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Modelling the heterogeneity of artificial debris layers of urban soils

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Soils in urban areas differ from those in natural locations regarding their composition and properties. One feature is a high fraction of debris with artifical origin, e.g. from rubble. Rubble is a mixture of various building materials and mainly contains brick, mortar, plaster and concrete. Especially bricks have a distinct system of pores, and therefore have a strong influence on the soil moisture regime. A layer of rubble debris is characterised by a strong heterogeneity in the pore structure and by different hydraulic properties.

Former research groups have described this phenomenon for different urban sites by investigating the related effective hydraulic properties. In our investigation we are studying the subject by numerical simulations. This aim is well connected to soil physics, concerning water flow in heterogeneous soil structures.

The base for our study is the examination of hydraulic properties of bricks from debris layers. Water retention and hydraulic conductivity have been measured in lab experiments. The corresponding hydraulic functions are described by the Mualem-van Genuchten function. In general, the hydraulic behaviour is to be characterised by (i) a high pore volume, (ii) a high number of uniform meso pores and (iii) good hydraulic conductivity. We where able to define four characteristic groups of rubble bricks, representing the variability of their hydraulic properties.

To examine the hydraulic interaction between bricks and natural soil, we realised experiments with packed soil columns. We found out, that both pore systems are well connected. The results of these measurements where used to derive effective hydraulic parameters for the soil / brick composition. Additional experiments use a brilliant blue tracer to identify patterns of preferential flow into the columns.

Finally, for numerical simulations of the water dynamic in debris layers, we used material specific and effective hydraulic parameters. In different scenarios we tested, how these different options to model the heterogeneity can be used, to investigate practical questions for urban sites, e.g. water availability for plants, preferential flow or solute transport.

Keywords: artificial debris, heterogeneous pore structure, debris layers, urban soil