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Multiscale analysis of depth-dependent soil penetration resistance in a tropical soil

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Soil penetration resistance (PR) is widely used because it is linked to basic soil properties; it is correlated to root growth and plant production and is also used as a practical tool for assessing soil compaction and to evaluate the effects of soil management. This study investigates how results from multifractal analysis can quantify key elements of depth-dependent PR profiles and how this information can be used at the field scale. We analyzed multifractality of 50 PR vertical profiles, measured from 0 to 40 cm depth and randomly located on a 6.5 ha sugar cane field in north-eastern Brazil. According to the Soil Taxonomy, the studied soil was classified as an Orthic Podsol The scaling property of each profile was typified by singularity and Rényi spectra estimated by the method of moments. The Hurst exponent was used to parameterize the autocorrelation of the vertical PR data sets. Singularity and Rènyi spectra showed the vertical PR data sets exhibited a well-defined multifractal structure. Hurst exponent values were close to one indicating strong persistence in PR variation with soil depth. Also Hurst exponent was negatively and significantly correlated to coefficient of variation (CV) and skewness of the depth-dependent PR. Multifractal analysis added valuable information to describe the spatial arrangement of depth-dependent penetrometer data sets, which was not taken into account by classical statistical indices. Multifractal parameters were mapped over the experimental field and compared with mean, maximum and minimum values of PR; these maps showed the multifractal approach also may complete information provided by descriptive statistics at the field scale.