Geophysical Research Abstracts
Vol. 15, EGU2013-1183, 2013
EGU General Assembly 2013
© Author(s) 2012. CC Attribution 3.0 License.

Environmental controls and spatio-temporal variability of chemical and mechanical denudation rates in the inner Nordfjord, western Norway

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

This study conducted over seven years (2004 - 2011) focuses on spatial and temporal variations of solute yields, chemical denudation rates and suspended sediment yields in a steep, cold climate and glacier-fed drainage basin system in the fjord landscape of western Norway. The selected Erdalen drainage basin (79.5 km2) is considered to be a typical valley system of the Nordfjord region in western Norway and is connected to the Jostedalsbreen ice cap through two outlet glaciers (Vesledalsbreen and Erdalsbreen).

The mean annual chemical denudation rate in the Erdalen drainage basin is 6704 kg km-2yr-1, which is in a similar range of magnitude than annual chemical denudation rates in a number of other cold region catchment systems worldwide. Mean annual TDS values of surface water sampled in creeks which are draining defined subsystems within the Erdalen drainage basin show a rather high spatial variability. The main controls of this detected spatial variability are (i) differences in slope deposit / regolith thickness, (ii) differences in slope angle, (iii) differences in areal regolith cover, (iv) differences in vegetation cover, (v) differences in snow cover and ground frost conditions, and (vi) differences in elevation (m a.s.l.).

Inter- and intra-annual temporal variations of surface water chemistry, solute gross concentrations, solute gross yields and chemical denudation rates are determined by the combined effects of inter- and intra-annual variations of precipitation and air temperature. Intra-annual temporal variations of surface water TDS values reflect the dilution of base flow from the drainage basin by (i) thermally controlled snowmelt in spring (April - June), (ii) thermally determined glacier melt in summer (July - August), and (iii) both more frequent and more intense rainfall events in fall (September - November).

The mean annual surface water TDS values in Erdalen are altogether rather low, which can be explained by (i) the shallow thickness of regolith across the very steep drainage basin, (ii) the small percentage of surface areas showing a significant cover of regolith, (iii) the cool climate in the fjord landscape of western Norway, and (iv) the weathering resistance of the predominant gneisses in Erdalen.

It is found that fall (September - November) is the most important period with respect to fluvial suspended sediment transport and suspended sediment yields. Sediment transport and suspended sediment yields in the Erdalen drainage basin are altogether supply-limited. The intensity of suspended sediment transport in fall and over the entire year depends strongly on the annual number of heavy rainfall events exceeding a threshold that triggers transfers of sediment from slopes into channels via saturation overland flow with connected slope wash and debris flow events. Annual suspended sediment yields in the Erdalen drainage basin are about two times greater than chemical denudation rates. Suspended sediment concentrations in glacier melt water during summer and annual suspended sediment yields are altogether lower than in many other glacierized drainage basins worldwide. The high resistance of the predominant gneisses in the area is assumed to be one of the main reasons for the comparably low suspended sediment concentrations in the Erdalen drainage basin.

Predicted climate change and the connected shifts in temperature and precipitation regimes are expected to have significant impacts on the intensity and the temporal variability of chemical and mechanical denudation in the fjord landscape of western Norway. It can be assumed that both chemical and mechanical denudation rates will increase under climate change.