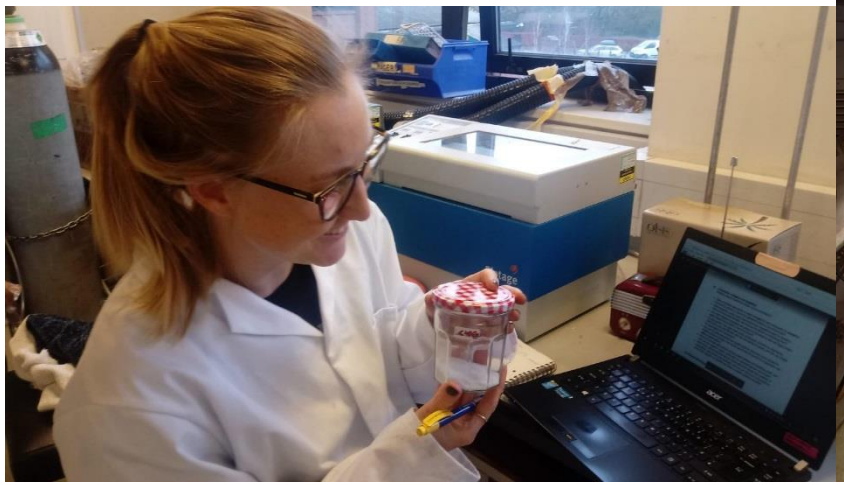
- Microplastics are ubiquitous in marine and terrestrial waters
- Understanding of principal fate and transport processes in freshwater environments is limited but fundamental to better understand potential risks of primary and secondary microplastics to humans and ecosystems

- Synthetic petroleum-based polyamides (PA) are a family of microplastics widely used in textiles, carpets and the automotive/transport industry in form of fibers or as granules that are further molded into different products
- PA can contain a variety of chemical additives that can be released into the environment during the PA life cycle and have detrimental effects.

Objective

- Study transport of polyamide (PA) fragments and fibers in mesocosms
- Investigate impact of PA fragment size and sediment type (sand, gravel) on transport



Making PA fragments using ball mill and liquid nitrogen. Source: own

Methods 1

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- PA fragments produced from pellets using ball mill and liquid nitrogen
- Size fractions divided by dry/wet sieving → 150-250 and 400-600 µm used as input in experiments
- Fragments dyed with Nile Red before use
- Nylon fibers acquired commercially → 500 µm, 1.7 dtex
- Water velocity about 0.1 m/s, measured with flowmeter

Nylon fibers, source: own

- Recirculating flume experiments set up in duplicate + 3 control flumes
- Flumes filled with medium gravel (10-20 mm) or medium/fine sand, 47.5 L of water and either fragments of one size, fibers or a mix of both.

Methods 2

- Sampling for microplastics at three locations per flume in 20 mL glass vials over 24 hours.

All photos - source: own

Methods 3

All photos - source: own

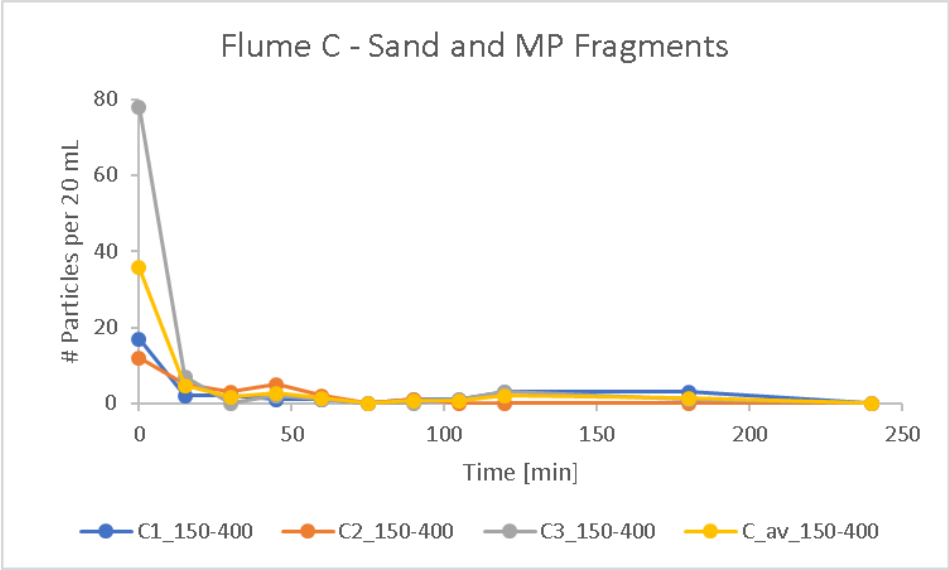
- Samples filtered on-site over GF/D filters.
- Particles/fibers counted using Zeiss Stemi 2000 stereo microscopes.
- Each filter counted by two people.
- Size + area of fragments to be determined with fluorescent microscope after lock-down

