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Sediment dynamics in glacierized catchments: a comparison study from two proglacial streams in the Sulden catchment (Eastern Italian Alps)

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Sediment dynamics of proglacial streams are strongly connected to meltwater contributions, supply and activation of sediments from subglacial and periglacial reservoirs. In this context, the present study investigates and compares these dynamics at two proglacial streams with respect to discharge, bedload rates, suspension, and runoff generation. The study area is the upper Solda-Sulden catchment in the Eastern Italian Alps (14 km² drainage area, 38 % of glacier cover, elevation range between 2225 and 3905 m a.s.l.).

From June to September 2017, 2018, and 2019, two proglacial streams from the Eastern Solda-Sulden glacier (almost without debris-cover) and the Western Solda-Sulden glacier (heavily debris-covered) were monitored. We performed bi-weekly to monthly sampling of bedload (by Bunte samplers), suspended sediment content (SSC), stable water isotopes (δ^2H and $\delta^{18}O$), and electrical conductivity (EC). During each sampling event, we measured water stages and carried out discharge measurements derived from salt dilution method. Meteorological data were measured at the Madritsch automatic weather station at 2825 m a.s.l. and at a temporary weather station installed on the Western Sulden glacier at about 2625 m a.s.l..

At the Eastern Sulden proglacial stream, we collected 32 bedload samples, which correspond to about 32 kg. The discharge during sampling ranged from 0.03 $m^3\ s^{-1}$ to 2.1 $m^3\ s^{-1}$ and led to bedload rates ranging between 0.002 kg $min^{-1}\ m^{-1}$ and 6.7 kg $min^{-1}\ m^{-1}$ in August 2018. At the Western Sulden proglacial stream, total weight of bedload samples amounted to about 332 kg (n = 56). The minimum and maximum discharge measured were 0.27 $m^3\ s^{-1}$ to 4.7 $m^3\ s^{-1}$, respectively. Bedload rates were much higher than those at the previous stream and ranged from 2 x 10^{-4} $m^3\ s^{-1}$ to a maximum bedload rate of 248 kg $min^{-1}\ m^{-1}$ in July 2019. Tracer-based runoff calculations (using δ^2H) estimated up to 65 % ± 12 of ice melt contribution during the highest bedload rates,

indicating that bedload rates were strongly controlled by ice melt contributions. At the daily scale, we generally observed that highest discharges in the afternoon temporally coincided with highest bedload rates. A change of one order of magnitude of discharge increased the bedload rates by one or two orders of magnitude.

However, in the case of the Eastern Sulden proglacial stream, sudden cloud overcast had an immediate effect on the sediment activation while discharges remained unaffected. Longer-period trends in bedload rate are also likely correlated with air temperature and radiation, suggesting a complex climatic control of sediment transport.

These results will help to better understand the important drivers and sensitivities of sediment dynamics in proglacial streams, thus supporting water and sediment management in glacierized catchments.