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Scaling Analysis of the Water Retention Curves in Unsaturated Soil. Case Study of Turbolo Experimental Basin

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The present study deals with the water retention curves analysis by the fractal geometry approach. Therefore three models, derived from the general Pore-Solid Fractal (PSF) relation, suited to model soil structure when the "solid" or the "pore" phase are considered. The models of Tyler and Wheatcraft (1990) (TW), Rieu and Sposito (1991) (RS) and Bird et al. (2000) (BP), representing the generalized PSF model through appropriate changes, were analysed. The estimate of the fractal dimension, parameter representative of each examined model, was carried out by two different numerical procedures: first by a non linear analysis of the experimental data fitting curve, and second by the direct scaling of the aforesaid models. The data, 30 undisturbed soil samples, came from an experimental area on the Turbolo basin (Calabria – Italy) presenting a sandy-loam soil texture. Soil samples were drawn and afterwards analysed in laboratory.

The experimental water retention curves were represented by means of graphs for each of the considered locations; afterwards the analysis of the interpolation relationships was carried out by a best fitting numerical procedure, that allowed evaluate either the fractal dimension or the saturated water content. From this analysis the functional relationships were deduced between the saturated water content and the pressure head and between the fractal dimension and the pressure head respectively. Regarding the

use of the scaling relations, the fractal dimension was computed as the slope of the linear fitting between the lower and upper cut-off limits, for which the determination coefficient is maximum.

The fractal dimension values obtained by the non linear procedure of RS and TW models presents a difference of 3%, not negligible for the rather reduced dimensions of the considered samples. The breaking of the symmetry due to the scale invariance of the water retention curves for pressure head values less than the mean value of 2,7 cm (0,27 kPa) and higher than the mean value of 541,4 cm (54,14 kPa), attesting how representative is the fractal dimension between the above pointed out boundaries.

In this case, the spatial invariance of the fractal dimension, computed through the direct scaling procedure of the water retention curves should foreshadow a mono-fractal behaviour of the soil structure, that reveals the isotropic nature of the media studied. Nevertheless, further research is needed on a larger scale or higher resolution to study a more general behaviour such as multiscaling one, that is able to represent, besides the local indexes (or exponents) of each punctual measurement of the water content, also the pore distribution in the field scale. This potential behaviour is very complex and representative of the relationships between micro and macro-porosity; being matter of study and of physical and geometrical interpretation of the pore distribution inside the soil solid matrix.