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Hydrologic modelling of a dynamic pore space

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The paradigm of a rigid pore space, which is generally assumed in hydrological modelling of soils, does not allow to evaluate the impact of dynamic processes such as bioturbation, structural changes through heavy machinery and tillage or swelling and shrinking. With that limitation, the estimation of the impact of land use scenarios on soil functions is hampered. We present a model that deals seamlessly with a dynamic pore space.
Soil is represented by mass centered nodes (soil horizons) that have an array of pores with different pore diameters. Their capacity is dynamic, and with that the volume of the nodes is also dynamic.
The pore classes have a water holding potential that depends on their diameter and the contact angle of water. If the matrix potential is higher than the pores' potential they get filled with water. The speed depends on the potential gradient and the inner resistance of the pores, which is determined by the pore size.
Water movement between soil nodes is calculated by the matrix and gravity potential gradient and the matrix conductivities of the nodes. This conductivity is calculated from the water content of the nodes and a power average of the local conductivities of the water filled pores.
The matrix potential is dynamically calculated from equilibrating the fluxes. Water entering a node must be redistributed to the air filled pores and to adjacent nodes. Under transient conditions this can lead to dynamic effects, e.g. if an infiltration front enters a soil node the potential will rise faster than the water content and some stable equilibrium between water content and water potential is only reached with time after redistribution as typically observed in soil under transient conditions.
As the conductivity and the capacities are derived from a dynamic pore space, the hydraulic properties are directly influenced by reconfigurations. Compaction, tillage, bioturbation and swell/shrinkage alter the hydraulic state and thus an integrated model allows the interpretation of the influence of these processes on soil hydraulics. The proposed model approach is compared to classical Richards equation.