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Controls of Holocene to contemporary sedimentary source-to-sink fluxes in valley-fjord systems in western Norway

Achim A. Beylich, Katja Laute, and Susan Liermann
Geological Survey of Norway (NGU), Geo-Environment Division, Trondheim, Norway (achim.beylich@ngu.no)

The presented research has been carried out since 2004 in two selected valley-fjord systems (Erdalen and Bødalen) in Nordfjord, western Norway. The focus of the work has been on Holocene to contemporary sedimentary fluxes and budgets, with particular interest in (i) Analyzing in which way glacial isostatic adjustment and surface denudational processes have been interacting over the Holocene, (ii) Analyzing how the inheritance of the landscape due to the influence of the Last Glacial Maximum (LGM) has affected surface process rates over time, (iii) Documenting changes in surface process rates over different timescales by combining knowledge on Holocene surface process rates with data on subrecent and contemporary surface process rates.

Detailed and longer-term monitoring of relevant denudational surface processes in the Erdalen and Bødalen drainage basin systems has provided high-resolution data for analyzing and quantifying contemporary solute and sedimentary fluxes as well as sediment sources, denudation rates, and meteorological and topographical / landscape morphometric controls of denudational surface processes. Proglacial lakes are functioning as significant sediment traps (with trap efficiencies reaching up to 85%) within both drainage basins and the volume and composition of lake sediments have been studied by using echo-sounder, georadar and different sediment coring techniques. Investigations on volumes and architecture of storage elements (talus cones, valley infills, deltas at the outlets of Erdalen and Bødalen) using different geophysical methods like georadar and seismic refraction surveys have been carried out to get quantitative knowledge on Holocene process rates and sedimentary budgets. Detailed geomorphological mapping has been conducted and interpreted in combination with slope and valley morphometric analyses and digital elevation models and data.

It is found that the U-shaped valley morphometry is the main control of the spatial organization of Holocene to contemporary denudational surface processes in the Erdalen and Bødalen drainage basin systems. Stepped longitudinal valley bottom profiles within both Erdalen and Bødalen have caused that glacial isostatic adjustment has, until today, not had significant effects on surface denudational processes in the middle and upper parts of both drainage basin systems. In Erdalen, the more clearly defined stepped longitudinal valley bottom profile combined with a greater main valley width have resulted in larger storage (larger volumes of valley infill and talus cones) and in a lower level of slope-channel coupling as compared to the Bødalen drainage basin.

It is pointed out that the glacial inheritance of topography is the most important factor controlling valley development since the LGM and that sediment storage capacity is primarily conditioned by valley morphometry. Different periods within the Holocene with varying intensity of denudational surface processes can be identified, with the time periods immediately after deglaciation and during the Little Ice Age period showing greater process intensities than the other time periods. The glacially sculpted topography has not yet adapted to denudational surface processes acting under Holocene environmental conditions. Under the contemporary environmental conditions mechanical denudations dominates over chemical denudation in both glacier-connected drainage basins. Compared to surface process rates in other cold climate drainage basin systems worldwide the rates found for Erdalen and Bødalen are moderate to low. Sediment transport in both drainage basin systems is supply-limited.