EGU22-4644, updated on 12 Aug 2022
https://doi.org/10.5194/egusphere-egu22-4644
EGU General Assembly 2022

Towards a monitoring approach for understanding permafrost degradation and linked subsidence in Arctic peatlands

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Permafrost thaw resulting from climate warming is threatening to release carbon from high latitude peatlands. The aim of this research was to determine subsidence rates linked to permafrost thaw in sub-Arctic peatlands in Sweden using historical orthophotographic (orthophotos), Unoccupied Aerial Vehicle (UAV) and Interferometric Synthetic Aperture Radar (InSAR) data. The orthophotos showed that the permafrost palsa on the study sites have been contracting in their areal extent, with the greatest rates of loss between 2002-2008. The surface motion estimated from differential digital elevation models from the UAV data showed high levels of subsidence (maximum of -25 cm between 2017-2020) around the edges of the raised palsa plateaus. The InSAR data analysis showed that raised palsa areas had the greatest subsidence rates with maximum subsidence rates of 1.5 cm between 2017-2020, however, all wetland vegetation types showed subsidence. We suggest that the difference in spatial units associated with each sensor explains parts of the variation in subsidence levels recorded. We conclude that InSAR was able to identify areas most at risk of subsidence and that it can be used to investigate subsidence over large spatial extents, whereas UAV data can be used to better understand dynamics of permafrost degradation at a local-level. These findings underpin a monitoring approach for these peatlands.