Sensivity analysis of geometrical and topological parameters to the thresholding soil images

A.M. Tarquis (1,2), M.E. Sanchez (2), J.M. Antón (2), J. Jimenez (3), A. Saa-Requejo (1), D. Andina (3), and J.W. Crawford (4)

(1) CEIGRAM, ETSIA, Universidad Politecnica de Madrid, Madrid, Spain (anamaria.tarquis@upm.es), (2) Dpto. de Matemática Aplicada a la Ingeniería Agronómica. E.T.S. Ing. Agrónomos, U.P.M.. Ciudad Universitaria, s.n. 28040 Madrid. SPAIN, (3) E.T.S. Ing. de Telecomunicación, U.P.M. Ciudad Universitaria s.n. MADRID 28040. SPAIN, (4) Judith and David Coffey Chair in Sustainable Agriculture, Faculty of Agriculture, Food and Natural Resources, University of Sydney, NSW 2006. AUSTRALIA

The sensitivity of mass fractal dimension (D_m), a spectral dimension (d), and the ratio of the two, ($\frac{d}{D_m}$), that relates to the scaling property of dynamical processes in soil such as diffusion, to different threshold criteria was estimated. In order to do so, intact soil samples were collected from four horizons of a Brazilian soil and 3D images, of 45.1 mm resolution (256x256x256 voxels), were obtained. Four different threshold criteria were used to transform CT grey-scale imagery in binary imagery (pore/solid), based on the frequency of CT units.

To compare the effect of threshold and soil horizons on the two parameters studied and its ratio, an analysis of variance was performed in a split-plot design. In this study each image is the "main plot unit" where we have performance four determinations of the parameters. Therefore, it was considered the three locations as blocks, each horizon as main plot effect and each threshold as subplot effect. GenStat® version 12.1 was used to performance these analysis. The significance level of all the statistical analysis was at 5%.

Fractal-like scaling was observed overall length scales, however the effect of thresholding on the estimate for D_m depended on the range of length scales used. The log-log plots, from which D_m is estimated, show that thresholding influenced mainly the scaling at the smallest length scales (of size length from 1 to 16 voxels). This demonstrates that different thresholding schemes mainly influence the features close to the resolution limit of the image.

D_m and d showed a relation with the apparent porosity (i.e. the value calculated for different threshold criteria) in the image for the 12 samples studied. Plotting the apparent soil porosity against D_m or d we found that both increased with respect to porosity, being logarithmic for D_m and linear for d. The ratio ($\frac{d}{D_m}$) can characterize each of the horizons considered in this study when the mass dimension was estimated not using only the smallest length scales, which is highly sensitive to the threshold criteria.

REFERENCES

[1] Tarquis, A.M., R.J. Heck, J.B. Grau, J. Fabregat, M.E. Sanchez and J.M. Antón. 2008. Influence of Thresholding in Mass and Entropy Dimension of 3-D Soil Images. Nonlin. Proc. Geophys., 15, 881–891.

[2] M.E. Sanchez, A.M. Tarquis, J. Fabregat, D. Andina, J. Jimenez, and J.W. Crawford. Variation in spectral and mass dimension on 3D soil image processing. Geophysical Research Abstracts, 11, EGU2009-2260, 2009.

[3] A.M. Tarquis, M.E. Sanchez; J.M. Antón; Juan Jimenez; A. Saa-Requejo; D. Andina and J.W. Crawford. Variation in spectral and mass dimension on 3D soil image processing. Soil Science, 177(2), 10 pp, (in press) 2012.

ACKNOWLEDGEMENTS