Abstract

Among the most efficient agents of erosion, glaciers react dynamically to climate change, leading to a significant adjustment of downstream sediment flux. Present-day global warming raises the question regarding the evolution of the sediment load originating from partially glaciated catchment. The detrital export from such environment results from erosion processes operating within distinct geomorphological domains : supraglacial rockwalls, ice-covered substratum and the proglacial area, downstream from the glacier. The general intent of this doctoral research is therefore to characterize the origin and transport of sediments in the watersheds of two streams draining Bossons glacier (Mont-Blanc massif, France).

For this purpose, the components of the sediment flux coming from supraglacial, subglacial and proglacial domains are separated and quantified by innovating methods:

i. Using the terrestrial cosmogenic nuclides concentrations as evidence of a supraglacial transport;
ii. Combining meteorological data and hydro-sedimentary data acquired at a high time resolution (2 min) and completed by multi-linear models;
iii. Estimating sediment flux by source for 7 years and with a probabilistic method;
iv. Associating radio-frequency identification of pebbles in the proglacial area with a stochastic transport analysis.

Through numerical tools, applying the presented methodologies provides erosion rates of the supraglacial, subglacial and proglacial domains, and determines the sediment transfer mechanisms within the catchment.

Thus in the terminal part of the glacier, 52±14 to 9±4% of the supraglacial load is transferred to the subglacial drainage network. Moreover, its evolution throughout the melt season leads to the export of the winter sediment production during a limited period. Furthermore, the drainage configuration beneath the glacier and its retreat control the remobilization of a long-term sediment stock. These processes explain the contrast between the mean subglacial erosion rates of the two monitored streams, 0.63 ± 0.37 et 0.38 ± 0.22 mm.yr^{-1}, respectively. This values are lower than the tectonic uplift, $\sim$1.5 mm.yr^{-1}, and of the same order of magnitude than the mean erosion rate of supraglacial rockwalls, evaluated at 0.76 ± 0.34 mm.yr^{-1}.

Downstream from the glacier, hillslopes are not efficiently connected to the proglacial stream and the glacier is the main source of the sediment export. Hence, without extreme events, the input from proglacial domain corresponds to $13 \pm 10\%$ of the total sediment export from the catchment. Besides, the proglacial area acts as a buffer functioning from the daily to the year scales for fine particles, and at a decennial scale for coarser particles. In total, despite the rapid recent retreat of the glacier, the Bossons catchment exhibits a limited paraglacial dynamic whose intensity corresponds to a mean proglacial erosion rate of 0.25±0.20 mm.yr^{-1}. Finally, at the catchment scale, the sediment dynamic is multi-frequential and buffered by storage and release mechanisms.