Geophysical Research Abstracts
Vol. 19, EGU2017-18185, 2017
EGU General Assembly 2017

Prediction of Ba, Mn and Zn for tropical soils using iron oxides and magnetic susceptibility

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Agricultural activity is an important source of potentially toxic elements (PTEs) in soil worldwide but particularly in heavily farmed areas. Spatial distribution characterization of PTE contents in farming areas is crucial to assess further environmental impacts caused by soil contamination. Designing prediction models become quite useful to characterize the spatial variability of continuous variables, as it allows prediction of soil attributes that might be difficult to attain in a large number of samples through conventional methods. This study aimed to evaluate, in three geomorphic surfaces of Oxisols, the capacity for predicting PTEs (Ba, Mn, Zn) and their spatial variability using iron oxides and magnetic susceptibility (MS). Soil samples were collected from three geomorphic surfaces and analyzed for chemical, physical, mineralogical properties, as well as magnetic susceptibility (MS). PTE prediction models were calibrated by multiple linear regression (MLR). MLR calibration accuracy was evaluated using the coefficient of determination (R2). PTE spatial distribution maps were built using the values calculated by the calibrated models that reached the best accuracy by means of geostatistics. The high correlations between the attributes clay, MS, hematite (Hm), iron oxides extracted by sodium dithionite–citrate–bicarbonate (Fed), and iron oxides extracted using acid ammonium oxalate (Feo) with the elements Ba, Mn, and Zn enabled them to be selected as predictors for PTEs. Stepwise multiple linear regression showed that MS and Fed were the best PTE predictors individually, as they promoted no significant increase in R2 when two or more attributes were considered together. The MS-calibrated models for Ba, Mn, and Zn prediction exhibited R2 values of 0.88, 0.66, and 0.55, respectively. These are promising results since MS is a fast, cheap, and non-destructive tool, allowing the prediction of a large number of samples, which in turn enables detailed mapping of large areas. MS predicted values enabled the characterization and the understanding of spatial variability of the studied PTEs.