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3D imaged soil pore morphology and SPH simulated water flow

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The morphological and topological characteristics of the soil pore network determine the capabilities of the network to transport water, agrochemicals and contaminants. The objective of this study was to evaluate the relation between the pore network shape (morphological and topological) properties and the macropore water flow obtained through numerical simulation. X-ray microtomography was used to obtain the cross-sections images of the soil samples. The images were used to label and segment the 3D pore network structures up to the resolution of the micro-CT scanner. Several Representative Elementary Volumes (REVs) were calculated using the porosity as a threshold. Selected soil morphological and topological properties were extracted from the 3D structure in each REV. The relationship between these pore properties of one REV and the numerical-simulated water flow throughout the pores was by the mean of a correlation matrix. In this study, the volumetric flow was simulated with the Smooth Particle Hydrodynamics (SPH) method.
Low connectivity inside the REVs was found at the CT resolution. The descriptors most correlated with the flow were pore extend, variability of the cross-section areas, perimeter, and integration of the distance field. For pores with a tubular form, the skeleton form and tortuosity (angle change between skeleton segments) were the descriptors most correlated. However, the values of these descriptors vary considerably from one REV to the other. Porosity as threshold to calculate the size of the REV might not be the best parameter when studying the flow behavior.