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Farm scale application of EMI and FDR sensors to measuring and mapping soil water content

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Soil water content (SWC) controls most water exchange processes within and between the soil-plants-atmosphere continuum and can therefore be considered as a practical variable for irrigation farmer choices. A better knowledge of spatial SWC patterns could improve farmer's awareness about critical crop water status conditions and enhance their capacity to characterize their behavior at the field or farm scale.
However, accurate soil moisture measurement across spatial and temporal scales is still a challenging task and, specifically at intermediate spatial (0.1–100 ha) and temporal (minutes to days) scales, a data gap remains that limits our understanding over reliability of the SWC spatial measurements and its practical applicability in irrigation scheduling.
In this work we compare the integrated EM38 (Geonics Ltd. Canada) response, collected at different sensor positions above ground to that obtained by integrating the depth profile of volumetric SWC measured with Diviner 2000 (Sentek) in conjunction with the depth response function of the EM38 when operated in both horizontal and vertical dipole configurations.
On a 1.0-ha Olive grove site in Sicliy (Italy), 200 data points were collected before and after irrigation or precipitation events following a systematic sampling grid with focused measurements around the tree. Inside two different zone of the field, characterized from different soil physical properties, two Diviner 2000 access tube (1.2 m) were installed and used for the EM38 calibration. After calibration, the work aimed to propose the combined use of the FDR and EMI sensors to measuring and mapping root zone soil water content.
We found strong correlations (R2 = 0.66) between Diviner 2000 SWC averaged to a depth of 1.2 m and ECa from an EM38 held in the vertical mode above the soil surface. The site-specific relationship between FDR-based SWC and ECa was linear for the purposes of estimating SWC over the explored range of ECa monitored at field levels.
Volumetric SWC changes in the root zone were observed by differencing the maps, where differences in the observed ECa are primarily the result of changes in soil water status. As with the data showed in the research, more structured patterns occur after wetting event, indicating the presence of subsurface flow or root water uptake paths.
A vision for the future at hydrological watershed scale is to combine EMI measurements with FDR-based sensor networks, the last with the scope to constrain calibration of the EMI measurements.