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Bedload transport measurements with impact-plate geophones in a glacier-fed Alpine river

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In mountain rivers, the capability to predict bedload transport rates is affected by large uncertainties. Different sediment supply regimes, runoff origin and flood events have a strong impact on bedload transport trends. Therefore, long-term observations of both water and sediment discharge are valuable to constrain transport capacity equations. In 2014, a monitoring station of bedload transport has been deployed in the Sulden/Solda river (South Tyrol, Italy). The Sulden basin (130 km^2) ranges in elevation between 1110 and 3905 m a.s.l., has a glacier extent of about 17.7 km^2 and is characterized by steep slopes feeding the main channel with sediments. The station is equipped with a 4m-rack of eight geophone plates, which continuously measure the vibration induced by the impact of moving particles with a sampling frequency of 5 kHz. Calibration measurements are performed using a bedload trap, made by a net (opening size of 3.6 mm) anchored to a metal frame. The trap is handled by a crane and remains in the sampling position for 5 to 10 minute, depending on the bedload transport intensity. The number of geophone impulses and total transported bedload mass of 30 measurements carried out from 2014 to 2017 were used to derive the calibration function (power law, R^2 = 0.41) adopted to infer the bedload mass.

Data show how the joint effect of flood events and seasonal changes in sediment supply significantly affects bedload transport rates. On 13-14 August 2014, a large flood event occurred that was characterized by a peak discharge of 80 m^3/s and an intense bedload transport which reached a peak value of 1 000 kg/s. Based on the calibration function, the bedload mass transported during the entire flood event (duration of 48h) was estimated to be equal to 7 100 tons, which is the 18% of the whole bedload mass transported during the 2014 season (39 600 tons). The following year, a flood event that occurred in late spring (8-9 June 2015, peak discharge of 30 m^3/s) transported 1 100 tons of bedload in 48h, while the annual bedload yield was 24 200 tons. In 2016, the flood event that occurred on 12-13 July (peak discharge of 55 m^3/s, 3 800 tons of bedload transported in 48h) significantly contributed to the total bedload yield observed during the whole season (36 800 tons). The moderate bedload transport rate measured in May-June can be related to sediment sources located within the riverbed, while the high sediment yield observed in July-August are probably due to the sediments coming from the glacial and proglacial areas. During summer, daily cycles and longer-period trends in bedload impulses are respectively correlated with water discharge and air temperature, suggesting a complex climatic control of sediment transport.