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Fate of microplastic particles in agricultural soil systems: Transport and accumulation processes in contrasting environments

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There is a paucity of data regarding the sources and fate of microplastics in agricultural settings. This is despite indication that these environments may receive significant contributions of microplastics from a range of inputs. Several studies have documented the enrichment of sewage sludge by microplastic particles as a result of wastewater treatment processes. In many countries, sludge is applied to agricultural soils as a soil conditioner. Based on the extent of application and microplastic loads in sludge material, it is expected that sludge application to land represents a considerable release pathway for microplastic particles to the environment. The fate of these particles across spatial and temporal scales is, however, unknown. This includes the potential for the propagation of contamination to connected aquatic systems and beyond.

The Water JPI-funded IMPASSE project addresses significant gaps in our understanding of microplastic contamination in agricultural systems. As part of this project, two case study locations in contrasting environments were selected for study: the semi-arid Henares catchment in central Spain and the humid continental Beaver and Orillia catchments in the Lake Simcoe watershed in Ontario, Canada. Agricultural fields subjected to different sludge application treatments (timing and origin of material) were assessed for microplastic contamination through repeat soil core sampling. This was coupled with runoff experiments using modified Pinson collectors to track the mobilisation of sewage sludge-derived particles from soils. Laboratory analysis was performed according to Hurley et al. (2018). Thorough characterisation of all microplastics particles down to a lower size limit of 50 µm was achieved, including particle size, morphology, polymer type, and estimated mass. Microplastic loads in soils increased following sludge application. The dynamics of contamination from soil core analyses show complex spatio-temporal patterns of accumulation and vertical and lateral transport of particles. Through the use of experimental runoff plots, the mobilisation of microplastic particles from agricultural soils has been documented for the first time. Preferential accumulation and transport of different particle morphologies – e.g. fibres vs fragments – was also observed. These findings form the basis of innovative modelling work in the case study catchments to predict dynamics of agricultural microplastic contamination and

subsequent transfer to aquatic environments.