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Stable isotopes of water in estimation of groundwater dependence in peatlands

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Peatland hydrology and ecology can be irreversibly affected by anthropogenic actions or climate change. Especially sensitive are groundwater dependent areas which are difficult to determine. Environmental tracers such as stable isotopes of water are efficient tools to identify these dependent areas and study water flow patterns in peatlands. In this study the groundwater dependence of a Finnish peatland complex situated next to an esker aquifer was studied. Groundwater seepage areas in the peatland were localized by thermal imaging and the subsoil structure was determined using ground penetrating radar. Water samples were collected for stable isotopes of water (δ^{18}O and δ^{2}H), temperature, pH and electrical conductivity at 133 locations of the studied peatland (depth of 10 cm) at approximately 100 m intervals during 4 August – 11 August 2014. In addition, 10 vertical profiles were sampled (10, 30, 60 and 90 cm depth) for the same parameters and for hydraulic conductivity. The cavity ring-down spectroscopy (CRDS) was applied to measure δ^{18}O and δ^{2}H values. The local meteoric water line was determined using precipitation samples from Nuoritta station located 17 km west of the study area and the local evaporation line was defined using water samples from lake Sarvilampi situated on the studied peatland complex. Both near-surface spatial survey and depth profiles of peatland water revealed very wide range in stable isotope composition, from approximately -13.0 to -6.0 ‰ for δ^{18}O and from -94 to -49 ‰ for δ^{2}H, pointing to spatially varying influence of groundwater input from near-by esker aquifer. In addition, position of the data points with respect to the local meteoric water line showed spatially varying degree of evaporation of peatland water. Stable isotope signatures of peatland water in combination with thermal images delineated the specific groundwater dependent areas. By combining the information gained from different types of observations, the conceptual hydrological model of the studied peatland complex, including groundwater – surface water interaction, was built in a new, innovative way.