Project *brief*

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Microplastics in the environment: Investigations in the Weser catchment

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- **As part of the collaborative project PLAWES, we estimated the spatial distribution of microplastic inputs in a hydrologically and agriculturally heterogeneous river basin**
- **Through the parallel investigation of two river basins (Weser and Warnow) in cooperation with the MicroCatch_Balt project, the influence of the different land use structures was considered**
- **The results point to strong regional variability with local microplastic concentrations, which should be considered in more detail in subsequent studies**
- **Such an overall view is indispensable in order to assess the scope for policymaking and to develop efficient options for action**

The study area:
The Weser catchment area (approx. 46,000 km² area) stretches from the low mountain ranges to the North German Plain. Its hydrology, topography and land use are therefore very heterogeneous. It is characterised by forest areas, arable farming and grassland as well as special crops and urban zones.

By NordNordWest - Own work
by means of: GTOPO-30 Elevation
Data by USGS, CC BY-SA 3.0

Background and objective

In the public discussion on the topic of microplastics in the environment, agriculture is increasingly attributed a significant role.

As the largest user of land and due to the easily perceivable cultivation with plastic cover and mulch film as well as the use of plastic films in silage production, it is often seen as a relevant emitter of microplastics into the soil. However, it is also a victim because, according to the current state of knowledge, 81 % of emissions occur outside agriculture and farms recycle contaminated compost and sewage sludge as a service in the sense of the circular economy.

Microplastics are ubiquitous in the environment and have also been detected in soils with no known agricultural pollution history. The significance of microplastic sources associated with agriculture cannot be quantified with certainty at present. The most commonly discussed sources are contaminated sewage sludge, polluted compost, and the application of agricultural films.

From 2017 to 2021, we investigated the topic of microplastics in agriculture as part of the joint project PLAWES, which was funded by the BMBF as part of the FONA program "Plastics in the Environment". The aim of the project was to improve the understanding of the overall system of microplastic sources, transport pathways and fate in the environment. The Weser river basin served as a large and heterogeneous study area with different land use types and hydrological conditions. At the same time, we were involved in the partner project MicroCatch_Balt, which investigated the Warnow catchment with the same objective.

Approach

In the joint project PLAWES, special attention was paid to microplastic inputs through the use of mulch and cover films. To this end, we adapted the RAUMIS model to the microplastic question in order to estimate the spatial distribution on agricultural land. For this purpose, we multiplied spatially explicit cultivation areas of speciality crops that are preferably grown with mulch and cover films by crop-specific emission factors and scaled them for each year in the period under consideration according to the assumed temporal development of film cultivation in order to obtain total inputs over the period from 1960 to 2016. In the partner project MicroCatch_Balt, the focus was on the development of the sewage sludge and compost input model.

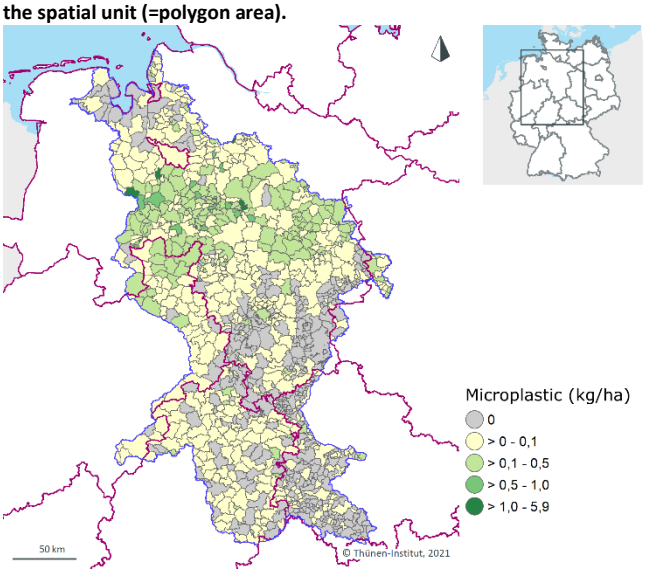
Results

According to our initial estimates, a total of 1,877 t of microplastics were introduced into agricultural soils in the Weser catchment area from 1960 to 2016 through sewage sludge, 1,591 t through compost and 440 t through mulch and

cover films. The spatial variability of the inputs is high for all sources. Inputs from compost are strongly linked to population density, as we were unable to take transport distances into account due to the input data. Inputs of sewage sludge are primarily in the area of the arable farming centres south of Bremen to the Hessian uplands.

In comparison, the average values of the Weser and Warnow catchment areas show clear differences. In the Weser catchment area, the stronger influence of agricultural films stands out, which can be explained by the cultivation focus of early potatoes, asparagus and lettuce in the area of the Middle Weser. In the Warnow catchment, on the other hand, sewage sludge is more important in relation to the total area.

Spatial distribution of modelled cumulative microplastic inputs from mulch and cover film into agricultural soils, shown in kg per hectare of the spatial unit (=polygon area).



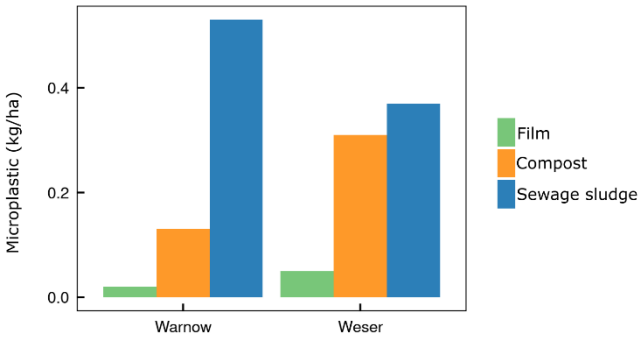
Source: own calculation.

Recommendations

The clear spatial variability suggests that regional agricultural structures have a considerable influence on the distribution of the pollution hotspots and should be taken into account in the development of monitoring projects. Although the best available data basis was used, the results are partly based on a still thin data base. The model can easily be adapted to improved input data, e.g. for a more detailed consideration of a smaller region taking into account compost and sewage sludge data or differentiated information on the extent and management of special crops. The focus on the agricultural input sources considered here should also be extended to the overall picture of possible emissions in order to better classify the relevance of agricultural options for action.

In Germany and across Europe, the first monitoring programmes have been launched to record microplastic levels in soils of different uses. However, due to the methodological challenges and the high workload, analysis will only be able to provide selective results in the long term. Models are needed to improve our understanding of microplastic sources, pathways and sinks in the environment. On this basis, possible mitigation measures can be identified and their efficiency and boundary conditions can be tested.

Mean modelled cumulative microplastic inputs from 1960 to 2016 from sewage sludge, compost and agricultural films, related to the area of the Warnow (Microcatch_Balt) and Weser (PLAWES) catchment.



Source: own calculation

Further information

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Publications

Brandes E, Henseler H, Kreins P (2021) Identifying hot-spots for microplastic contamination in agricultural soils - a spatial modelling approach for Germany. *Environ. Res. Lett.* 16 (2021) 104041 DOI:10.1088/1748-9326/ac21e6

Brandes E, Cieplik S, Fiener P, Henseler M, Herrmann F, Klasmeier J et al. (2020): Modellbasierte Forschung zu Mikroplastik in der Umwelt. https://bmbf-plastik.de/de/publikation/modellbasierte-forschung-zu-mikroplastik-der-umwelt

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