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Controls and geomorphic effects of a high-magnitude/low-frequency snow avalanche event in the proglacial area of the Bødalsbreen glacier, Nordfjord, western Norway

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Due to the interactions between the prevalent climatic factors and the local topography snow avalanches are a common phenomena especially in western and northern Norway. Compared to the annually occurring snow avalanches (low-magnitude/high-frequency events) so-called extreme snow avalanches (high-magnitude/low-frequency) are more difficult to record as they are characterized by recurrence intervals often larger than a decade.

During the winter-spring period 2011/2012 an extreme snow avalanche occurred within the upper valley part of a steep mountain catchment (Bødalen) in western Norway. The snow avalanche run-out zone was located directly in front of the Bødalsbreen glacier which had a substantial effect with respect to the reworking and remobilization of exposed sediment and debris within the proglacial area. Due to the ongoing glacier retreat of the Bødalsbreen glacier freshly exposed areas are enlarged which e.g. exhibit a comparably higher sediment availability enabling active sediment reworking and re-deposition by secondary transfers (e.g. by snow avalanches or fluvial processes).

This study focuses on (i) morphometric and meteorological controls of this specific snow avalanche extreme event and (ii) its related relative role in mass transport as compared to the annually monitored snow avalanche activity within the Bødalen valley. Mapping of the extension and run-out distance of this extreme snow avalanche event is combined with spatial data analysis of possible morphometric controls. The timing and meteorological controls of this event are explored based on meteorological data from two different climate stations located nearby. The volume of the entire snow avalanche, its speed and possible pressure effects are estimated and the total transferred sediment mass is calculated.

First results show that this extreme snow avalanche was initiated by a large breakup of the snowpack developed along the cliff of an E-facing rockwall located above the Bødalsbreen outlet glacier. The longitudinal extent of this snow avalanche covered a distance of in total 2550 m, including an upper stretch of ca. 600 m where downwards sliding of larger snow volumes on top of the Bødalsbreen outlet glacier tongue was observed. The snow avalanche had a massive impact on the proglacial area of the Bødalsbreen outlet glacier. A number of in total 2000 stones (with b-axis varying between < 15 cm and > 150 cm) was remobilized and transported further downwards by this snow avalanche event. The existing glacial melt water channels were partly blocked or translocated due to the snow avalanche deposits. In addition, larger areas of fine grained sediments have been exposed through the scraping of the snow avalanche along the surface of the proglacial area causing recognizably increased aeolian transport within the upper valley part.

Compared to annually occurring snow avalanches the relative importance of extreme-sized snow avalanches is comparably low with respect to direct erosion and sediment transfer along rockwalls. However, extreme-sized snow avalanches play a significant role due to the remobilization of debris/sediment as well as due to the sediment transport down-valley including recognizable transfers of debris into main stream channels.