DIGITAL SOIL MAPPING WITH DEPTH USING EM38 AND EM31 SIGNAL DATA AND A 1-D LATERALLY CONSTRAINED INVERSION MODEL

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The ability to map the spatial distribution of average soil properties using geophysical methods at the field level has been well described. This includes the use of electromagnetic (EM) instruments which measure bulk soil electrical conductivity (s_a). However, soil is a three-dimensional medium. In order to better represent the spatial distribution of soil with depth, various methods of inverting EM instrument data have been employed. In this paper we use a 1-D inversion algorithm with 2-D smoothness constraints to predict the true electrical conductivity (s) from s_a data collected with an EM38 and EM31 in the vertical (v) and horizontal (h) dipole modes and at heights of 0.2 and 1.0 m, respectively. In addition, we collected EM38 s_a at heights of 0.4 and 0.6 m. We compare and contrast the value of the various s_a data by conducting individual and joint inversions. We find that the values of s achieved represent the duplex nature of the soil. The EM38 data assists in resolving root zone variability of cation exchange capacity (CEC – cmol(+)/kg of soil solids) and the electrical conductivity of a saturated soil paste extract (EC_e – dS/m), whilst the EM31 assists in characterising the likely location of a shallow perched-water table. In terms of identifying an optimal set of EM s_a data for inversion we found that a joint inversion of the EM38 at a height of 0.6 m and EM31 signal data provided the best correlation with electrical conductivity of a saturated soil paste (EC_p – dS/m) and EC_e (respectively, 0.81 and 0.77) closely followed by a joint inversion of all the EM38 and EM31 s_a data (0.77 and 0.56).