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Short-term dynamics of debris-flow-dominated fans mapped and quantified using time-series of UAV data: a case study from Svalbard and Iceland

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Different processes are responsible for the construction of fans and cones, including a whole range from gravitational mass movements to fluvial transport and deposition. To understand fan evolution and its response to environmental changes it is necessary to obtain knowledge of fan morphology, processes acting on fans, and how these processes change in various temporal and spatial settings. However, despite the number of studies related to alluvial and colluvial fans in cold environments, our understanding of the evolution of fans in such conditions is still limited. The purpose of this study is to provide detailed data on short-term transformations of fan surfaces in cold environments based on examples from Svalbard and Iceland.

We mapped and quantified seasonal dynamics of topography for four debris-flow-dominated fans located in the vicinity of Adventdalen (central part of Spitsbergen Island, Svalbard archipelago), and for three fans in the foreland of Breiðamerkurjökull (SE Iceland). Time series (2015-2018) of unmanned aerial vehicle (UAV) surveys and structure-from-motion approach enabled us to create cm-scale digital elevation models (DEMs) and orthomosaics. DEMs were coregistered and used to calculate volumetric changes, whereas orthomosaics allowed investigations of geomorphological processes related to the recorded transformations.

Our results demonstrated that the seasonal dynamics of fan surfaces was very diversified in time and space. Some sections of fans were stable over four years despite the occurrence of an active layer, and topography “prone” to erosion/deposition. Conversely, relatively short periods of activity of processes such as debris flowing or thermokarst erosion resulted in large transformations recorded for other fragments of fans.

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