A Structural Classification System of the Soil Pore Space

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The concept of soil structure does not yet have a consolidated means of quantification, but it plays an important role because of its significance in the understanding and representation of flow and transfer phenomena in soils. An useful way of quantifying soil structure is to consider pore-size distribution (PSD) equal to effective air saturation calculated as an increasing function of soil water suction. Based on similarities between the particle-size distribution and the PSD curves, a structural classification system of soil pore space is developed, which is comparable to the textural classification. Three pore-size fractions are arbitrarily defined in the effective porous space, as: effective macroporous space (0-60cm suction); effective mesoporous space (60-15,000cm suction); and effective microporous space (suctions larger than 15,000cm). For the sake of classification, the effective porous space is subdivided into three fractions: 0-1/3, 1/3-2/3, and 2/3-1. The three pore-size fractions sum up to 1, allowing a soil sample to be represented in an equilateral triangle, we called soil structural triangle. The resulting nine subareas in the triangle (three pore-size fractions x three porous space fractions) represent the nine orders (from A to I) of the classification system, namely: A - highly macroporous; C - highly mesoporous; I - highly microporous; D - macroporous; E - mesoporous; H - microporous; B - macro-mesoporous; G - meso-microporous; and F - macro-microporous. This system aims to group soils with similar air availability (AA) curves (air content vs. suction). So, the van-Genuchten model for water retention is assumed and effective porosity is determined in a standardized manner. Four suborders (from 1 to 4) are then further used to represent effective porosity ranges, respectively: 0-0.20; 0.20-0.40; 0.40-0.60; and >0.60$cm^3.cm^{-3}$. The resulting 36 soil classes assemble samples with similar AA curves. They are called soil structural families. A large international database with more than 3000 soil samples from Europe and Brazil was used to evaluate the proposed system. It is confirmed that the families grouped soils with similar AA curves and only three structural families were not represented in the database. The results also show that soils with different textures and pedogenesis can behave similarly in terms of pore-size distribution: a typical case was clayed tropical soils joining the sandy European soils in the macroporous orders A and D. More frequently, sandy soils were in the macroporous orders, silty soils in the mesoporous, and clayey soils in the microporous orders. The proposed system can contribute to the enhanced understanding and modeling of soil structural behavior, including a better formulation of pedotransfer functions.

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