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Remote thermal infrared imaging as an identifier for groundwater dependent ecosystems of esker aquifers in Northern boreal region

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Remote thermal infrared imaging (TIR) is a rapid and feasible method to map groundwater seepages in different surroundings. As the thermal cameras are more available, TIR could be more used as a mapping and management tool for groundwater dependent ecosystems (GDEs). This study demonstrates how TIR was used in a boreal esker aquifer where springs, peatlands, lakes and stream ecosystems are present. Two esker aquifer areas in Finland were mapped with a two-day helicopter based thermal imaging campaign. Imaging included 67 lakes, a bog mire, three headwater streams and a peatland forestry area with ditches. The results of the TIR indicated that many of the lakes had shore seepage points or longer shoreline seepage areas of groundwater. When compared to a previous groundwater dependence study with stable water isotopes of the same lakes, a one-way analysis of covariate (ANCOVA) indicated a correlation between the groundwater dependence and the seepages of a selected lake. The studied mire bog had unmapped springs 0.5 – 1 km beyond the current groundwater protection area of the esker. Also the temperature of the headwater streams referred to a groundwater connection beyond protection limits. The forestry ditches of the discharge zone had a complex temperature pattern due to groundwater seepage. With carefully planned imaging route the TIR resulted to be highly informative and an efficient method to study different GDEs on varying surroundings. The study results emphasize the use of TIR as a standard tool in GDE management planning of boreal eskers comparable to the vegetation based mapping.