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Comparison of 1D and 2D modelling approaches for cracking clay fields under artificial drainage conditions in pesticide fate studies

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The use of agrochemicals in the European Union causes concern over the presence of pesticides in the environment, including pesticide residue in drainage water. Environmental models are powerful tools for evaluating and predicting pesticide losses from the drainpipes to surface waters. Field scaled regulatory models are often based on one-dimensional (1D) simulation domains, even though the problem is inherently two- or even three-dimensional (2D or 3D). To investigate the limitations of a 1D approach, the same pesticide leaching scenario was simulated for both 1D and 2D geometries, with the agro-ecological model Daisy. In the 1D model, horizontal water flow to drains was simulated by using a sink term based on the Hooghoudt theory, called the Hooghoudt Drainage Model (HDM). In the 2D model, we used the so called dynamic drainage model (DDM), where one node was specified as a drain node. Pressure in the drain node is assumed to be equal to the atmospheric pressure, when the surrounding grid cells are saturated, allowing this cell to act as a sink. The simulation results were compared to observed data for drain flow, bromide and pesticide leaching in the drains, for the Andelst survey field (Wageningen University). Andelst survey field is a cracking clay field, where it has been observed that preferential flow patterns are crucial for solute transport and leaching patterns. Thus, both the 1D and 2D model included a macropore module with one class of macropores connecting the soil surface to the drain pipes. Simulation results of water dynamics, bromide and pesticide leaching for the 1D and 2D versions were similar and gave a good description of observed data. We present a discussion on the required assumptions and potential limitations behind both 1D and 2D approaches.