



GEOPHYSICAL METHODS: A KEY TO A BETTER UNDERSTANDING OF SOIL-WATER SYSTEMS AT THE FIELD SCALE

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Research in soil and groundwater hydrology has continuously increased our understanding and conception of the shallow subsurface environment. Most of this knowledge, e.g. in terms of realistic flow and transport models, is originally based on experiments and observations. Conventional measurement strategies in soil hydrology normally yield only effective (i.e. volume-averaged) or local information. Moreover, they often involve a significant destruction of the system due to their invasive nature. Since structure and dynamics in soil-water systems are complex, in particular involving processes at multiple scales in space and time, more adequate observation techniques are desired as a prerequisite for an improved understanding. Motivated by this, geophysical methods have received increased attention in soil hydrology in recent years. In particular electrical and electromagnetic methods appear to bear significant potential for hydrogeological investigations at the field scale. For instance, the soil moisture distribution has been imaged using ground penetrating radar (GPR), transport properties have been assessed using electrical resistance tomography (ERT) in tracer experiments, and attempts have been made to estimate hydraulic conductivity using electrical impedance tomography (EIT, an extension of ERT taking electrical polarization phenomena into account). Although different geophysical approaches have been proposed and studied in several applications, there is still demand for methodological improvements and further developments. In particular, two key challenges can be identified. First, the actually measured physical properties (e.g. electrical conductivity) must be transformed into hydrological properties, requiring improved macroscopic models. Secondly, many geophysical imaging procedures require certain a-priori knowledge (or assumptions) on the system itself, e.g. in terms of structural

characteristics - finding an adequate balance between ingoing and outcoming (new) information is a non-trivial task. Such aspects make clear that, today, the potential of geophysical methods in soil hydrology has not yet been fully exploited. This remains to be the major challenge for the up-growing generation of "hydrogeophysicists".