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Soil erosion as pathway of microplastic transport from agricultural soils to inland waters

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Agricultural soils play a key role as sink of microplastic (MP) coming from different sources, especially via the application of sewage sludge, compost, the decay of plastic mulch, and tire ware particles along streets. However, the effectiveness of this sink might be substantially reduced in areas subjected to water erosion. The aim of this study is to determine the transport potential of MP during water erosion events on agricultural land. More specifically, we are interested if MP is preferentially transported or if it is attached or associated to soil minerals and aggregates leading to a more conservative transport behavior. The transport behavior is studied based on a series of plot rainfall simulations on a silty loam (16% sand, 59% silt, 25% clay; 1.3% OC) and a loamy sand soil (72% sand, 18% silt, 10% clay; 0.9% OC) located at experimental farms in Southern Germany. To simulate heavy rain on dry and wet soil a sequence of two simulations with a gap of 30 min was performed for 30 min each (rainfall intensity 60 mm/h) on each of the four plots (2 m x 5 m). The simulations are repeated in spring and autumn for two years. Before the beginning of the experiment all plots were prepared, adding fine (53-100 µm) and coarse (250-300 µm) microplastic (high density polyethylene) in a topsoil (< 10 cm) concentration of 10 g/m^{-2} and 50 g m^{-2}. The different soils show similar mean runoff rates for the dry run (2 l min^{-1}), whereas the wet run produced slightly higher rates on the silty loam (5.5 l min^{-1}) compared to the loamy sand soil (4 l min^{-1}). In contrast, MP erosion and transport under the loamy sand was more selective, leading to MP enrichment for the first set of experiments of a factor of 3 to 20, compared to MP under silty loam with an enrichment factor of 0,4 to 0,8. The results from the first set of rainfall simulations clearly underlines the selective nature of MP erosion and transport leading to a disproportionate loss of MP from eroding sites into inland waters. The degree of MP enrichment in surface runoff is heavily depending on soil texture and especially moisture status at the beginning of an erosive rainfall event. Further investigations regarding more long-term MP enrichment effects depending on MP association to soil minerals and aggregates are under preparation.