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Analysing runoff and sediment dynamics at different spatial and temporal scales in a glacierized Alpine catchment (Eastern Italian Alps)

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Glacierized catchments are important sources of fresh water and sediment, where hydrological and geomorphological processes are strongly coupled. This study analyses the spatial and temporal variability of snowmelt and glacier melt runoff components and their interaction with sediment fluxes by means of hydro-sedimentary, tracer and geophone data over the last years.

The study area is the glacierized Sulden/Solda catchment (130 km^2 drainage area, Eastern Italian Alps), which ranges in elevation between 1112 and 3905 m a.s.l.. Metamorphic rocks characterize the Sulden sub-catchment while sedimentary (Dolomitic) rocks are mainly present in the Trafoi sub-catchment.

Since 2014, water stages, water temperature, electrical conductivity (EC), turbidity, and bedload transport are measured at the outlet of the catchment. Bedload transport was indirectly measured using a rack of geophone-plates installed in an instrumented check dam. Applying an automatic sampling approach, stream water for isotopic analysis and suspended sediment content (SSC) were sampled daily from May to October. To investigate sub-catchment specific sediment dynamics, turbidity and EC were measured at the Trafoi River at 1478 m a.s.l. since May 2017, accompanied by manual water sampling for isotopic and SSC analysis. Close to the glacier terminus, two vertical geophones were installed along the channel in July 2017. Furthermore, an hourly water sampling approach was conducted at the upper Sulden River at 2225 m a.s.l.. This monitoring was complemented by an erosion/deposition volumes estimation detected by morphological changes monitoring of the proglacial areas through difference of DEMs (DoD), obtained by SfM photogrammetry.

Results show that the study is characterized by a nivo-glacial runoff regime, with very low discharge during winter, a snow melting period from March to June and a glacier melting period from July to September. However, highest discharges resulted from few storms in summer (reaching up to 81 $m^3\ s^{-1}$). These dynamics were corroborated by stable water isotopes and EC. When comparing the turbidity of the Trafoi River and the outlet, general dynamics were in agreement with each other and strongly followed the discharge. Turbidity variation was larger at the major tributary (often close to 3000 ntu), potentially revealing the Dolomitic sub-catchment as main source of suspended sediments. Geophone data showed lower bedload transport during the snow melting period, contrasting with higher transport during the glacier melting period. Daily cycles and seasonal trends in geophone data were correlated with discharge and air temperature, respectively, suggesting a strong and complex climatic control of bedload transport. Field evidences and direct sediment sampling performed after the opening of a new glacier mouth, during an extremely warm week in August 2017, confirmed these observations.

These observations highlight the need of multi-proxy data to analyse complex runoff and sediment dynamics and may support future investigations on sediment connectivity in glacierized catchments in the context of climate change.

Keywords: tracer; turbidity; bedload; geophone; glacierized catchment