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Wind erosion of microplastics from soils: linking soil surface properties with microplastic flux

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Recent studies of soils in the Alps and Middle East indicate airborne transport of microplastics following wind erosion may be significant. Where microplastics have been entrained by wind they show substantial enrichment ratios compared to mineral particle erosion. Further, microplastic shape affects enrichment ratios with those for fibres greater than for microbeads which may reflect the lower density and asymmetric shape of microplastics compared to soil particles. This suggests that terrestrial to atmospheric transfer of microplastics could be a significant environmental transport pathway. However, currently we have very little understanding of how the properties, in particular the surface characteristics, of the sediment which they are being eroded from affects their entrainment potential.

This paper reports wind tunnel studies run to explore the impacts of soil surface characteristics on microplastic flux by wind erosion. Experiments were performed in a boundary layer simulation wind tunnel with an open-loop suction design. The tunnel has a working section of 12.5m x 0.7m x 0.76m and is housed in an environmental chamber which, for this study, was held constant at 20 ^{o}C and 20% RH. In experiments two types of low density microplastic (microbeads and fibres) were mixed into a poorly-sorted soil containing 13% organics. The polyethylene microbeads had a size range of 212-250 microns and density of 1.2 g cm^{3} and the polyester fibres were 5000 microns long and 500-1000 microns in width with a density of 1.38 g cm^{3}. Microplastics were mixed into the sediment in concentrations ranging from 40-1040 mg kg^{-1}. For each experiment, test surfaces were prepared by filling a 1.0m x 0.35m x 0.025m metal tray with the given mixture of test material which was lowered into the wind tunnel such that it was flush with the tunnel floor and levelled. The wind tunnel was then switched on and run with increasing wind speeds using 0.25 m s^{-1} increments until continuous saltation occurred. Soil surface roughness was scanned prior to and after each experiment using a high resolution laser scanner (0.5mm resolution over the entire test section). Transported soil and microplastic particles were captured in bulk using a 2 cm wide by 40 cm tall Guelph-Trent wedge trap that was positioned 2 m downwind of the test bed.

Discussion concentrates on linking the changes in soil surface topography to the magnitude of microplastic flux where data shows that there is a correlation between the development of the soil

surfaces and overall microplastic flux. Specifically, soil surface roughness is seen as a significant control on microplastic flux where it has a greater overall effect on microplastic fibre flux as compared to the microplastic beads. The outcome of this research is pertinent to developing understanding surrounding the likely controls and hence propensity of microplastics to be entrained from soil by wind erosion.