Hydraulic Conductivity of a Soil Pedon

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Numerical modeling of water flow and pollutant transport in soils attempts to describe a dynamic equilibrium among the elements of a pedon whose characteristic properties are assumed to be known. Soil water will then move within a pedon in response to pressure gradients which are unique to each element. We propose here a method to define characteristic properties of such elements within a pedon matrix from a limited knowledge of soil profile characteristics. The property chosen for detailed analysis was field saturated hydraulic conductivity (K_{sat}). The method is based on profile description, in situ measurements of K_{sat} with a Guelph permeameter, available soil survey information, and geostatistical probability field *(P-field)* simulation. A 30m long, 10m wide, and 1.5m deep trench was excavated within an area mapped as Leck Kill channery silt loam. The profile was described as a fine-loamy, mixed, mesic Typic Hapludult, and a detailed description was prepared by conventional means. The pedon was also evaluated in a GIS format on a 10x10cm grid. To do so the horizontal face was examined visually as to whether it was firm or soft, wet or dry, composed of rock or soil. The orientation of the coarse fragments in each grid square was then noted, and an overlay of each property was prepared. Combining overlays of soft and wet soil areas with an overlay of all non-horizontal coarse fragment directions gave an overlay of potential water-conducting zones in the pedon. In another approach K_{sat} values both measured and estimated from texture, were assigned to selected pedon elements, staggered in 10cm increments with depth. A 3-D distribution of hydraulic conductivity within a pedon was then conditionally simulated using a geostatistical *P-field* approach. Analysis showed similarities between visually observed flow regions and the conditionally simulated realizations. Ability to generate multiple realizations allowed computation of probability of exceeding a given flow threshold. The method is self-validating. Based on measured values, the goodness of fit can be related to standard concepts of accuracy and precision using a *leave-one-out* cross validation approach. Potential applications are many. Here the method is illustrated by a distribution of K_{sat},, but any other property could have been used. The method is well suited to spatial characterization of most 3-D soil properties based on the field access hole record, so long as the respective locations are properly georeferenced.