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Mapping soil salinity and a fresh-water intrusion in three-dimensions using a quasi-3d joint-inversion of DUALEM-421S and EM34 data

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In order to understand the drivers of topsoil salinization, the distribution and movement of salt in accordance with groundwater need mapping. In this study, we described a method to map the distribution of soil salinity, as measured by the electrical conductivity of a saturated soil-paste extract (ECe), and in 3-dimensions around a water storage reservoir in an irrigated field near Bourke, New South Wales, Australia. A quasi-3d electromagnetic conductivity image (EMCI) or model of the true electrical conductivity (sigma) was developed using 133 apparent electrical conductivity (ECa) measurements collected on a 50 m grid and using various coil arrays of DUALEM-421S and EM34 instruments. For the DUALEM-421S we considered ECa in horizontal coplanar (i.e. 1 mPcon, 2 mPcon and 4 mPcon) and vertical coplanar (i.e. 1 mHcon, 2 mHcon and 4 mHcon) arrays. For the EM34, three measurements in the horizontal mode (i.e. EM34-10H, EM34-20H and EM34-40H) were considered. We estimated σ using a quasi-3d joint-inversion algorithm (EM4Soil). The best correlation (R2 = 0.92) between σ and measured soil ECe was identified when a forward modelling (FS), inversion algorithm (S2) and damping factor (lambda = 0.2) were used and using both DUALEM-421 and EM34 data; but not including the 4 m coil arrays of the DUALEM-421S. A linear regression calibration model was used to predict ECe in 3-dimensions beneath the study field. The predicted ECe was consistent with previous studies and revealed the distribution of ECe and helped to infer a freshwater intrusion from a water storage reservoir at depth and as a function of its proximity to near-surface prior stream channels and buried paleochannels. It was concluded that this method can be applied elsewhere to map the soil salinity and water movement and provide guidance for improved land management.|