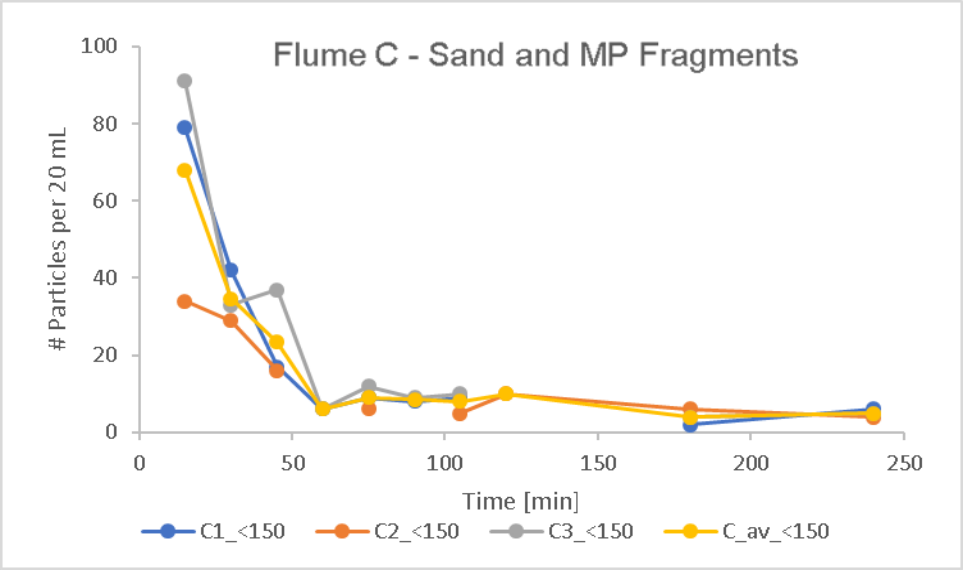
Results

- Two size fractions injected are actually two different ranges according to laser granulometry:
  - 150-250 µm → about 50 % in that range; 98 % between 104-416 µm
  - 400-600 µm → about 55 % in that range; 97 % between 275-831 µm
- Fragments break down further during experiments
- Very small particles <150 µm were found that stay longer in water column while larger particles settle out very quickly

