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Charactering Spatial Variability of Soil Properties Measured on a Transect by Multifractal Analysis

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Spatial variability of soils in landscapes has been studied in different ways, for example in terms of soil survey reliability, soil development and erosive processes. Due to the advent of site-specific management in the 1990s, there is now an increasing interest in measuring the amount of soil variability within a field. Methods for assessing spatial variability also include use of transect techniques to sample soil sequences. On the other hand, over the past few decades fractal and multifractal models have been applied in the evaluation of the spatial variability of soil attributes. Therefore, the aim of this study was to characterize the spatial variability of general soil properties and extractable nutrients measured along a transect by means of multifractal analysis. The field work was conducted at the experimental farm of CIAM located in Mabegondo, A Coruña, Spain on a gently slope. The soil was loamy textured. Soil samples were taken at 66 points located 0.8 m apart along a transect of 52 m. Samples were analyzed for pH, organic matter content (OM), exchangeable K, Mg and Ca, exchangeable H+Al, and DTPA extractable Fe, Mn, Cu and Zn. In addition, sum of bases (SB), cation exchange capacity (CEC) and percent base saturation (V) were calculated from exchangeable cations. For all the studied statistical moments the logarithm of the normalized measures varied linearly ($r^2 > 0.87$) with the logarithm of the measurement scale, meaning that the distribution of the measure could be considered as a fractal. The scaling properties of the soil properties studied were further characterized to determine if the scaling types was monofractal or multifractal. To this effect selected indices were calculated from the generalized dimension function, D_q. So for a distribution with a monofractal tendency values of the correlation dimension D_2 and the entropy dimension, D_1, become similar to the capacity dimension, D_0, however $D_0 > D_1 > D_2$ if the distribution has a tendency to multifractal behaviour. For pH, H+Al, CEC and DTPA extractable Fe, $D_0 \approx D_1 \approx D_2 \approx 1.00$ (value which corresponds to a one-dimensional spatial series), meaning a monofractal scaling type. However, for OM, exchangeable K, Mg and Ca, percent base saturation (V) and DTPA extractable Mn, Cu and Zn, $D_0 > D_1 > D_2$, which implies a multifractal nature where low and high density regions of the variable scale differently.

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