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Impact of macroporosity on pesticide losses from tile-drained soils in the Netherlands

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Spatially-distributed pesticide leaching models are now commonly accepted in pesticide registration procedures and policy evaluations. For example, in the Netherlands the GeoPEARL model (Tiktak et al., 2002) is used to evaluate leaching to groundwater and surface waters. In surface waters, the peak concentration of pesticides is considered an important ecological endpoint. So far, the leaching models were less suitable to describe this endpoint, because procedures to fully parameterise fast transfer routes (amongst others by macropores) through the soil were not available at the national scale. For this reason, a macropore flow version of the pesticide leaching model GeoPEARL model has been developed.

The model describes the transport of pesticides through the soil matrix and through two preferential flow domains, i.e. a bypass domain and an internal catchment domain (Kroes et al., 2008). Macropores can be either permanent or temporary (due to shrinking of soils). Exchange between the macropores and the soil matrix in the saturated zone is described by Darcy flow, infiltration from macropores into the unsaturated zone is described with Philip's sorptivity. The maximum depth of the macropores in both domains is related to the mean lowest groundwater depth. Experimental studies showed a good correspondence between macroporosity and the Coefficient of Linear Extensibility (COLE). The COLE is related to organic matter and clay content. Parameters of the shrinkage characteristics were related to organic matter, clay content and moisture content at saturation. Mean aggregate size (necessary in the description of exchange between the macropores and the matrix) is described by an equation published by Jarvis et al. (2007).

Application of the model to a tile-drained field-site showed that the model could adequately describe the peak concentration and the later decline of the concentration for two different pesticides. Application of the model at the national scale shows that preferential flow through tile-drains is the dominant pathway of pesticide losses in tile-drained soils. In 20-years simulations, the variability between the years is large. Comparison of the preferential flow version of GeoPEARL with the matrix flow version suggests a relatively small impact on the mass fraction lossed to surface waters and groundwater. Main differences were in the timing: the matrix flow version of GeoPEARL was not able to simulate the peak adequately.

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