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Changes in multifractal parameters from profiles of soil penetration resistance obtained with increasing soil dryness

Marcelo Germán Wilson (1), Marcos Lado Liñares (2), and Antonio Paz González (2)

(1) Estación Experimental Agropecuaria INTA Paraná, RN 11 km 12.5, Oro Verde, 3100, Paraná, Entre Ríos, Argentina, (2) Facultad de Ciencias, Campus A Zapateira, 15008, A Coruña, Spain

Soil penetration resistance (PR) is linked to basic soil physical properties and correlated to root growth and plant production, so that it has been extensively used as a practical tool for assessing soil compaction and to evaluate the effects of soil management on soil physical quality. We analyzed multifractality of PR vertical profiles, measured from 0 to 80 cm depth at 1 cm intervals. Soil PR was recorded at 10 successive dates with decreasing soil water content in Entre Ríos Province, Argentina, and 10 replicate PR profiles were obtained in each date. The scaling property of each depth-dependent PR profile was typified by the singularity spectrum, αs versus f(α)s and the generalized dimension spectrum, estimated by the method of moments. Both, singularity and Rènyi spectra showed the vertical PR data sets exhibited a well-defined multifractal structure. The multifractality (scaling heterogeneity) in our data series decreased as the mean soil water content decreased. Overall, singularity spectra were asymmetrical and shifted to the right, which is compatible with a greater heterogeneity of the low values in the PR data sets studied. The entropy dimension, D_1, increased with decreasing soil water content, and mean values ranged from 0.956 to 0.981; this means that the wetter the soil the more homogeneously is distributed the measure over a large range of scales. Multifractal analysis yielded information about changes with scale of the higher moments, which gives a deep insight into the inner structure of soil PR depth-dependent profiles.