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2D and 3D micromorphological analyses for improving soil hydrological characterization

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The discrepancy between observed processes and those predicted by models assuming homogeneous unimodal porous media may result from the limitation of accurately characterizing the effects of pore-scale heterogeneities in determining a non-ideality of transport in soils. To be effectively and reliably applied all the approaches require that the predominant effects of the soil hydrological behaviour near saturation be supported by accurate and detailed experimental descriptions of BTCs, retention curve and hydraulic conductivity for high water content values, which would allow less uncertain identification of the processes and related parameters involved. This is especially true if one consider that most analytical and numerical approaches for the unsaturated hydraulic conductivity lye on the knowledge of the pore-size distribution (PSD). In such approaches, estimating the tortuosity factor and the existence of different porous domains still remain a critical point.

In this study pore-size geometry of porous media were estimated by coupling direct micromorphological measurements and equivalent pore-size distribution deduced from the water retention curves. Specifically, high resolution X ray microtomography (SKYSCAN 1072) and mechanical serial sectioning based tomography (developed at CNR-ISAFOM) were used for direct measurements while Wind's method, tension table method, infiltrometry were used for deducing water retention, hydraulic conduc-

tivity and sorptivity.

The analysis of the following selected case studies were performed :

- pore size distribution obtained from 2D image analysis measurements vs unsaturated hydraulic conductivity curve $k(h)$ obtained by tension infiltrometer in a Vertisol;
- 3D mechanical tomography (serial sectioning) and X-ray Micro CT vs soil water retention curve and unsaturated hydraulic conductivity in a sandy Luvisol, in an Inceptisol and in a calcarenite;
- 2D pore size distribution analysis vs sorptivity in soil crusts formed after irrigation on a Vertisol;

These examples showed the power of using a 2D and 3D micromorphological characterization for an insight improving of the standard methodologies of both water retention and hydraulic conductivity measurements. The study also enabled to assess the reliability of the equivalent pore-size distribution for representing the actual geometry of the pore-system, the real existence of separate fast and slow flow domains and their effects on the predictions of unsaturated hydraulic conductivity.