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Impact of seasonal macropore dynamics on infiltration: field-based evidence and model simulations

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The large impact of macropores on water and solute transport is widely recognized. Most macropores are of biogenic origin (biopores), but the resulting temporal dynamics are often neglected. We present evidence from infiltration experiments and model scenarios about seasonal variations of biopore numbers and related infiltration patterns.

The field data consists of Brilliant Blue profiles from irrigation experiment campaigns on pasture land in the Luxembourgian Attert catchment (May, July, October 2105). To identify and quantify dynamics in biopores and infiltration patterns we developed a semi-automated image processing scheme. Subsequently we used the image-derived biopore metrics to parameterise the EchoRD hydrological model, which includes explicit macropore flow and interaction with the matrix. We compared the simulation results with observed infiltration patterns to assess the underlying process assumptions of the model.

The observed infiltration patterns revealed variations in both biopore numbers and biopore-matrix interaction. The field-observed biopore numbers varied seasonally mainly in the topsoil. Largest biopore numbers were found in October and smallest in July, which affected the biopore connectivity that was lowest in July. In July a strong biopore-matrix interaction was observed. In July and October most of the irrigated water was stored whereas drainage was the dominant process in May. The model was capable to simulate the observed infiltration patterns for July and October. But in May, biopore-matrix interaction was largely overestimated. Because the biopore-matrix interaction is an important factor for the extent of macropore flow and this interaction is seen to be temporally variable, we suggest focusing on the causes for the temporal variations in biopore-matrix interaction – such as initial water supply, biopore connectivity, side wall coating, matrix characteristics, or soil moisture state – in future studies.