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Visualisation and quantification of water in bulk and rhizosphere soils using X-ray Computed Tomography

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Understanding how water is distributed in soil and how it changes during the redistribution process or from root uptake is crucial for enhancing our understanding for managing soil and water resources. The application of X-ray Computed Tomography (CT) to soil science research is now well established; however few studies have utilised the technique for visualising water in pore spaces due to several inherent difficulties. Here we present a new method to visualise the water content of a soil in situ and in three-dimensions at successive drying matric potentials. A water release curve was obtained for different soil types using measurements from their real pore geometries. The water, soil, air and root phases from the images were segmented using image analysis techniques and quantified. These measurements allowed us to characterise pore size, shape and connectivity for both air filled pores and water. The non-destructive technique enabled water to be visualised in situ and repeated scanning allowed wetting patterns to be analysed. The experimental results were validated against conventional laboratory derived water release curves and specifically developed mechanistic models of soil-water-root interactions. Micro-scale revelations of the water-soil-root interfaces enabled us to make macro-scale predictions on water movement in soil. The information and insights obtained on the hydraulic properties of rhizosphere and bulk soil will enhance our understanding of rhizosphere biophysics and improve current water uptake models.