AGU FALL MEETING
San Francisco | 14 – 18 December 2015

H51K-1535: Analytical Deriving of the Field Capacity through Soil Bundle Model

Friday, 18 December 2015
08:00 - 12:20
Moscone_South - Poster Hall

The concept of field capacity as soil hydraulic parameter is widely used in many hydrological applications. Althought its recurring usage, its definition is not univocal. Traditionally, field capacity has been related to the amount of water that remains in the soil after the excess water has drained away and the water downward movement experiences a significant decresase. Quantifying the drainage of excess of water may be vague and several definitions, often subjective, have been proposed. These definitions are based on fixed thresholds either of time, pressure, or flux to which the field capacity condition is associated. The flux-based definition identifies the field capacity as the soil moisture value corresponding to an arbitrary fixed threshold of free drainage flux. Recently, many works have investigated the flux-based definition by varying either the drainage threshold, the geometry setting and mainly the description of the drainage flux. Most of these methods are based on the simulation of the flux through a porous medium by using the Darcy's law or Richard's equation.

Using the above-mentioned flux-based definition, in this work we propose an alternative analytical approach for deriving the field capacity based on a bundle-of-tubes model. The pore space of a porous medium is conceptualized as a bundle of capillary tubes of given length of different radii, derived from a known distribution. The drainage from a single capillary tube is given by the analytical solution of the differential equation describing the water height evolution within the capillary tube. This equation is based on the Poiseuille's law and describes the drainage flux with time as a function of tube radius. The drainage process is then integrated for any portion of soil taking into account the tube radius distribution which in turns depends on the soil type. This methodology allows to analytically derive the dynamics of drainage water flux for any soil type and consequently to define the soil field capacity as the latter reachs a given threshold value. The theoretical model also accounts for the tortuosity which characterizes the water pathways in real soils, but neglects the voids mutual interconnections.

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