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Improved understanding of soil hydraulic parameters using Electromagnetic Induction technique and inversion algorithm

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Improved understanding of soil hydraulic parameters and determining the potential for water movement in the root zone are very important in managing scarce water and agricultural land in a sustainable manner. Direct methods are based on drilling and cause major disturbance to the natural conditions. In addition, this procedure is time-consuming, labor intensive, and expensive, given a large number of soil samples that need to be collected.

Recent research has shown that how Electromagnetic induction (EMI) method allow a rapid, noninvasive, and spatially dense data for soil characterization on a large scale. However, the potential of this method has not been fully addressed in the hydrogeophsyical approach.

In our study, we used the Electromagnetic Induction (EMI) method and the inversion algorithm in the monitoring of salt and water infiltration in order to investigate the potential of EMI in root zone hydraulic parameters characterization. In this regard, water and salt infiltration measurements were performed at a parcel scale using an EMI sensor (i.e. CMD mini-Explorer) and Time Domain Reflectometry (TDR) sensors during 11 irrigation events in one day. In this regard, 3 TDR probes were inserted at 3 depths: 20, 40, 60 cm and in the 4 corners of the experimental plot prior to the experiment to monitor water content and bulk electrical conductivity (σb) while EMI data were collected at the middle of the plot in two directions.

The apparent electrical conductivity data (σa) was inverted to estimate σb distribution in time. In addition, an inverse procedure was applied using HYDRUS 1D to estimate the hydraulic properties through data set collected by TDR sensors and tensiometers during the experiment. The σb data inferred from the inversion of σa at depths 20, 40 and 60 were compared to the σb measured by the TDR sensors and those simulated by the HYDRUS. We also investigated the resolution of the inverse model by performing a synthetic test.

The results of our study show a very strong correlation between modeled σa data and TDR measurements as well as the HYDRUS simulations revealing the potential use of EMI data and inversion process for soil hydraulic characterization. The proposed EMI measurements and modeling techniques also allowed for detecting water and salt variations.

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