Bedload measurements in periglacial environments - examples from Svalbard

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Abstract

Bedload transport in periglacial streams differs significantly from other environments. In periglacial environments, surface is frequently covered by ice. As a consequence, shear resistance on channel beds is low due to reduced surface roughness. This leads to increased runoff, accompanied with low infiltration into the ground. This effect has been studied in more detail with respect to bedload transport in the Kvikkåa and Beinbekken catchments, Liefdefjorden in Northwest Svalbard.
Bedload movement including sliding, rolling, and saltation processes was measured through fixed installed baskets samplers and sediment traps to approximate grain size distribution and loads for specific events and through sediment basins to determine total sediment load in a given period. Painted and numbered stone tracers allowed an approximation of travel distances at different locations within the river profile. Changing river courses on the active fluvial fan were observed during melting periods using coloured stone lines. These techniques have been applied to the Kvikkåa catchment at various locations, e.g. above the junction of the two tributaries of Småbreen and Kvikkåabreen, in the main river stream before reaching the fluvial fan, on the fan and at the outlets to Liefdefjorden. In addition, sediment baskets have been positioned in the Beinbekken catchment. Stream stage measured at gauging stations have been calibrated using NaCl-tracer and current meters to determine flow velocities and subsequent discharge, both available for comparisons with bedload measurements.
In the Kvikkåa catchment, clasts larger 2cm were not supplied from Småbreen during the observation period. From the Kvikkåabreen tributary, some sediment > 2cm has been supplied to the Canyon. It is assumed that most of the sediment reaching the fluvial fan has been mobilized in the Canyon. Comparison of total sediment collected in sediment basins, basket samplers, and sediment traps indicate, that both latter techniques underestimate total sediment transport by approx. 82%. Nevertheless, measurements on the outlet of the Kvikkåa to the Liefdefjorden showed, that only 3% of the bedload sediment supplied to the fan is transported into the Fjord. Coloured stone lines indicate a continuous change of the river course on the fluvial fan during melting periods. Transport distances of single stones from different painted stone lines is up to 28m on the fan during melting period. Coloured and numbered stone tracers have been transported of up to 405m in the Canyon, 317m on the Canyon base, and 32m on the fan. Largest travel distance is independent on pebble form and size and has been reached during frozen ground conditions. As a consequence, if sediment is available and not frozen to the ground, even low river discharge is able to transport large clasts over long distances.
Comparisons of sediment transported by slush flows and fluvial processes indicates,

however, that slush flows contribute significantly to the overall sediment transport. It is suggested, that during the observation period, slush flows are more important for sediment delivery than fluvial processes.