Development of reflectance spectral libraries for characterization of soil properties

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Abstract

Methods for rapid estimation of soil performance are needed for quantitative assessments of land management problems. We developed a scheme for the use of soil spectral libraries for rapid non-destructive estimation of soil properties based on the use of diffuse reflectance (0.35–2.5 µm) spectroscopy (DRS). A diverse library of over 1000 archived topsoils from eastern and southern Africa was used to test the approach. Air-dried soil fines were scanned using a portable spectrometer with an artificial light source.

Soil properties were calibrated to soil reflectance using multivariate adaptive regression splines, and screening tests were developed for various soil fertility constraints using classification trees. A random sample of one-third of the soils was withheld for validation purposes. Validation r^2 values were: exchangeable Ca, 0.88; effective cation-exchange capacity, 0.88; exchangeable Mg, 0.81; organic carbon concentration, 0.80; clay content, 0.80; sand content, 0.76; and soil pH, 0.70. Diagnostic tests for various soil fertility constraints gave positive likelihood ratios for the validation data ranging from 2.7 to 11.4. Calibrations based on a limited number of samples selected from the spectral library provided sufficient predictive accuracy for large-area applications and farm advisory services. We demonstrate how the predictive value of spectral libraries can be iteratively increased through detection of spectral outliers among new samples. The spectral library approach opens up new possibilities for modelling, assessment and management of risk in soil assessments in agricultural, environmental and engineering applications, and provides a coherent framework for linking soil information with multi- and hyperspectral remote-sensing imagery.

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