Inferring pore size distribution of soil aggregates using synchrotron X-ray computed microtomography

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Abstract:

Soil aggregates play an important role in many soil processes, including water flow and solute transport, nutrient and organic matter storage, and microbial activity. Synchrotron X-ray computed microtomography (CMT) is a great tool that enables quantitative analysis of internal structure in aggregates from different soil types. One of the main interests is on pore size distribution (PSD) information that is hard to measure in the lab but extremely useful in understanding soil aggregate physical properties. However, effective use of soil aggregate CMT images depends on successful resolving a number of image and data processing issues. These include handling imaging technique artifacts; selecting appropriate threshold methods to convert grey scale images into black/white binary format necessary for pore structure characterization; proper identification of the aggregate boundaries, such that would ensure minimal distortion in describing pore structure of the external aggregate layers. In this study, we addressed several aspects of optimal use of the 3D soil aggregate CMT image information, including (i) proposing a simulation approach for soil pore/solid classification and assessing segmentation criteria in selecting best segmentation method; (ii) using imaging processing technique, i.e. flood fill algorithm, image closing and image filling, to define aggregates boundaries; (iii) utilizing 3DMA-Rock software for image segmentation and PSD characterization. The techniques were applied and tested using aggregates with a variety of pore parameter values originated from soils with contrasting long-term differences in land use and management.