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Isolation of the combined water content and salinity effects on ERT measurement to locate the preferential flow pathways in water repellent soils

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Electrical resistivity tomography (ERT) has been used for measuring the dynamics of water flow in soils without disturbing the soil, and recently for identifying the preferential flow pathways that are reported to develop in water repellent soils. Since electrical resistivity is affected mainly by soil saturation and salinity, and given that in many cases salinity in the root zone reaches high values, the isolation of spatial and temporal distribution of water content or salinity in the root zone from ERT scans is a challenge. A model for transient variation of soil water content and salinity within a well-mixed soil unit was developed in the frame of this challenge. The model aims to isolate the temporal changes in water content from subsequent ERT scans. The model assumes that four stages of water dynamics occur in the root zone during an irrigation cycle: 1) Soil water content decreases by evapotranspiration – no irrigation, 2) Irrigation with saline water begins, water content increases but remains below field capacity – negligible drainage, 3) Irrigation continues and drainage starts as the water content becomes higher than field capacity, and 4) Irrigation stops, water content is higher than field capacity, and water content decreases by drainage and evapotranspiration. These four stages restart when drainage stops and water content decreases solely by evapotranspiration. The model was solved analytically and successfully applied to a series of sequential ERT scans accomplished during and between subsequent irrigation events for a soil that was rendered hydrophobic by olive trees irrigated with saline water, and a soil in a citrus orchard that was rendered hydrophobic by prolonged effluent irrigation. The suggested model helps in distinguishing between the temporal changes in water content and salinity within a given soil volume, locating the preferential plow pathways, and tracking the spatial and temporal salinity variation within the root zone during and between irrigation events.