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A new approach for the in situ determination of soil water retention characteristics for shallow groundwater systems

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Obtaining representative effective hydraulic properties for the pedon to field scale as input for models is a major challenge in hydrology. Hydraulic properties are often determined by laboratory measurements on small soil cores. Due to the high small-scale variability, many samples are needed to obtain representative values, which is time consuming and costly. Here, we present a new approach which is focused on the in situ determination of the soil water retention characteristics that is applicable to shallow groundwater systems. The method integrates over small-scale heterogeneity (appr. several meters) and uses only precipitation and water-level data.
Our approach is built on two assumptions: i) for shallow groundwater systems (with water table depths of appr. < 0.5 to 1 m) , e.g. wetlands, with medium- to high conductive soils the soil moisture profile is close to hydrostatic equilibrium before and after rain events (Dettmann et al., 2014, J Hydrol, 515, 103-115) and ii) over short time periods lateral fluxes into and out of the system are negligible. Given these assumptions, the height of a water level rise after a precipitation event only depends on the soil water retention characteristics, the precipitation amount of the event and the initial water table depths. We use this dependency, to determine van Genuchten-parameters by Bayesian inversion.
The applicability of the method is proved by synthetic data. Water retention characteristics are very well-constrained for the low suction range. At high suctions uncertainties strongly increase as this suction range is not covered by the approach. With real field data, some phenomena make an accurate determination more difficult. Wetlands are typically characterized by a distinct microrelief leading to partly inundated areas around a monitoring well in dependence of the water level. For field application, we thus developed a model that takes into account the microrelief by assuming frequency distributions. Furthermore, preferential flow phenomena were accounted for by waiting for the system to equilibrate a few hours after the rain events. The inversely-determined parameters are compared against laboratory data.