Simulating pharmaceutical and personal care product transport

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Pharmaceuticals and personal care products (PPCPs) carried in biosolids (i.e., treated sewage sludge) may reach surface waters or groundwater when these materials are applied as fertilizer to agricultural land. During the high flow conditions created by land application of liquid municipal biosolids (LMB) the residence time of solutes in soil macropores may be too short for sorption equilibration which increases the risk for leaching.

Physically based solute transport simulation models are widely used in environmental risk assessment for pesticides. These models may also be applicable for PPCPs when their physical and chemical properties and soil dissipation characteristics are available. However, these models do not account for non-equilibrium sorption in soil macropores. The model MACRO is one of the models used in environmental risk assessments for pesticides and may have potential as an environmental risk assessment tool for PPCPs.

A group of scientists from the Swedish University of Agricultural Sciences, the Swiss Federal Institute for Aquatic Science and Technology, Agriculture and Agri-food Canada, and Trent University, Canada, evaluated the MACRO model and an updated version of MACRO which included non-equilibrium sorption in macropores using data from experiments on the transport of three PPCPs (atenolol, carbamazepine, and triclosan), the nicotine metabolite cotinine, and the strongly sorbing dye rhodamine WT applied in LMB. The study was financed by grants from the European Union (ERAPharm, project no. 511135) as well as Health Canada, the AAFC GAPs program, and the

Ontario Ministry of Agriculture and Rural Affairs, Nutrient Management Joint Research Program. Results from the study were published in the May-June issue of the Journal of Environmental Quality .

Results showed that the MACRO model could not reproduce the measured rhodamine WT concentrations in drain discharge. The updated version resulted in better fits to measured data for both PPCP and rhodamine WT concentrations. However, it was not possible to simulate all compounds using the same set of hydraulic parameters, which indicates that the model does not fully account for all relevant processes.

Mats Larsbo, one of the authors of the article, stated that "Our results show that non-equilibrium sorption in macropores has a large impact on simulated solute transport for reactive compounds contained in LMB. This process should be considered in solute transport models that are used for environmental risk assessments for such compounds".

The identification of key model processes, such as non-equilibrium sorption in macropores, is an important step in the development of better tools for environmental risk assessment for PPCPs. However, further field studies and model evaluations are needed to establish under which conditions this process plays an important role.

More information: View the abstract at jeq.scijournals.org/cgi/content/abstract/38/3/1274 .

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