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# Numerical simulation of the nitrate fate in a dual-permeability porous system

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The groundwater quality in the regions under intensive agriculture is frequently affected by nitrogen compounds. Complexities of the nitrogen cycle are often reflected in large spatial and temporal variations of nitrate in the soil profile. In our study, the fate of nitrate was simulated by means of one-dimensional numerical models of transient flow and transport in variably saturated porous media. To model the transport of nitrates in the soil profile, the fertilizer application, the nitrification/denitrification processes, and the nitrate uptake by plant roots, as occurred in the simulated period, had to be considered. The spatiotemporal variability of the plant root water uptake as well as the variability of the zero-order nitrate transformations were also taken into account. Two principal scenarios were evaluated: (i) transport of nitrate in a dual-permeability system, representing the soil matrix with preferential pathways, and (ii) transport in a single-permeability soil matrix system. The simulated breakthrough curves provided a valuable insight into the nitrate dynamics throughout the period of interest. The matrix domain breakthrough curve showed continuously changing nitrate concentration in time. The much more erratic behavior of the fracture domain breakthrough curve revealed two major mechanisms of the nitrate transport: (1) The storm related transfer of the nitrate-loaded water, which suddenly increases the concentration at the depth of interest at the beginning of the storm event. (2) The leaching of the cleaner storm water at the end of the storm event. Because of the compensating effect of the two mechanisms, the dual-permeability simulation in our case does not deliver larger cumulative nitrate leakage through the bottom boundary than the single-permeability one. The

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