Results

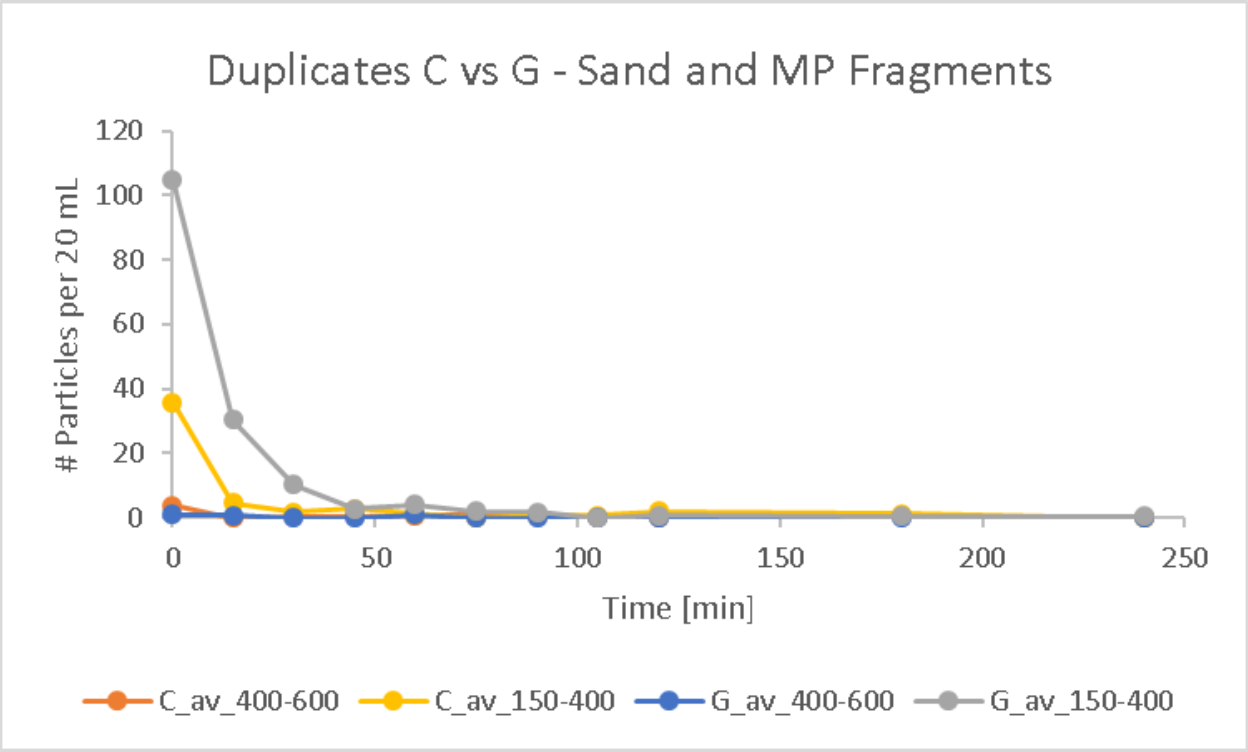
- Each flume sampled at three different locations per time-step (here C1; C2 and C3 for two size ranges) → Sampling location influences results but when compared across flumes there are no sampling locations where results are always significantly different.
- Very small fragments <150 µm stay in water column longer





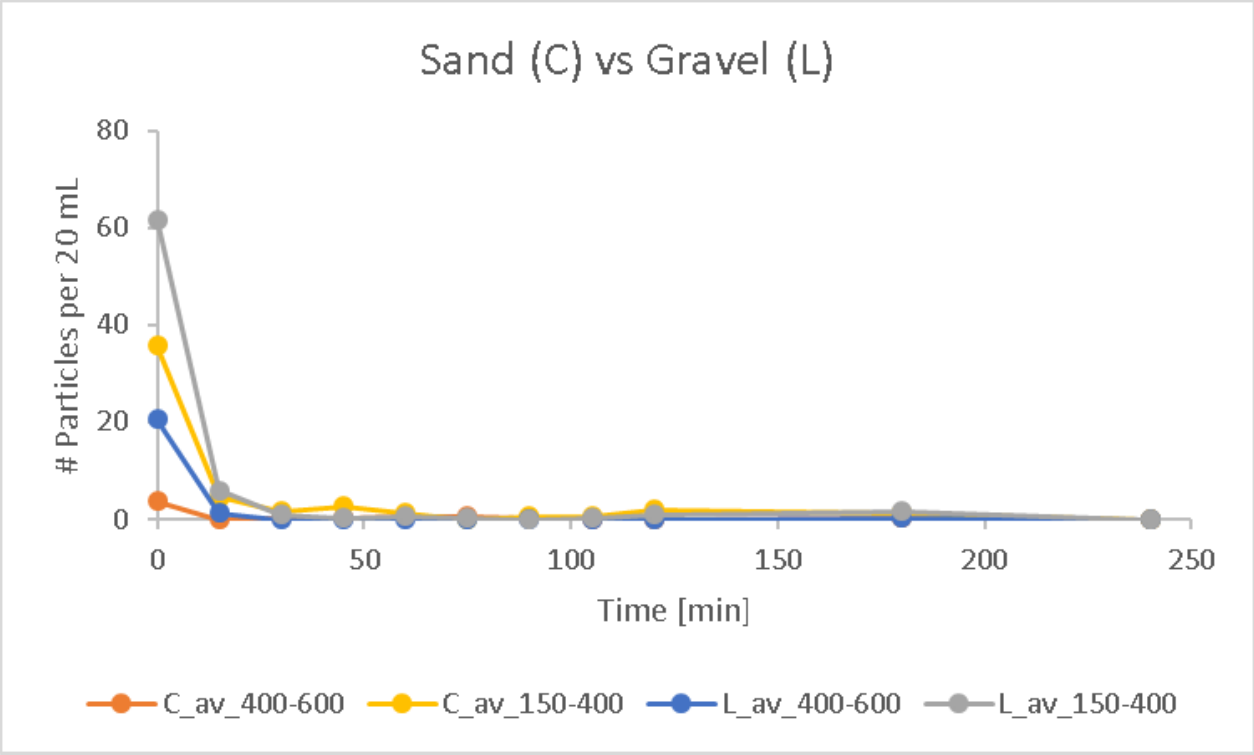
Results

- All flume setups were carried out in duplicate → results between individual flumes can at times vary significantly (here C and G for two fractions)



