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ABSTRACT

Moraine de-icing progression in high-Arctic proglacial environments: the use of unmanned aerial vehicles and Structure from Motion photogrammetry for monitoring geomorphological change

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The preservation of ice-cored moraines in the geomorphological (landform) record is poorly understood. Current climatic amelioration provides an opportunity to study the de-icing progression of ice-cored moraines first hand. Here, topographic data are produced using SfM ('Structure from Motion') photogrammetry from: (1) UAV (unmanned aerial vehicle) derived low-altitude aerial imagery acquired in 2014 and (2) traditional high-altitude aerial imagery acquired in 2003. These topographic surfaces are used to report on geomorphological changes at the margin of the high-Arctic, land terminating glacier, Austre Lovénbreen (Svalbard). Surface lowering, predominately via down wastage, is the dominant landform transformation process. Limited evidence of moraine disintegration via back wasting is observed. Rates of surface lowering are reported to reach as high as 5.14 m over the study period, corresponding to a maximum rate of surface lowering of 0.47 m/yr. The average thresholded depth of surface lowering over the study area is reported at 1.75 ± 0.89 m. Differential volumes of buried-ice inclusion are reflected by higher rates of down wastage in the lateral zone, and low or undetectable rates of change in debris-rich frontal zone. Excavations show that the buried-ice is protected by a debris layer of gravel and clast-rich diamicton which is in excess of 1 m thick in lateral areas of the landform. Causes of spatial variations in buried-ice distribution are discussed and the preservation potential of the ice-cored lateral-frontal moraine is considered. This research also serves as an example of the potential for unmanned aerial vehicles and 'Structure from Motion' technologies to aid research on rapidly evolving environments.