Multi-scale thermal remote sensing for delineating groundwater discharge areas in glaciofluvial formations

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ABSTRACT

This work focuses on the development of multi-scale thermal remote sensing approaches for delineating groundwater discharge areas (GDAs) near glaciofluvial formations (eskers and moraines) in a boreal region of the Canadian Shield (north-western Quebec, Canada). The working hypothesis is that groundwater discharge buffers surface temperature variations in GDAs. Resampled low-resolution (30 m x 30 m) LANDSAT TIRS satellite images are first used to identify thermal gradients based on the calculation of the Temperature Vegetation Dryness Index (TVDI) at the regional scale (9184 km^2). The classification of the calculated TVDI index is conducted using the F-statistical grouping analysis (GA) method in ArcGIS for identifying the appropriate TVDI group for the study area GDAs values along the margins of glaciofluvial formations. These areas are identified as potential groundwater discharge zones and are targeted for the acquisition of high-resolution (0,1 m x 0,1 m) thermal images. These high-resolution images are collected using a DJI Zenmuse XT2 camera with uncooled thermal sensors mounted on DJI Matrice 200 drone. The high-resolution images were collected during two summer days (August 2019 and June 2020 respectively) at regular intervals from before the sunrise to after sunset. The images are subsequently mosaicked using Pix4DMapper and classified using the GA method to identify thermal groundwater discharge areas where the temperature remains cold and stable throughout warm summer days. The multiscale approach proposed here presents a potential for a broader application in vast and remote areas for the identification of groundwater discharge areas and associated ecosystems.