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Identification of long-term irrigation effect on plant water use from geophysical and proximal sensing observations: example of a vineyard

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This study investigated the influence of long-term irrigation management on plant water use with an emphasis on the development and activity of grapevine root systems in an irrigated vineyard under semi-arid conditions located in the Madrid region (central Spain). The study tested three types of irrigation management, based on the potential evapotranspiration ETp computed with varying crop coefficient Kc (0.2KC, under-irrigated. 0.4KC, control and 0.8KC, over-irrigated). Note that the irrigation water used is considered as highly saline (3890 µS/cm at 20°C).
The interpretation was supported by soil geophysical surveys with electrical resistivity Tomography (ERT), plant physiological traits, and drone-based remote sensing observations. The ERT collected before irrigation showed strong evidence of soil long-term changes, with a gradient of electrical resistivity (ER) increasing with the stress applied, while time lapse ERT before/after the irrigation season showed changes implying deeper root contribution to water uptake in the stressed area. However, uncertainties persisted in interpreting higher ER areas, as it was unclear whether they stemmed from increased soil moisture or were linked to soil salinity caused by soil sodicity.
Insights could be derived from proximal and remote sensing data, revealing patterns consistent with soil responses to the applied irrigation stress. Notably, the higher Normalized Difference Vegetation Index (NDVI), thermal-based actual evapotranspiration rates and stomatal conductance (gs) observed in the over-irrigated area, in contrast to the under-irrigated area, may suggest enhanced plant water accessibility and increased transpiration rates.
The study paves the way towards the adoption of geophysical methods in combination with remote sensing to control irrigation management particularly in the context of saline water.