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# Quantifying soil complexity using Fisher Information of 3d X-ray CT scan images

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Degradation of soils due to land use change driven by economic factors represents a major concern in many parts of the world. Important questions regarding soil degradation demand further efforts to better understand the effect of land use change on soil functions. With the advent of 3d Computer Tomography techniques and computing power, new methods are becoming available to address these questions. In this work, we investigate how land use change affects soil structure by using information theory to quantify the complexity of soil 3d X-ray CT soil samples in northeastern Brazil. We implement the Fisher-Shannon method, borrowed from information theory, to quantify the complexity of 14 3d CT soil samples from native Atlantic forest sites, and15 samples from nearby sites converted to sugarcane plantation. The distinction found between the samples from the Atlantic forest and the sugarcane plantation is found to be quite pronounced. The discrimination results at the level of 89.6% accuracy were obtained in terms of Fisher information measure (FIM) alone, and 93% level accuracy was attained considering the complexity in the Fisher Shannon plane (FSP). Atlantic forest samples are found to be generally more complex than those from the sugar plantation. The approach introduced in the current work does not use arbitrary parameters, and it provides a rather precise quantitative FSP complexity measure, that may be seen as a quantifier of soil degradation level.