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Effectiveness of apparent electrical conductivity surveys at varying soil water contents for assessing soil and water dynamics across a rainfed mountain olive orchard in SW Spain.

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Knowledge and understanding of the spatio-temporal variability of soil physical and chemical properties at the field or micro-catchment scale are of prime importance for many agricultural and environmental applications that aim at soil, water and carbon conservation. Geophysical methods, such as electromagnetic induction (EMI), are nowadays a key tool to monitor these properties across relevant scales, as a result of their non-destructive nature and their capability to survey repeatedly large areas within a small time window. Geophysical instrument response depends on the electromagnetic properties of the subsoil and for EMI in particular moist soil conditions are generally considered as most suitable for data acquisition. In water-limited environments, such as those under Mediterranean climate, these conditions are not met during large periods of the year, apparently hampering the usefulness of the method in these regions. The aim of this study is to obtain a better understanding of the sensor response and the contribution of soil properties to the geophysical signals under varying water contents.

An experimental micro-catchment in SW Spain under rainfed olive cultivation was surveyed for apparent electrical conductivity (ECa) on 11 moments in time using a Dualem-21S. In addition, ECa and soil water content (SWC) was measured at 48 locations throughout the catchment on each survey date. At each of these locations, soil profile samples were analyzed for texture, soil organic matter content (SOM), soil depth, gravel content, and bulk density.

Overall, correlations between the different soil properties and ECa improved with increasing SWC, although the ECa patterns remained constant in time. Time-lapse imaging offers the most promising results under the conditions of this study, but still requires at least one survey under wet soil conditions. Despite the smaller correlations between ECa and soil properties under dry conditions, ECa patterns are still relevant for assessing soil and water dynamics at the field or micro-catchment scale.