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Analysing pore structure dynamic at clod scales: implications for flow and transport

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Based on capillary theory and rigid pore flow equations, the assessment and modelling of flow and transport in soils face severe difficulties since decades. These difficulties can be related to some of the assumptions commonly required by the physical background used. In particular, the assumptions of rigidity and homogeneity were not verified in most soils. Attempts to overcome these limitations were developed along with their evidence, e.g. to take into account soil swelling in flow models, to characterize preferential flow, or to correlate the soil physical parameters to soil constituents and their associated properties to better account for spatial variability.
The fundamental splitting of the soil porosity into structural and plasma pores makes a consensus in many fields of soil science. This was seldom considered, however, as a basis for soil physical behaviour modelling, so far. Nevertheless, the mathematical bases for this are deciphered in recent works. Today, the quantification and modelling of these pore systems and their dynamics according to water content, soil constituents, soil biology and chemistry, or external stress, has greatly improved. These factors show different time and space scale dynamics, which are therefore, extremely important to assess separately. The dynamic of the two pore systems appears to be large according to the different factors and time scales. Contrarily to structural pores, the plasma pores do not allow air entry in most of their water content range, which is of consequence for capillary theory and its applications. The soil shrinkage behaviour appears to be closely related to the content in colloidal constituents, though the relation is different according to the two pore system, which is of consequence to account for spatial variability. The mechanical response to stresses is different for the two pore systems as well. The role of soil organic matter variability and changes is strongly highlighted by these researches, which opens perspectives to key present issues. This communication reviews the related knowledge and opened questions, and points out to the potential consequences and opportunities for dynamic flow and transport modelling.