Project Title	The fate of microplastics in aquatic environments
University (where student will register)	University of Warwick
Theme (Max. 2 selections)	Climate & Environmental Sustainability ☐ Organisms & Ecosystems ☒ Dynamic Earth ☐
Supervisory team (including institution & email address	**PI:** Jonathan Pearson, School of Engineering, University of Warwick; j.m.pearson@warwick.ac.uk **Co-I:** Gary Bending, School of Life Sciences, University of Warwick; Gary.Bending@warwick.ac.uk Soroush Abolfathi, School of Engineering, University of Warwick; Soroush.Abolfathi@warwick.ac.uk

Project Highlights:

- Hone novel methods to track (real-time) and analyse microplastics
- Large scale flume studies to investigate the behaviour of microplastics in both the water column & sediment beds
- Training in a wide range of ecological methods using state-of-the-art technologies

Overview (including 1 high quality image or figure): *Maximum 350 words*

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Microplastics (MPs) are an emerging contaminant of increasing concern that are ubiquitous within freshwater and marine ecosystems. Rivers are recognised as a fundamental transport pathway for MPs; connecting terrestrial plastic sources to marine ecosystems, as well as an area where high levels of biological activity and modification can occur. However, there is little consideration as to the sources and fate of plastics within these freshwater ecosystems. Rivers are subject to plastic pollution from both point (i.e. sewage systems) and diffuse (i.e. agricultural and urban runoff) sources. It is expected that riverbed sediments act as a sink for microplastic debris [(1)]. However, the extent to which riverbeds interact with MPs and their entrapment rates will be governed by many physical, biological and chemical factors. Colonisation studies of plastic debris by microbial biofilms have shown to cause buoyant polymers to sink [(2,3)]. Equally, microbial biofilms over riverbed sediment will influence MP infiltration and settling rates. Nevertheless, the relative importance of these processes remains largely unclear with empirical data urgently needed to parametrise models. In this project you will investigate the interactions and feedbacks between riverbed dynamics and MPs. The main aim will be to determine the key variables which contribute to the entrapment and resuspension of MPs within this freshwater ecotone. Different types of plastic particles with different densities will be considered and analysed using novel state-of the-art technology and innovative methods. The release rate and sources of MPs is vital for a more complete understanding and assessment of the hazards posed by these contaminants. As such, the new insights offered by the project have the potential to contribute directly towards new policies relating to water management and environmental conservation.

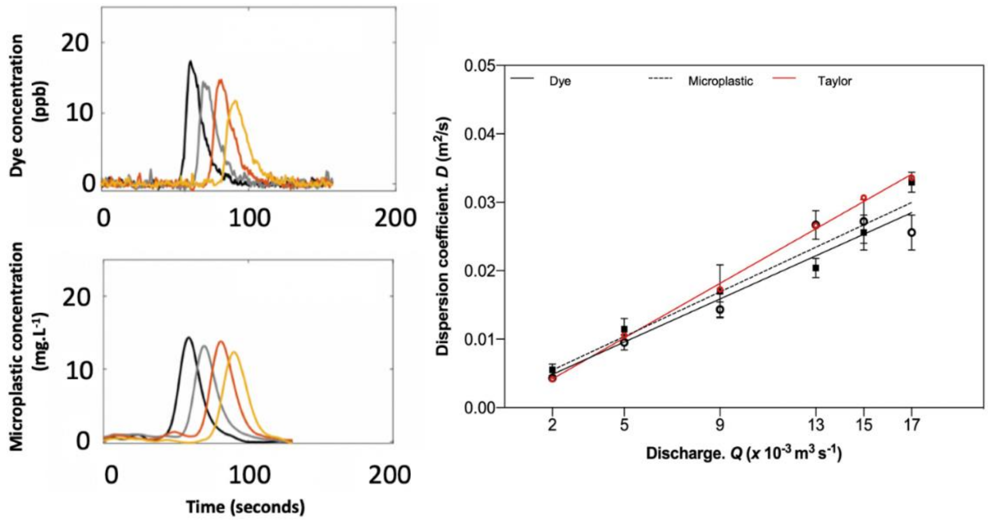

Figure 1: Longitudinal Dispersion in uniform open channel flow of a solute tracer and microplastics compared to Taylors (1953, 1954) classical theory (adapted from Cook et al. (2020)).

