Joint assessment of soil hydraulic properties by constraining geoelectrical tomography measurements with X-ray Computed Tomography pore architecture information

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Developing a better understanding of hydraulic properties of soils is of significant importance for such diverse fields as agriculture, soil and ecosystems management, vadose zone hydrology, contaminant transport, civil engineering and geotechnics and the tourism and leisure industries. We propose a new method of investigating soil hydraulic properties by the joint appraisal of two advanced tomography technologies: Electrical Resistivity Tomography (ERT) and X-ray Computed Tomography (CT). Both methods are non-invasive and allow properties measurements without disturbing the structural integrity of the sample. The method implies contemporaneous moisture dynamics measurements in soil columns. ERT enables the continuous time-lapse measurement of the 4D resistivity profile. This allows monitoring and modelling the fluid preferential pathways inside the column. X-ray CT has the ability to determine the pore structure and matrix architecture of the samples.

The information obtained from the X-ray scanner is used to refine the mesh used to reconstruct the 4D resistivity profile hence constraining the model. Synthetic modelling has been run integrating spatial information extracted from X-ray scans into ERT inversion models. Obtained constrained models as such have been compared with unconstrained scenarios. The results suggest that the constrained models provide a higher accuracy and resolution. This innovative methodology of mapping and monitoring fluids, which combines the advantages of two established techniques, holds promise for soil science application and related fields.