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# An error budget for digital soil mapping using proximally sensed EM induction and remotely sensed gamma-ray spectrometer data

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The cation exchange capacity (CEC) of soil is widely used for agricultural assessment because it is a measure of fertility and an indicator of structural stability. However, measurement of CEC is time consuming. Whilst geostatistical methods have been used, a large number of samples must be collected. Using pedometric methods and specifically coupling easy-to-measure ancillary data with CEC have improved efficiency in spatial prediction. The evaluation of mapping uncertainty has not been considered, however. In this study, we use an error budget procedure to quantify the relative contributions that model, input and covariate error make to prediction error of a digital map of CEC using gamma-ray spectrometry and apparent electrical conductivity (ECa) data. The error budget uses empirical best linear unbiased prediction (E-BLUP) and conditional simulation to produce numerous realizations of the data and their underlying errors. Linear mixed models (LMM) estimated by residual maximum likelihood (REML) is used to create the prediction models. Results show that the combined error of model (5.07 cmol(+)/kg) and input error (12.88 cmol(+)/kg) is approximately 12.93 cmol(+)/kg, which is twice as large as the standard deviation of CEC (6.8 cmol(+)/kg). The individual covariate errors caused by the gamma-ray (9.64 cmol(+)/kg) and EM error (8.55 cmol(+)/kg) are also large. To overcome the former, pre-processing techniques to improve the quality of the gamma-ray data could be considered. In terms of the EM error, this could be reduced by the use of a smaller sampling interval and in particular near the edges of the study area and also at Pedoderm boundaries.