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Scaling properties of soil images

Ivan G Torre, J J Martín Sotoca, J C Losada, J B Grau, A Saa Requejo and **A M Tarquis**
Technical University of Madrid, Spain

Fractal geometry has been increasingly applied to quantify soil structure using fractal parameters due to the complexity of the soil structure and thanks to the advances in computer technology. Mass dimension fractal analysis can be implemented in a binary image, which in general is displaying two phases: pore and solid. However, it has been shown that there is variability in the local porosity, which could be better studied using multifractal analysis (MFA). This type of study has been increasingly applied to quantify soil structure and is becomingly popular. We have applied two different techniques of MFA: box counting (BC) and gliding box (GB). The first one BC combines pixels to form larger, mutually exclusive boxes each containing a different set of pixels, while GB constructs samples by gliding a box of a certain size over the grid map in all possible directions. We show that there are some advantages and handicaps in both methods. From a CT-scan 3D image of a soil aggregate sample, three slices from each main direction have been selected. Then, for each slide we have computed using GB and BC, the mass function, the generalized dimension and the multifractal spectrum. All images analyzed presented a multiscaling character pointing out that the lower grey values are mainly influencing the scaling behaviour. The multiscaling nature of these images suggests using these algorithms as a basis to create synthetic images for testing thresholding algorithms.

Recent Publications

1. Torre I G, Losada J C, Heck R J and Tarquis A M (2017) Multifractal analysis of 3D images of tillage soil. Geoderma 311:167-174.

2. Martín-Sotoca J J, Saa-Requejo A, Grau J B and Tarquis A M (2017) New segmentation method based on fractal properties using singularity maps. Geoderma 287:40-53.

3. Torre I G, Losada J C and Tarquis A M (2016) Multiscaling properties of soil images. Biosystems Engineering DOI: 10.1016/j.biosystemseng.2016.11.006.

4. Martín-Sotoca J J, Saa-Requejo A, Grau J B and Tarquis A M (2016) Local 3D segmentation of soil pore space based on fractal properties using singularity maps. Geoderma 311:175-188.
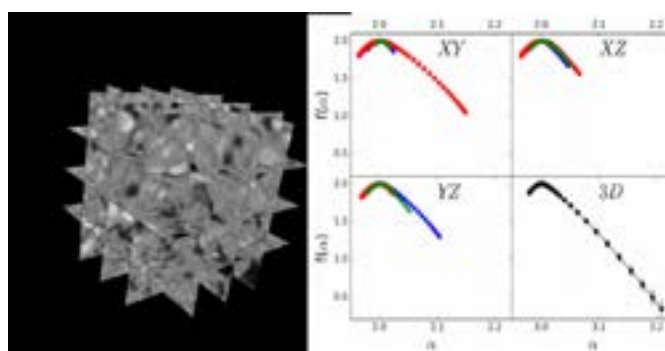

Figure 1: On the left: visualization of some slices from the three main directions of the soil sample used in the study. On the right: Multifractal spectra of all the 2D slices (both above and lower left), and the 3D sample (lower right). Blue circles, red boxes and green triangles corresponds to different slices in each direction.

Biography

Ivan G Torre is pursuing his third year of PhD in Physics of Complex Systems at Technical University of Madrid (UPM). He has a Predoctoral fellow with the Department of Applied Mathematics of UPM, Spain. He has been studying the structure of soil porosity in collaboration with the Group of Complex Systems of UPM and with the Research Center for the Management of Agricultural and Environmental Risks.

ivan.gonzalez.torre@upm.es

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Page 30