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Estimating spatial variations in soil water content from electrical conductivity surveys across semiarid Mediterranean agrosystems

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Soil water content (SWC) is an important driver for number of soil, water and energy fluxes at different temporal and spatial scales. The non-invasive electromagnetic induction sensor, such as EM38, that measures the soil apparent electrical conductivity (ECa), has been widely used to infer spatial and temporal patterns of soil properties. The objective of this study has been to explore the opportunity for estimating and mapping the soil water content (SWC) based on in-situ data collected in different fields and during dry and wet soil conditions in a hilly landscape. The experiment was carried out during two campaigns under dry and wet conditions to represent the major soil association, land use and topographic attributes at the cultivated semiarid Mediterranean Lebna catchment, north-eastern Tunisia. The temporal evolution of SWC is a dry-wet-dry pattern. Gravimetric soil water content sampling and ECa measured with EM38 (Geonics Ltd., Ontario, Canada) surveys have been performed simultaneously. ECa measurements, geo-referenced with GPS, were collected raising the EM38 to sample at various depths of the soil. The EM38 was placed in both horizontal and vertical dipole modes on a PVC stand 150 cm above the soil surface. The number of investigated points varied between n=70 in February to n=38 in October 2012. Results showed that different SWC related to the soil spatial variability and lead to differences in ECa averaged values and a substantial changes in the ECa as SWC changed. The relationship between SWC an ECa in a separate vertical and horizontal mode using all possible sets of surveys was tested with linear regression. The correlation coefficient between ECa and SWC for the horizontal mode was lower than the vertical mode. Coefficients of determination of linear regressions between SWC in 0-100 cm soil depth and ECa in the vertical mode were, r^2=0.74, in February 2013, r^2=0.52 in October 2012. The lowest correlations were found in horizontal mode when SWC was close to permanent wilting point. Soil ECa may provide useful information for assessing variation in soil water content across Lebna catchment in the Cap Bon region in Mediterranean conditions and other regions with similar characteristics. The further testing of the procedure with intensive soil sampling by landscape position may improve the ability of the calibration equations to infer SWC and map its spatial variability.