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A multi-tracer approach to determine groundwater discharge patterns in pristine peatlands

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Changes in water flow patterns (e.g. due to ditching or pumping water) in the vicinity of a peatland can affect its hydrology and ecology irreversibly. In Finland esker aquifers, often used for water abstraction, discharge groundwater typically to peatlands. Locations of these discharge zones are important for understanding peatland hydrology and ecology in general and for predicting the impacts of groundwater abstraction. In this study, a Finnish pristine peatland connected to an esker aquifer was sampled for natural tracers (stable water isotopes, electrical conductivity and temperature, n = 55) from two depths (30 cm and under the peat layer) in the summer of 2013. The peat levels of the sampling points varied between 0.57 – 1.00 m. In addition, hydraulic conductivity measurements (n = 13) and airborne thermal imaging were carried out and local precipitation was sampled for stable water isotopes. The CRDS-method (Picarro L2120-i analyzer) was applied to analyze δ^{18}O and δ^{2}H values. Local Meteoric Water Line (LMWL) was determined using precipitation from Nuoritta (17 km west from the study site), $\delta^{2}H = 7.24\ \delta^{18}O + 7.94$ ($R^2 = 0.996$). Ranges for δ^{18}O and δ^{2}H of peatland water were, -13.3 ‰ – -10.3 ‰ and -96.1 ‰ – -75.6 ‰ respectively. Furthermore, electrical conductivity varied between 19.6 – 192.8 mS m^{-1}, hydraulic conductivity between $1.7 \cdot 10^{-8}$ – $5.0 \cdot 10^{-4}$ m s^{-1} and temperature between 6.1 – 16.8 ˚C. Natural tracers were used for identifying water flow patterns of the peatland. Interpretation of the results was complicated due to a stream flowing through the studied peatland. However, groundwater discharge zones were observed alongside the esker and also further away from the esker in the peatland area. This research shows that combination of high-resolution thermal images and discrete field measurements will result in more reliable and precise water flow patterns.