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Suitability of multifractal parameters to describe the effect of intensification of rice production on soil structure decay

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Vertisols and soils with vertisolic properties are important for rice production on the province of Entre Ríos (Argentina). These soils are characterized by a high structural stability under natural vegetation. However, Vertisols and related soils in Entre Rios have been demonstrated to be highly sensitive to structure degradation under continuous cultivation, as shown by losses of soil organic matter .and structure stability decay. Crop rotations with irrigated lowland rice is a common practice in these soils. A magnification of degradation symptoms of these soils has been observed when irrigated using sodic bicarbonate groundwater for rice cultivation, which increases exchangeable sodium. In a previous work we showed increasing proportion of rice in the rotation under irrigation caused decline of organic matter, total porosity, structural stability and infiltration, whereas exchangeable sodium increased. Pore size distribution as measured by mercury intrusion porosimetry has also been demonstrated to be altered due to the effects of lowland rice cultivation. The purpose of this study was to asses the effect of increasing rice proportion in the rotation on multifractal parameters obtained from pore size distribution as measured by mercury intrusion porosimetry. Soil samples were collected at the 0-12 cm depth from fields with increasing rates of rice in the rotation, i.e. 40%, 60%, 80% and 100%. For the sake of comparison with these treatments, samples under natural vegetation and never-irrigated cultivated land were taken and used as a control. Pore-size distributions (PSDs) were determined in the equivalent cylindrical diameter range 150-0.005 μm. Pores larger than 10 μm as the intensification of rice production increased. Porosity was positively correlated with organic matter content and decreased with increasing exchangeable sodium. Multifractal analysis was performed by the moment based box-count technique in three different pore size ranges, i.e. 100-0.005 μm, 150-10 μm and 10-0.005 μm. The scaling properties of all the complete Hg injection curves as well as those of the 150-10 μm and 10-0.005 μm segments could be fitted reasonably well with multifractal models. In irrigated Vertisols, the entropy dimension, D_1, of the pore size distributions showed a trend to decrease as the proportion of rice in the rotation increased. This result is compatible with a decay in the evenness of the mercury intrusion PSDs due to intensifying rice production and therefore increased use of the Vertisol as a paddy soil. Moreover, width of the singularity spectra varied with soil use treatment increasing with increasing rate of rice in the rotation. We conclude that the multifractal approach provided considerable detailed information on PSDs that was useful for describing soil structure changes under rice cultivation.