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"Development on the margin"

# Quantification of the Variability and Pattern in Total Element Composition of sub-Saharan African Soils

Erick Kibet Towett[1], Keith Shepherd[2], Georg Cadisch[1]

[1] *University of Hohenheim, Dept. of Plant Production and Agroecology in the Tropics and Subtropics, Germany*

[2] *World Agroforestry Centre (ICRAF), Research, Kenya*

**Abstract**

Measuring total element concentration of soils using conventional methods is time-consuming. Total X-ray Fluorescence Spectroscopy (TXRF) provides for rapid and simultaneous determination of the concentrations of most elements from sodium to Uranium with minimal sample preparation time. The technique opens up the possibilities for using total element profiling to improve global predictions of soil functional properties, such as soil organic carbon, cation exchange capacity, extractable nutrients, P sorption, water holding capacity, and soil stability. In this paper we present our investigations of the quantification of the variability and patterns in total element composition of soils from eight 100-km$^2$ sites across sub-Saharan Africa: Tanzania (3 sites), Congo (2 sites), Mali (2 sites), Burkina Faso (1 site). Paired topsoil and subsoil samples taken from 32 randomised sample points at each site were analysed. We explored the within and between site patterns of variation in total element composition and their relationships with directly measured soil functional properties and TXRF soil spectral properties using scatter plots, principal component analysis, and classification and regression trees in R statistical software. The results indicate that TXRF provides chemical fingerprinting that relates to potential soil nutrient supply capacity. There were also relative variations in total element composition within and between the sites analysed. Thus TXRF can be used as a complementary input to pedotransfer functions for low cost, rapid prediction of soil functional properties. TXRF could also provide improved capabilities, for improving advisory services on soil constraints to plant growth with subsequent benefit to food security and human health.

**Keywords:** Soil functional properties, total element composition, TXRF

**Contact Address:** Erick Kibet Towett, University of Hohenheim, Dept. of Plant Production and Agroecology in the Tropics and Subtropics, Garbenstr. 13, 70599 Stuttgart, Germany, e-mail: e.towett@uni-hohenheim.de