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Using an Unmanned Arial Vehicle (UAV) and a thermal infrared camera to estimate temperature differences on a lake surface, revealing incoming groundwater seepage.

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UAVs are at the budding stage of becoming efficient tools in geosciences due to their fast coverage of large areas, creating opportunities to collect comprehensive amounts of spatially distributed data. In this survey a fixed-wing UAV is equipped with a thermal infrared camera (Optris PI 450) conducting spatially distributed measurements of radiometric surface temperature, from a small groundwater-fed lake. We hypothesis that larger temperature differences in the lake surface will reveal locations of incoming groundwater seepage. During wintertime, warmer groundwater will have great incentive to rise to the lake surface without significant mixing with colder lake water and hence enable detection of incoming groundwater seepage with surface measurements. The investigated area is a 300x150 m section of Lake Vaeng in southern Jutland, Denmark.

Detecting areas of groundwater seepage into lakes and quantifying these fluxes are of great importance not only for water budgets but also in relation to lake environments. Incoming groundwater might be a large nutrient source in lakes.

GPS coordinates from the UAV are correlated with each thermal image based on UTC time stamps. Geo-reference is further improved with ground control points in the form of 0.2x0.2 m aluminum foil rectangles. Aluminum stands out clearly in thermal images and using seven of these ground control points, evenly distributed in the investigated area, led to an accuracy of 0.3 m. Using the Structure from Motion photogrammetric technique, a point cloud model is produced and camera positions along with intrinsic and extrinsic properties are established.

Distinct temperature differences of 1.5 C have been detected along the south-eastern shore of Lake Vaeng. The location of these hotspots is in agreement with temperature differences measured with Distributed Temperature Sensing (DTS) system – indicating zones of groundwater seepage into the lake. In addition to faster execution of large spatially distributed measurements, UAVs have greater accessibility to areas that are difficult to reach with instruments on ground such as DTS systems.