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Modelling wetland-groundwater interactions in the boreal Kälväsvaara esker, Northern Finland

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Many types of boreal peatland ecosystems such as alkaline fens, aapa mires and Fennoscandia spring fens rely on the presence of groundwater. In these ecosystems groundwater creates unique conditions for flora and fauna by providing water, nutrients and constant water temperature enriching local biodiversity. The groundwater-peatland interactions and their dynamics are not, however, in many cases fully understood and their measurement and quantification is difficult due to highly heterogeneous structure of peatlands and large spatial extend of these ecosystems. Understanding of these interactions and their changes due to anthropogenic impact on groundwater resources would benefit the protection of the groundwater dependent peatlands.

The groundwater-peatland interactions were investigated using the fully-integrated physically-based groundwater-surface water code HydroGeoSphere in a case study of the Kälväsvaara esker aquifer, Northern Finland. The Kälväsvaara is a geologically complex esker and it is surrounded by vast aapa mire system including alkaline and springs fens. In addition, numerous small springs occur in the discharge zone of the esker. In order to quantify groundwater-peatland interactions a simple steady-state model was built and results were evaluated using expected trends and field measurements.

The employed model reproduced relatively well spatially distributed hydrological variables such as soil water content, water depths and groundwater-surface water exchange fluxes within the wetland and esker areas. The wetlands emerged in simulations as a result of geological and topographical conditions. They could be identified by high saturation levels at ground surface and by presence of shallow ponded water over some areas. The model outputs exhibited also strong surface water-groundwater interactions in some parts of the aapa system. These areas were noted to be regions of substantial diffusive groundwater discharge by the earlier studies. In contrast, the simulations were not able to capture small scale point groundwater discharge i.e. springs. This reflects that modelling small scale groundwater input to wetland ecosystems can be challenging without detailed information on the aquifer and wetland geology. Overall, the good consistency between simulations and observations demonstrated that wetland-groundwater interactions can be studied using fully-integrated physically-based groundwater-surface water models.