EGU2020-20054
https://doi.org/10.5194/egusphere-egu2020-20054
EGU General Assembly 2020

Estimating regional distributions of agricultural microplastic immissions into soils - a top-down modeling approach for Germany

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The topic of microplastic (MP) contamination in agricultural soils has recently gained attention in science and society. Experimental studies indicate that microplastic (i.e., plastic particles < 5mm in size) can have negative effects on soil physical properties and ecology, but an actual impairment of soil functions at current concentration levels in agricultural soils has yet to be shown. Nevertheless, the continuous production of single-use plastic and low degradation rates implicate an accumulative effect of MP in the environment that calls for more research on the amounts and impacts of this contaminant. The most discussed agricultural sources for microplastic contamination of cropland are biosolids (e.g., sewage sludge and compost) applied as soil amendment to fields, as well as tarps used in plasticulture. However, knowledge about how much microplastic is accumulating in agricultural soils is scarce. Only a few analytic quantification studies have been published so far. Existing estimates from production and consumption statistics have been performed at national level, but as of yet, spatially explicit regional quantification of microplastic immissions into agricultural soils are missing in the scientific literature.

Using data on microplastic concentrations in biosolids from the literature in combination with national and regional statistics on sewage sludge, compost and organic waste production, as well as specialty crop areas, we estimated annual microplastic immissions into agricultural soils in Germany at NUTS3 (county) resolution. This top-down modeling approach allowed us to identify hot spots where potential microplastic concentration is high.

Although these estimates are based on limited data availability, they yield information on the spatial distribution of potential microplastic contamination in agricultural soils in Germany. Our results provide first indications about locations where detailed soil analysis could be useful to investigate in situ processes and impacts. The methodology can be applied to other regions and continuously adapted when more knowledge on relevant sources, transport, accumulation, and degradation rates of microplastic in soils is gained in the future.