Geophysical Research Abstracts
Vol. 21, EGU2019-14404, 2019
EGU General Assembly 2019

PFAS – a new class of emerging agrochemicals?

Matthias Gassmann (1), Sandy Falk (2), Hubertus Brunn (3), Anna Merle Liebenehm-Axmann (1), Harald Rückert (4), Georg Berthold (4), and Thorsten Stahl (5)

(1) University of Kassel, Institute for Water, Waste, Environment, Water Quality Management - Modelling and Simulation, Kassel, Germany (gassmann@uni-kassel.de), (2) Hessian State Laboratory, Wiesbaden, Germany, (3) Hessian State Laboratory, Giessen, Germany, (4) Hessian Agency for Nature Conservation, Environment and Geology, Wiesbaden, Germany, (5) Hessian State Laboratory, Kassel, Germany

Even though perfluoroalkyl substances (PFAS) are mainly used in industrial processes and consumer products, they have often been detected in agricultural environments and groundwater in recent years. While some sources are directly connected to contamination events (such as PFAS from fire-fighting foam), other sources may be more continuous. Especially soil melioration by applying sewage sludge and compost may provide long-term input into the agricultural environment. However, it is unclear if all PFAS are available in sewage sludge and compost or if their occurrence is selective. Therefore, we investigated 201 samples of sewage sludge and 45 samples of biowaste for their concentrations of 14 different PFAS. The results suggests that sewage sludge functions as a sink for long-chain PFAS, and the plants preferentially take up short-chain PFAS from the sludge/soil, as seen by the concentrations found in biowaste. This behaviour may be an effect of substance adsorption, which is stronger for long-chain and weaker for short-chain PFAS. Our results also indicate that about 15 kg of PFAS are spread onto agricultural fields in Germany each year via sewage sludge.
Following application, the behaviour of PFAS in soils is still poorly understood. While there is evidence that they behave similarly to other organic agrochemicals such as pesticides, their partial dissipation during soil passage was rather attributed to irreversible adsorption than biodegradation. In order to test the applicability of well-known environmental fate process descriptions, we used the pesticide leaching model MACRO for the simulation of the two lead substances of PFAS: perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). The model was set up by using soil and crop rotation data of a long-term field lysimeter study investigating the leaching of PFOS and PFOA over a period of eight years. Irreversible adsorption was mimicked in the model by degradation in the adsorbed phase. Using this setup, the MACRO model was able to reproduce water and substance leaching within parameter ranges taken from the literature. The dynamics of plant uptake could only partially be reproduced. Concluding, PFAS leaching may be estimated using similar environmental fate descriptions than pesticides.
In order to examine the groundwater contamination potential resulting from leaching of different PFAS, we sampled 364 groundwater monitoring wells in the federal state of Hesse, Germany, from 2009 – 2016 for 21 PFAS, which resulted in 32800 concentration values. Positive PFAS values were found in about 90 % of the investigated monitoring wells. PFOA and PFOS were found in 45 % (average of 1.2 ng/l), the short-chain PFAS in 29 % (average of 0.7 ng/l) and the long-chain PFAS in 5 % (average of 0.07 ng/l) of the samples. This shows, that more mobile PFAS (short-chain) and PFAS with the highest usage (PFOS and PFOA) are most likely found in groundwater, whereas long-chain PFAS may be mostly retained in the soils during leaching.
These studies suggest that, even though PFAS are not deliberately introduced into the environment, their mode of application, their behaviour in agricultural soils and their ubiquitous occurrence in groundwater is similar to other organic agrochemicals.