Combining geophysical data, microtopography, and very-high resolution UAV imagery to map lowland permafrost degradation in the Stordalen mire, Abisko, Sweden.

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In situ field studies in thawing permafrost regions have shown that organic carbon (OC) geochemical stability and therefore its emissions resulting from decomposition depends a.o. on the variability in soil water content, which can be directly related to microtopography. An assessment of the evolution of OC stability as a function of thermokarst development requires high-resolution quantification of thermokarst-affected areas, as lowland thermokarst development induces fine-scale spatial variability (~ 50 – 100 cm). Here, we investigate a gradient of lowland thermokarst development at Stordalen mire, Abisko, from well-drained undisturbed palsas to inundated fens, which have undergone ground subsidence. We produced orthomosaics and digital elevation models from very-high resolution (10 cm) UAV photogrammetry as well as a spatially continuous map of soil electrical conductivity (EC) based on Electromagnetic Induction (EMI) measurements performed in September 2021. In conjunction, we monitored *in situ* the soil water content and ionic strength corresponding to maximum thaw depth from the different stages of thermokarst development at the same period. The measured values for soil EC show contrasting results along the gradient consistent with the results of the landscape classification derived from the orthomosaics and digital elevation models. Palsas are flat areas with low soil EC (drier), whereas fen areas are subsided areas with higher EC (water-saturated). Transitional zones are well identified based on their much higher slope, and broad range of EC (high range of water saturation and ionic strength). Importantly, the transition zones are only detected using a very fine spatial scale (i.e., 10 cm) coupled to information on the microtopography. Future work will quantify the temporal evolution of this gradient in recent years. Identifying an acceleration of the physical permafrost degradation in the Stordalen mire has implications for the associated permafrost carbon emissions and their estimation at the site scale.

Keywords: permafrost degradation; remote sensing; geophysics; UAV; classification

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