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# Holocene hillslope processes and deposits in two U-shaped mountain valleys in western Norway

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This doctoral research project is integrated in the Norwegian Research Council (NFR) funded SedyMONT-Norway Project within the ESF EUROCORES TOPO-EUROPE SedyMONT (Timescales of sediment dynamics, climate and topographic change in mountain landscapes) Programme. Research is carried out within two steep, U-shaped and glacier-connected tributary valleys (Erdalen and Bødalen) on the western side of the Jostedalsbreen ice cap in western Norway. Contemporary denudative processes in both valley systems include rock and boulder falls, avalanches, slush flows, debris flows, creep processes, wash- and chemical denudation and fluvial transport of solutes, suspended sediments and bedload.

The main aims of this research project which are approached within a Holocene to contemporary timescale are: (i) to investigate the spatio-temporal variability of Holocene hillslope development, (ii) to analyse more specificly the morphometric influences and geomorphic consequences of the Little Ice Age (LIA) glacier advance on selected hillslope systems within defined headwater areas in both valleys, (iii) to study morphometric and meteorological controls of contemporary denudative slope processes as well as (iv) to quantify the rates of sediment delivery from headwater areas and its changes over time.

A process-based approach is applied using a variety of different methods and techniques. Focus is on different temporal (Holocene to contemporary) and spatial (selected hillslope systems, headwater areas and entire valley system) scales. The applied methods include orthophoto- and topographical map interpretation, GIS and DEM computing, geomorphological fieldmapping and hillslope profile surveying complemented by relative dating techniques (lichenometry and dendrochronology), geophysical investigations and terrestrial laser scanning (LIDAR). For monitoring contemporary rates of slope processes a designed monitoring programme (running since 2009) with a wide spectrum of instrumentation; e.g. installed nets for collecting freshly accumulated rockfall debris, continuous photo-monitoring of rapid mass movement events (avalanches, slush- and debris flows) as well as installed temperature loggers both in rock walls and talus slopes for analysing rock temperatures and mechanical weathering is applied at selected hillslope test sites within the two valley systems.

The overall tendency of landscape development is a Postglacial modification of the defined U-shaped valley morphometry (valley widening) throughout rockwall retreat and connected accumulation of debris material beneath these rockwalls. Active fluvial material removal at the base of slopes is almost negligible due to a very limited hillslope-channel coupling in both valleys. Results regarding the spatio-temporal variability of Holocene hillslope development show Holocene rockwall retreat rates for the two valleys which are in a comparable range with other estimates of rockwall retreat rates in other cold mountain environments worldwide. Further on the findings indicate probably higher accumulation rates of slope deposits mainly throughout an enhanced rockfall activity shortly after the glacier retreat as compared to subrecent and contemporary rates. Within the LIA period a recognizable modification of hillslopes in proximity to the outlet glaciers of the Jostedalsbreen is noticeable. A more complex hillslope morphometry (steepening of lower hillslope segments) as well as a more complex composition (inherited by a combination of debris from gravitational processes and lateral moraine ridges) of loose material generating a higher intensity of currently acting slope processes within the hillslope systems located inside of the LIA glacial advance limit as compared to hillslopes situated outside of this limit is found.