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Mapping soil CEC using Bayesian modeling and proximal sensors at the field scale

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The soil cation exchange capacity (CEC) is one of the most important soil properties because it has an important bearing on soil fertility, acidity and structural resilience. This is particularly the case in the sugarcane growing areas of far north Queensland, because the soil there is sandy (>60 %), strongly acidic (pH < 5.5) and strongly sodic (ESP > 15 %). Unfortunately, obtaining information on CEC at the field level is time consuming and expensive. In this research, we use a digital soil mapping (DSM) approach to value add to limited topsoil (0-0.30 m) and subsoil (0.6-0.9 m) CEC information. We do this by first collecting proximally sensed ancillary data from three sources, including; a digital elevation model, gamma-ray spectrometer (RS700) and electromagnetic induction instrument (DUALEM-421). To understand the uncertainty in the DSM, we evaluate the performance of a Bayesian inference approach called Integrated Nested Laplace Approximation with Stochastic Partial Differential Equation (INLA-SPDE) for predicting skewed topsoil and subsoil CEC. We also compare the accuracy (RMSE), bias (ME) and concordance (Lin's) of DSM that can be generated from the different sources of ancillary data, either in combination or alone. We conclude, overall, that the INLA-SPDE approach could provide estimations of the posterior marginal distributions of the model parameters as well as the model responses. We also conclude that using various ancillary data sources in combination was most accurate to predict CEC, least biased and had the highest concordance in both the topsoil and subsoil than using the ancillary data alone. The best set of ancillary data, when used alone, and for DSM mapping of CEC in the topsoil was gamma-ray, followed by DUALEM-421 and elevation. For subsoil CEC, it was elevation, followed by [U+F067]-ray and then DUALEM-421.