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“Development on the margin”

Accumulation and Binding of Human Pharmaceuticals in Wastewater Irrigated Fields in the Mezquital Valley, Mexico

DALKMANN PHILIPP¹, JAN SIEMENS¹, ELISHA WILLASCHEK¹, CHRISTINA SIEBE², WULF AMELUNG¹

¹*University of Bonn, Institute of Crop Science and Resource Conservation (INRES), Germany*

²*University of Mexico City, Institute of Geology: Soil Science, Mexico*

Abstract

As a consequence of population growth and urbanisation, arable fields are increasingly irrigated with untreated wastewater worldwide. Wastewater irrigation is associated with risks arising from dissolved pharmaceutical residues, including the contamination of soils and crops as well as the proliferation and formation of antibiotic resistance. Environmental and health risks caused by pharmaceutical residues are profoundly affected by the compounds' binding and bio-availability in soils. The Mezquital Valley, located in the north of Mexico City, is one of the largest wastewater irrigation areas facing these risks.

We investigated the accumulation and sequestration of the antibiotics ciprofloxacin, enrofloxacin, sulfamethoxazole, trimethoprim, clarithromycin and the anticonvulsant carbamazepine in soils with different duration of wastewater irrigation (zero to 100 years). Sequential extractions with CaCl₂ solution and accelerated solvent extraction (ASE) were performed in order to determine an easy extractable (“bio-available”) and a sequestered fraction of the compounds. The extracts were pre-concentrated via solid phase extraction (SPE) and quantified via LC-MS/MS. In contrast to our expectation no accumulation of ciprofloxacin, enrofloxacin, and clarithromycin were found. However, sulfamethoxazole and carbamazepine concentrations in the soils increased until a steady state was reached. Equilibrium between sorption, especially to the organic matter, and dissipation of sulfamethoxazole and carbamazepine seems to be reached.

Presently we are testing in batch sorption and desorption experiments whether the accumulation of organic matter in soils as a consequence of wastewater irrigation leads to an increasing binding and therefore decreasing extractability of the compounds over time. This process would lead to an inherent “mitigation” of the exposition of plants, animals, and humans to these pharmaceuticals in the wastewater irrigation area.

Keywords: Aging, carbamazepine, ciprofloxacin, clarithromycin, enrofloxacin, irrigation, soil, sulfamethoxazole, water re-use