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Application of Electromagnetic Induction Method and Distributed Process-Based Modeling for Optimized Soil Water Variability Assessment

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Irrigated agriculture plays a crucial role in the food supply in many countries where ecological conditions are characterized by warm and dry summers with high solar radiation and evapotranspiration rates. Evaluating spatio-temporal variability of soil water is critical for the delignating of management zones and optimal irrigation scheduling. However, the soil water content variability is normally obtained using simple water balance models and for representative areas, not taking into consideration the variability of soil properties. This is because for large-scale studies, the traditional sampling method is extremely difficult to implement and it remains critical to finding alternative methods of characterization of soil texture, which is required for soil hydraulic parameters assessment.

Geophysical techniques such as electromagnetic induction (EMI) provide enormous advantages compared to soil sampling because they allow for in-depth and non-invasive analysis, covering large areas in less time and at a lower cost. we carried out EMI surveys in a 23ha almond field, located in Alentejo, Portugal to evaluate the potential use of this methodology in mapping spatial distribution of soil texture in this water-scarce region. We firstly inverted field apparent conductivity data (σ_a) using a Quasi-3D inversion algorithm in order to obtain 3D electromagnetic conductivity images (EMCI) of the real soil electrical conductivity (σ) with depth. Afterward, we evaluated the possibility of establishing a linear regression (LR) relationship between σ and soil texture collected from 13 soil sample locations to a depth of 0.60 m. We concluded that it is possible to establish a relatively good LR between σ and clay and sand, allowing us to convert EMCI to clay and sand content maps and generate these maps for different depts. With this information at hand, pedotransfer functions were applied to define the soil hydraulic parameters necessary to run the distributed model and map the within soil variability at the field scale.

we used the MOHID-Land distributed process-based model to compute the variability of the soil water balance components in this field, at a resolution of 5m. Irrigation data was monitored on-

site, at two locations, while weather data was extracted from a local meteorological station. The distributed modeling approach included the definition of potential evapotranspiration fluxes computed from the product of the reference evapotranspiration obtained according to the FAO56 Penman-Monteith equation and a crop coefficient for each stage of almond's growing season, the variable-saturated flow using the Richards equation, and root zone water stress following a macroscopic approach. Modeling results are then used to present the maps of the variability of the seasonal actual crop transpiration and soil evaporation, the mean soil moisture, seasonal runoff, and seasonal percolation, which are then used to propose management zones for improving irrigation water use in the studied almond field.

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