



Consistent constraints for tortuosity parameter of Mualem's conductivity function

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Parameters of functions to describe soil hydraulic properties are usually derived from measurements by means of parameter estimation. Of crucial importance here is the choice of correct constraints in the parameter space. In this contribution, we derive constraints for the so-called tortuosity parameter of the Mualem conductivity model. If the tortuosity parameter is regarded as a physical meaningful parameter, its value must always be positive. However, often, the parameter is treated as a mere shape parameter without physical meaning, giving flexibility to the model. Then the value might be positive or negative.

A fundamental requirement is that the conductivity function is monotonic: the function can only decrease as the capillary suction increases. A stricter physical requirement is that its decrease with respect to saturation is at least linear. This linear decrease would occur if all pores of a capillary bundle had an equal radius.

Here we derive constraints for the tortuosity parameter, which allow highest possible flexibility on one hand and guarantee physical consistency on the other hand. In combination with the retention functions of Brooks and Corey, van Genuchten, or Durner, such a constraint for the lower boundary can be expressed as a function of the pore-size distribution parameters.

From a conservative point of view, setting the lower boundary to -1 will lead for any monotonous retention function to physical consistency of Mualem's conductivity function.