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Assessing soil thickness and depth to groundwater on shallow soils with electromagnetic induction

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Measuring soil apparent electrical conductivity (ECa) with electromagnetic induction (EM) can be a valuable tool for assessing soil spatial variability. However, ECa is integrated over soil depth in varying proportions depending on measuring geometry. While the integration function can be theoretically derived, little experimental evidence is available to prove it. We measured soil electrical conductivity with electromagnetic induction technology (EM38) at high spatial density on a 135 ha site with mostly thin (20-70 cm), fine-grained soils of high conductivity over fluvial gravels and sands with low conductivity over shallow groundwater (in 0-150 cm depth). This provided a physical three-layer model that allowed validating the integration function. Soil cores were taken at 62 locations and depth to groundwater was estimated from the groundwater surface obtained from 33 wells and a detailed (2x2 m) digital elevation model. Linear and non-linear regression models were established to examine the properties of the expected dependence of soil ECa on soil thickness and depth to groundwater. Measured ECa increased with increasing soil depth following the predictions of the integration function but the influence of groundwater was considerably less than predicted. This demonstrates that the integration function is not universal and difficult to predict because it depends on the arrangement of layers.