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Geomorphic influences of the Little Ice Age glacial advance on selected hillslope systems in Nordfjord, Western Norway (Erdalen and Bødalen valleys)

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Hillslopes in glacially formed landscapes are typically characterized by talus cones developed beneath free rock faces. Studying hillslopes as sedimentary source, storage and transfer zones as well as surface processes acting on hillslopes since the end of the deglaciation is of importance in order to gain a better understanding of the complex sedimentary source-to-sink fluxes in cold climate environments. Hillslopes function as a key component within the geomorphic process response system. Large areas of the Norwegian fjord landscapes are covered by hillslopes and are characterized by the influences of the glacial inheritance.

This PhD project is part of the NFR funded SedyMONT-Norway project within the ESF TOPO-EUROPE SedyMONT (Timescales of sediment dynamics, climate and topographic change in mountain landscapes) programme.
The focus of this study is on geomorphic influences of the Little Ice Age glacial advance on postglacial hillslope systems in four distinct headwater areas of the Erdalen and Bødalen valleys in the Nordfjord valley-fjord system (inner Nordfjord, Western Norway). Both valleys can be described as steep, U-shaped and glacier-fed, subarctic tributary valleys. Approximately 14% of the 49 km2 large headwater areas of Erdalen are occupied by hillslope deposits and 41% by rock surfaces; in Bødalen hillslope deposits occupy 12% and rock surfaces occupy 38% of the 42 km2 large headwater areas.

The main aims of this study are (i) to analyze and compare the morphometric characteristics as well as the composition of hillslope systems inside and outside of the Little Ice Age glacial limit, (ii) to detect possible changes within the mass balances of these hillslope systems, (iii) to identify the type and intensity of currently acting hillslope processes as well as (iv) to determine possible sediment sources and delivery pathways within the headwater areas of the catchments.

The process-based approach includes orthophoto- and topographical map interpretation, hillslope profile surveying, photo monitoring, geomorphological mapping as well as GIS and DEM computing. Two appropriate hillslope test sites within each headwater area are selected in order to follow the main aims of this study. The designed monitoring instrumentation of the slope test sites includes nets for collecting freshly accumulated rockfall debris, stone tracer lines for measuring surface movements, wooden sticks for monitoring of slow surface creep movements and peg lines for depth-integrated measurements of slow mass movements. In addition, remote site cameras for monitoring rapid mass movement events (avalanches, slush- and debris flows) and slope wash traps for analyzing slope wash denudation are installed and measurements of solute concentrations at small hillslope drainage creeks for investigating the role of chemical denudation are conducted. Measurements of morphometric characteristics and longitudinal profiles along the main axis of the talus cones are carried out at each test site. The manually obtained longitudinal profile data are combined with data derived from a DEM in order to generate complete longitudinal hillslope profiles reaching from the apex until the slope foot.

Preliminary results show a steepening trend of the talus cones located inside the Little Ice Age glacier limit which is due to erosion during the Little Ice Age glacial advance. In addition, some of these talus cones

are characterized by a recognizable more complex talus cone morphometry and composition, resulting from implementation of Little Ice Age glacier side moraines. The combination of (i) steepened talus cones and (ii) complex composition seems to increase currently acting hillslope processes which leads to a higher sediment delivery from these slopes as compared to hillslopes outside the Little Ice Age glacier limit. The implementation of moraine material but also the increased intensity of denudative processes has a recognizable influence on the mass balance of the hillslope systems inside the Little Ice Age glacier limit.

Research on the complex development of hillslope systems from a postglacial to contemporary time perspective in combination with analyses of contemporary sedimentary fluxes contributes to a better understanding of hillslopes acting as source, storage and transfer zones in cold climate environments (paraglacial systems).