Detailed Pesticide Fate Descriptions and Realistic Hydrogeological Settings applied in the Pesticide Leaching Risk Assessment for Clay Till Fields

Plenary Lecture (**SOIL**)

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The use of pesticides is of environmental concern because of the many non-targeted side effects it generates. Numerous guidelines and models have been set up, to predict the general fate of pesticides, and more specifically, the risk of pesticide leaching from primarily agricultural soils, e.g. Council-directive-91/414/EEC (1991) [1]. These guidelines and models incorporate key fate processes like sorption and degradation and flow through the variably-saturated soil. None of these predictions, however, take into account the variation in space and time of the fate processes nor do they account for realistic hydrogeological settings.

Field-scale monitoring results collected within the Danish Pesticide Leaching Programme (http://pesticidvarsling.dk/om_os_uk/uk-forside.html) [2] reveal that some pesticides and/or their degradation products, contrary to the predictions, can leach through the variably-saturated zone to the groundwater. This is especially pronounced at the low-permeable clay till fields.

At these fields, wormholes linked to deeper fractures seem to facilitate rapid preferential transport of solutes to great depth. Low permeability mineralized layer, or coating, often exists at the interface between the matrix and the discontinuities (fractures or wormholes), i.e., a layer, which reduces matrix imbibition and thus promotes discontinuities-dominated flow as opposed to matrix dominated flow. Coatings varies from organic matter in the wormholes to heavy deposits of iron- and manganese oxides in the deeper part of the fractures. Such hydrogeological setting responds quickly to the climatic input resulting in yearly groundwater fluctuations of 3-4 meters or more.

Recent studies of the degradation and sorption potential of different domains in clay tills have revealed a huge spatial heterogeneity [3]. The largest and most homogeneous degradation potential is found in the upper app. 30 cm layer if not artificial build, whereas deeper layers may have domains of fast and slow and even no degradation. The active domains are often linked to the discontinuities in the soil matrix, which give rise to a higher water-soluble carbon concentration, larger bacterial densities and thus activities in the discontinuity compared to the adjacent soil matrix. This difference can be caused by the presence of a coating on the walls of the discontinuity having negligible porosity and hence disconnecting the two domains. This coating also seem to play a role in the sorption potential of compounds. Like degradation, sorption is generally most pronounced in the top layer having the highest organic matter, but also sorption to the coating in the discontinuities can play a role.

With the modelling tool COMSOL Multi-physics® the impact of such heterogeneity and hydrogeological setting on the leaching risk of MCPA [4], glyphosate and tebuconazole through clay till is evaluated based on extensive laboratory experiments on soil samples from each soil domain together with realistic coherent net precipitation and fluctuating groundwater table. The results indicate that a fluctuating groundwater table and the influence of domain specific sorption and degradation (also in regard to artificial soil layer) in many cases are imperative for assessing the pesticide leaching risk from clay tills.

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