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In situ soil moisture and matrix potential – what do we measure?

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Soil moisture and matric potential are often regarded as state variables that are simple to monitor at the Darcy-scale. At the same time unproven believes about the capabilities and reliabilities of specific sensing methods or sensor systems exist. A consortium of ten institutions conducted a comparison study of currently available sensors for soil moisture and matrix potential at a specially homogenised field site with sandy loam soil, which was kept free of vegetation. In total 57 probes of 15 different systems measuring soil moisture, and 50 probes of 14 different systems measuring matric potential have been installed in a 0.5 meter grid to monitor the moisture state in 0.2 meter depth.

The results give rise to a series of substantial questions about the state of the art in hydrological monitoring, the heterogeneity problem and the meaning of soil water retention at the field scale:

A) For soil moisture, most sensors recorded highly plausible data. However, they do not agree in absolute values and reaction timing. For matric potential, only tensiometers were able to capture the quick reactions during rainfall events. All indirect sensors reacted comparably slowly and thus introduced a bias with respect to the sensing of soil water state under highly dynamic conditions.

B) Under natural field conditions, a better homogeneity than in our setup can hardly be realised. While the homogeneity assumption held for the first weeks, it collapsed after a heavy storm event. The event exceeded the infiltration capacity, initiated the generation of redistribution networks at the surface, which altered the local surface properties on a very small scale. If this is the reality at a 40 m^2 plot, what representativity have single point observations referencing the state of whole basins?

C) A comparison of in situ and lab-measured retention curves marks systematic differences. Given the general practice of soil water retention parameterisation in almost any hydrological model this poses quite some concern about deriving field parameters from lab measurements.

We will present some insights from the comparison study and highlight the conceptual concerns arising from it. Through this we hope to stimulate a discussion towards more critical revision of measurement assumptions and towards the development of alternative techniques to monitor subsurface states.

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