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Estimating water retention curves for sandy soils at the Doñana National Park, SW Spain

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The determination of soil water retention curves (SWRC) in the laboratory is a slow and tedious task, which is especially challenging for sandy soils due to their low water retention capacity and large water content changes for small pressure head differences. Due to spatial variability within larger areas and difficulties to obtain minimally disturbed soil samples, especially under dry conditions, laboratory measurements of the SWRCs are only suitable for guidance, as a consequence of their low representativity and accuracy.

This work was developed within the framework of a research project on the ecohydrological behaviour of the soil-plant-atmosphere system within the Doñana National Park (SW Spain). In order to characterise the hydrological behaviour of the soils, a good estimation of water retention curves and hydraulic parameters is needed. Ten locations within the study area were equipped with soil moisture sensors (ECH2O-EC20, Decagon Devices Inc.) to monitor volumetric water content at different depths throughout the vadose zone. These data allow the estimation of water fluxes and recharge of the underlying aquifer, which plays a crucial role in the wetland system of the Park, declared by UNESCO as Biosphere Reserve.

In this work three methods for estimating SWRCs were developed and compared. First, sand and kaolin suction tables were used to obtain SWRCs for both minimally disturbed and disturbed samples. Second, SWRC were estimated with HYDRUS-1D using the monitored volumetric soil water content data. Finally, SWRCs were estimated using the additivity hypothesis, based on the idea that SWRCs can be approximated by summing up SWRCs corresponding to different particle-size and pore-space classes of which the soil is composed. Particle-size distributions were determined in the laboratory while water retention data for the different particle-size classes were taken from literature.

The comparison of these three methods allowed us to define their strengths and weaknesses with respect to accurate estimation of SWRCs in sandy soils and to improve the estimation of water fluxes and recharge.