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Numerical modeling of shallow subsurface runoff on cultivated soil with temporary variable structure

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Temporary variable properties of periodically cultivated soils are one of the crucial factors that must be taken into account to understand flow processes on agriculture catchments. Soil structure is a property that is often considered as a static rather than dynamic. This could be a reasonable assumption for compacted subsoil, but not for the plough layer.

The man-made and natural processes such as an overuse of heavy machinery, tillage, plowing, harvest, quick vegetation and root growth, edaphon activity, raindrops kinetic energy, freezing, thawing etc. cause recurrent cycles of the topsoil loosening, compaction and surface sealing. Deformation of the structure causes reduction of volume and connectivity of inter-aggregate voids and eroded fine particles clog the macropores and preferential pathways, the infiltration capacity decreases. Originally connected large pores normally serve as a quick bypass for infiltrating water, therefore, based on the state of the topsoil structure one can expect different runoff mechanisms ranging from hypodermic to surface flow.

The aim of the contribution is to examine the runoff dynamics along the inclined slope under different structural properties of the topsoil. We will present a numerical analysis of the effect of variable preferential domain ratio on subsurface runoff, the simulation results will be qualitatively compared to measured hydrographs at the catchment. We used a combination of physically based macroscopic models S1D and HYPO. In the S1D the dual permeability approach with two coupled Richards equations is used, the simultaneously operating HYPO code is based on a diffusion wave (Boussinesq eq.).

The study is based on monitoring of water regime of the cultivated soils on experimental catchment Nucice (Central Bohemia, Czech Republic). The soil is classified as Cambisol, texture ranges from loam to clay loam classes. Soil is conservatively tilled till depth of approximately 17 cm, below that a compacted subsoil was observed. As a part of a complex rainfall-runoff and soil erosion monitoring also near saturated hydraulic conductivity of soil was measured throughout a vegetation season (Klípa et al., EGU2014-6568 and Klípa et al., EGU2014-7230). It has been shown that the soil matrix hydraulic conductivity does not significantly change. The reduction of infiltration capacity is caused by the temporal reduction of preferential domain and creation of soil crust.