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The role of biostabilisation in controlling microplastic flux in rivers

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Microplastic burden in aquatic environments is now recognised as a potential threat to human and environmental health. Although microplastic transfers to the ocean from the terrestrial river network contributes up to 90% of the plastics in the oceans the factors controlling that transfer remain largely unconstrained. In rivers microplastics are stored within sediment beds and whilst they are there both the microplastic particles and the sediment grains can become colonised by biofilms. Biofilm growth on river sediments has been shown to increase a particles resistance to entrainment but the effects of such biostabilisation on microplastic flux has not yet been considered. This is despite the fact that biofilm growth can change the buoyancy, surface characteristics and aggregation properties of the plastic particles such as to cause them to be deposited rather than transported and hence increase their residence time.

In order to quantify biostabilisation processes on microplastic flux a two stage experimental programme was run. During the first stage, bricks were submerged in a gravel-bed stream and biofilms allowed to colonise the bricks for 4 weeks. The biofilm covered bricks were then extracted and placed within a re-circulating 'incubator' flume which had been divided into 9 smaller channels. Within each of the 9 channels either a uniform sand, uniform gravel or a bimodal gravel mix were placed in Perspex boxes in the flume channels. Each sediment type was seeded with either high density PVC microplastic nurdles (D_{50} of 3mm, density of 1.33g/cm^3) or polyester fibres (5 mm long, 0.5-1 mm wide, density of 1.38 g cm^3), both at a concentration of 1%. Blanks were also run where the sediment mixtures did not contain any micropalstics. The flume was left to run with representative day/night cycles of lighting in order to let the biofilms colonise the test sediments for either 0 (control), 2, 4 or 6 weeks. At the end of the chosen colonisation periods the persepx boxes containing the sediment were removed from the incubator flume and placed within a glass-sided, flow-recirculating flume (8.2m x 0.6m x 0.5m); this constituted the second stage of the experiment. During this stage the samples were exposed to a series of flow steps of increasing discharge designed to establish the entrainment threshold of the D_{50} sediment grains. Entrainment thresholds were calculated for each of the growth stages such as to establish the effect of biostabilisation on sediment and microplastic flux. Bedload and microplastic transport rates were also measured at every flow step to establish biostabilisation effects on overall fluxes. Finally, photographs of the sediment surface were taken at each flow step in order to estimate the percentage loss of biofilm from the surface.

Discussion concentrates on linking the changes in the degree of biofilm colonisation with the

entrainment threshold of the sediment and the links between biofilm colonisation and the character of the bedload and microplastic flux. The outcome of this research is pertinent to developing understanding surrounding the role biostabilisation has to play in the residence times of microplastics within fluvial systems.