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Dynamics of bedload size and rate during snow and glacier melting in a high-gradient Andean stream

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The evaluation and prediction of coarse sediment movement and transport is crucial for understanding and predicting fluvial morphodynamics, and for designing flood hazard mitigation structures and stream habitat restoration. At the scale of single flood event, the relationship between water discharge (Q) and bedload rate (Qs) often reveals hysteretic loops. If Qs peaks before Q the hysteresis is clockwise and this suggests a condition of unlimited sediment supply. In contrast, counterclockwise hysteresis would suggest limited sediment supply conditions. Understanding the direction and magnitude of hysteresis at the single flood event can thus reveal the sediment availability. Also, interpreting temporal trend of hysteresis could be used to infer the dynamics of sediment sources. This work is focused in the temporal trend of hysteresis pattern of bedload transport in a small (27 km2) glaciarized catchment in the Andes of central Chile (Estero Morales) from 2014 to 2015. Bedload is measured using a 0.5 m long Japanese acoustic pipe sensor fixed on the channel bed, which register the intensity of impulses generated by the impact of sediments on the sensor. Based on flume and field measurements, the sensor was calibrated as to provide intensity of transported sediments. Also, direct bedload samplings were taken within a range of 0.01 – 1000 g s-1 m-1) sediment transport rates, and allowed to assess median and maximum grain size of transported sediments. The analysis reveals that hysteresis at the scale of single flood tends to be clockwise during snowmelt and early glaciermelting, whereas counterclockwise hysteresis is dominant during the late glaciermelting. Also, bedload transport rates and grain size of transported sediments reduces progressively from early to late glaciermelting. Interestingly, direct bedload samplings revealed that grain size of transported sediments tends to exhibit a counterclockwise hysteresis when the sediment transport is clockwise. Thus during the snowmelt and early glaciermelting, sediment availability appears to be unlimited and hysteresis can be ascribed to pulses of sediments coming from the proglacial area. Instead, as the glaciermelting season progresses, sediment availability decreases probably due to the progressive exhaustion of sediments stored in the channel bed, and counterclockwise hysteresis can be ascribed to changes in the organization of the surface sediments at the scale of clusters. Results highlight the complex relationships between dynamics of sediment sources at the basin scale and changes in channel sediment storage overtime, resulting in abrupt changes in rate and size of sediment transport. Long-term assessment of these dynamics using indirect methods to assess bedload transport can provide important insights for understanding probable trajectories of morphological evolution of glacierized streams which are subject to rapid environmental changes. This research is being developed within the framework of Project FONDECYT 1130378.