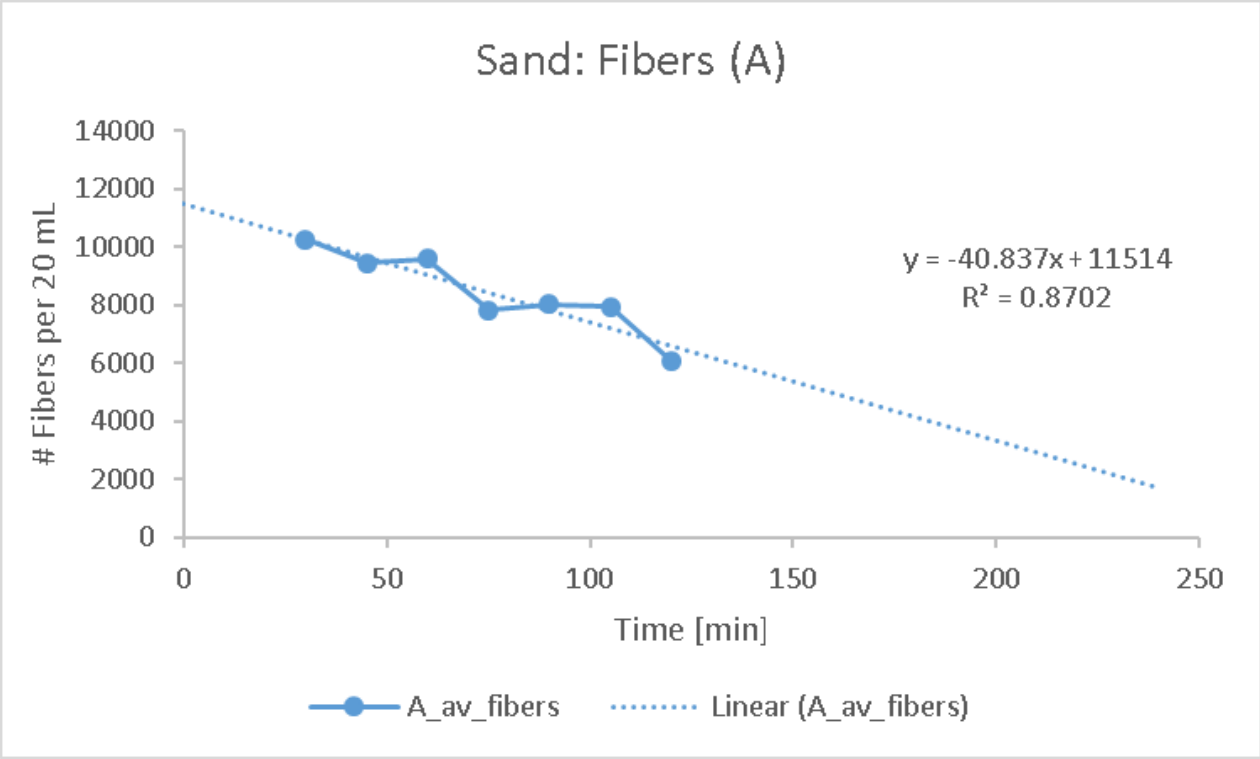
Results

- In both sand (fine sand in the water column) and gravel (clear water column) environments larger particles mostly seem to have sedimented within the first 30 min of the experiments. We still have to count for particles <150 µm.



Results

- Fibers stay in water column much longer than fragments and numbers show near linear decrease over time. As such they could have less impact on benthos/hyporheos.



Questions to be followed up…

- How quickly will particles be remobilized?
- What are typical particle deposition patterns in hyporheic bedforms (dunes, pool-riffle)?
- What is the bioavailability of fragments and fibers to different communities?
- What are the implications of chemical additives on the freshwater ecosystem?

Thank you Team Microplastics!

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