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Groundwater flow partitioning in near-coastal catchments of central Scandinavia

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Diffuse mass loads to the sea in near-coastal catchments have been highlighted to be of relatively high importance when investigating nutrient transport to and eutrophication of coastal environments. Around the Baltic Sea in general and the along the Swedish coast in particular, the importance of near-coastal catchments in water management have been highlighted due to the combination of high population density and lack of monitoring data. The lack of monitoring and difficulties of estimating and measuring diffuse discharges and mass transport in unmonitored catchments pose an important water and environmental management problem, not least to all states committed to the Baltic Sea action plan, where important reductions on nutrient discharge to the Baltic Sea have been agreed upon. In order to investigate the importance of different catchment characteristics and on diffuse discharge and mass transport processes, a study has been initiated of the groundwater flow partitioning and the distributions of solute transport time through the Forsmark coastal catchment in central Sweden.

The groundwater flow partitioning and distributions of solute travel times in the Forsmark catchment are modeled with a finite volume groundwater model DarcyTools. Heterogeneity is represented by spatially distributed parameter fields for overburden and discrete conductivity fields for fracture zones. Interaction between the two main flow systems (overburden and bedrock) is studied through the individual travel time distributions of each system, revealing exchange between the systems that is important for transport processes.

Transport is implemented through particle tracking methods giving the travel time distributions (TTD) for the groundwater in the catchment as a whole and especially with a focus on the diffuse discharge into the sea. A virtual experiment approach is applied to investigate the relative importance of several conceptual and structural features on the TTDs, i. e. the influence of stochastic fracture networks, salinity of sea water, conceptual differences in groundwater recharge, and vertical variability of conductivity and porosity, allowing for transmissivity feedback effects.

The aim is for results from this study to provide important information and guidance for large-scale modeling of mass transport through the whole Baltic Sea catchment. Flow partitioning and deep groundwater have been shown earlier to play an important role in catchment transport and effective methods are required to bound the TTDs, which can have important implications for effective water quality management.