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Estimating groundwater recharge by accounting for storage and residence times in unsaturated zone with spatially variable properties

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Groundwater recharge is determined by water balance in the top soil and the water transfer processes in the deeper unsaturated zone. Water balance in the topsoil depends on precipitation, evapotranspiration, runoff and topsoil storage processes and defines the infiltration rates to the unsaturated zone below. On regional scale this unsaturated zone is characterized by spatially variable properties of the sediment layers, mainly their hydraulic parameters and thicknesses. This subsurface structure determines storage and residence times in the unsaturated zone. In order to account for the spatial variability on larger scales simple approaches are required for the estimation of groundwater recharge and associated solute transport to the groundwater.

Based on an one-dimensional analytical solution for steady state water flow in a layered unsaturated soil profile the analytical model UL_FLOW has been developed. This model calculates transient water flow to the groundwater by a simple volume balance respecting the layer structure of the profile. Model applications provide groundwater recharge rates which respect storage in the unsaturated zone. Furthermore, residence times of water and non reactive solutes are obtained which can be used to assess the influx of reactive solutes to the groundwater. GIS application enables estimations on regional scales by model application in simulation units with distinct properties.