Mapping soil particle-size fractions using additive-log ratio transformation and proximally sensed ancillary data

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Together the three particle size fractions (PSFs) of clay, silt, and sand are the most fundamental soil properties because of their relative abundance influences the physical, chemical and biological activities in soil. Therefore, there is an increasing need for high-resolution information on spatial distribution of soil texture. Unfortunately, determining PSFs requires a laboratory method which is time-consuming. One way to add value is to use digital soil mapping. Specifically, using mathematical models, such as multiple linear regression (MLR), to couple ancillary data to PSF data. However, this approach does not account for the special requirements of compositional data. Here we demonstrated how ancillary data can be coupled via MLR modelling to an additive log-ratio transformation (ALR) of the PSF to meet these requirements. We compared these two approaches (MLR vs. ALR-MLR). We also compared the use of different ancillary data including proximally sensed gamma-ray spectrometry (i.e. RS700), electromagnetic induction (i.e. DUALEM-421S) and elevation data. In addition, we tested how prediction might be improved by using ancillary data measured on transects (which simulated measurements made on 6.5 m transects) as compared to interpolation from transects spaced 13 m and 26 m apart. Although the ALR-MLR approach did not produce significantly better results, it generated predicted soil PSFs which summed to 100. We found that for predicting PSFs at various depths, all ancillary data was useful with elevation and gamma-ray slightly better for topsoil and elevation and EM data better for subsoil prediction. In addition, a reduced transect spacing (26 m) and sampling size (9–16) can be adopted for mapping soil PSFs and soil texture across the study field.