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Using a tank flow model with PEARL to measure the variation in pesticide persistence between anaerobic and aerobic soil conditions

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Pesticide leaching is very sensitive to the transformation rate (Boesten and Linden, 1991). The values of the transformation rates of the pesticides differ between aerobic and anaerobic soil conditions.

The main objective is to determine if there is a significant variation in pesticide persistence between aerobic and anaerobic soil conditions. An auxiliary hydrological model is used with the PEARL model (Leistra et al, 2001). The auxiliary model determines the degree of saturation of the soil at each time step. The value of the degradation rate for a given pesticide in the PEARL model varies depending on the time periods with saturated or unsaturated soil conditions.

The proposed auxiliary model has been conceptualized as a static tank flow model based on the actual evapotranspiration of the crop plants. It is based on the RIBAV model (Garcia-Arias et al. 2012) used for the modeling of riparian vegetation zonation. The tank represents a soil column which also includes the superficial root layer. The lower capacity limit of this tank is the permanent wilting moisture of the soil. The upper capacity limit represents the saturated condition of the soil. The tanks input flows are precipitation and irrigation. In contrast, output flows are the actual evapotranspiration and the discharge of the tank. The most relevant model parameters are the soil retention curves, the crop parameters (specially related to root depths and crop coefficients) and the daily meteorological data (such as precipitation and potential evapotranspiration). The main output of the auxiliary model is the relative soil moisture, which determines if the PEARL model should use the transformation rate value for aerobic or for anaerobic conditions.

In order to prove the applicability of the model, it was tested with various pesticides, which cover a wide range of transformation rates. The results show that the auxiliary tank model is able to determine the partition of the pesticides degrading in both aerobic and anaerobic soil conditions. Therefore it can be examined to which extent anaerobic soil conditions influence the predicted pesticide concentrations in groundwater.