Methodology: Maximum 150 words

We will use our novel flume systems to investigate and isolate the different mechanistic processes governing the interaction between the riverbed and MPs. We will test different plastic polymers, with a range of densities and sizes, across a range of riverbed systems with unique characteristics (i.e. pore size, biofilm coated, bedform shape). Methods will include metagenomics to analyse biofilm community structure and optical spectral imaging to visualise where the biofilm colonises the different plastic polymers. In addition, we will adopt our newly developed method to track the movement of MPs within our laboratory-based system [(4)] using fluorescence-based technology, and baseline the MPs results against traditional regulatory approved fluorometric solute tracing techniques. It is important to apply our understanding to the real-world environment. As such, we will also use local rivers and sites across London as a ‘living laboratory’ to collect sediment cores from the river bed & perform regulatory approved tracing tests.

Training and skills: Maximum 100 words – excluding CENTA training information

Students will be awarded CENTA2 Training Credits (CTCs) for participation in CENTA2-provided and ‘free choice’ external training. One CTC equates to 1⁄2 day session and students must accrue 100 CTCs across the three years of their PhD.

Training will be provided by the supervisory team in a wide range of environmental science approaches and techniques including environmental river processes in physical laboratories based in Warwick, molecular techniques (16S amplicon sequencing), bioinformatics, molecular spectroscopy and multivariate data analysis.

Partners and collaboration (including CASE):

Name of L1/L2 Partner (where applicable)	
Name of CASE partner (where applicable – project proposal **must** be accompanied by a letter of support from the CASE partner)	Thames 21

Further information on partners and collaboration (including CASE): *Maximum 100 words*

The PhD researcher will have a training placement at Thames 21, an environmental NGO operating in London, delivering environmental pollution management with communities and municipal stakeholders. There will be the opportunity to work closely with the Thames 21 team in their river catchment sites around London; collecting sediment cores and exploring plastic management solutions.

Respiratory and Contact Infection Resilience of the Project: *Maximum 100 words:*

Although the proposed project will principally based in a physical laboratory (with large scale flumes), we also have instrumented field sites available (e.g. https://www.youtube.com/watch?v=wwQJKMNKbgA, with specialist measurement equipment) if Covid dictates that indoor laboratory work is no longer possible.

Possible timeline:

Year 1: Mesocosm and biofilm community studies to develop process level understanding of the environmental pathways and interactions of microplastics

Year 2: Targeted extraction and analysis of microplastics from riverbed cores to investigate their environmental fate and temporal / spatial distribution

Year 3: Integration and ecological interpretation

Further reading:

1. Rillig, M.C., 2012. Microplastic in terrestrial ecosystems and the soil? Environmental Science and Technology 46, 6453-6454.

2. Rummel, C.D., Jahnke, A., Gorokhova, E., Kuhnel, D., Schmitt-Jansen, M, 2017. Impacts of biofilm formation on the fate and potential effects of microplastic in the aquatic environment. Environmental Science & Technology Letters, 4, 258-267.

3. Kaiser, D., Kowalski, N., Waniek, J.J, 2017. Effects of biofouling on the sinking behavior of microplastics. Environmental Research Letters, 12, 124003.

4. Cook, S., Chen, H.L., Abolfathi, S., Bending, G.D, Schäfer, H., Pearson, J.M. Longitudinal dispersion of microplastics in aquatic flows using fluorometric techniques, Water Research Volume 170, 1 March 2020, 115337

Further details:

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