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Field evidence and monitoring of slope processes in subarctic Québec, Canada

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This research aims to document slope dynamics in subarctic Québec (Nunavik) in relation to human occupation. We observed evidence of recent and past slope processes in the Tasiapik Valley, located at the front slope of the Hudson Bay cuestas near the Inuit village of Umiujaq and Tursujuq National Park. Few studies have focused on the risks associated with slope processes in Nunavik. Nevertheless, tragic events have occurred there, such as the 1999 snow avalanche in Kangiqsualujjuaq. Such events show the importance of better understanding slope dynamics in isolated inhabited areas.

Talus slopes are a predominant geomorphological feature in the area. These slopes were surveyed and characterized using topographic, granulometric, morphometric, petrographic and vegetation parameters. Results suggest that significant catastrophic rockfalls likely occurred in the past, causing the grouping of basalt boulders in distal parts of talus slopes. Recently, discrete rockfalls have occurred, as fresh debris tend to accumulate in the proximal parts of talus slopes, although there is evidence of downslope remobilization on the snow-covered slope. Accordingly, two main rockfall-triggering processes were identified. First, early Holocene debuttressing that resulted from paraglacial adjustment likely caused slope instability after the retreat of the Laurentide Ice Sheet at about 7600 cal. BP. The frequency of slope failures conforms to the exhaustion model, suggested by Cruden & Ho (1993), and therefore with the Holocene glacio-isostatic uplift rate in the Hudson Bay area. Second, recent and/or ongoing periglacial processes, including jointing from gelifraction and frost heave, have led to extensive bedrock weathering and the availability of rocks. As a result, basalt monoliths located at the top of the cuesta are tilting downslope and are now on the verge of falling.

Snow avalanches were monitored using time-lapse photography. Results revealed accretion (November), tilting/creeping (January-March) and collapsing/melting periods (April-July). Cornice evolution is closely linked to meteorological conditions. The SW prevailing wind remained consistent for most of the winter months, contributing to cornice accretion and overloading on the NE-orientated ridge, while warm and rainy conditions cause cornice failures. Collapsing cornices triggered snow avalanches, whose compact and thick deposits were surveyed in June 2018. Runout distances reaching up to 350 m indicate that snow avalanches endanger people using the road located downslope, which connects Umiujaq to Tasiujaq Lake. In addition, rock debris can be dislodged from the rockwall and carried downslope by snow avalanches, contributing to the debris supply on talus slopes. Slope topography and orientation play an important role in snow-avalanche distribution, as the snow cover is better preserved on the NE-oriented slope.