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Bedload monitoring via RFID particle tracking in three mountain streams of the Eastern Italian Alps

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The general purpose of the study is to increase knowledge on bedload sediment dynamics in steep mountain streams. In particular, we aim to: (i) evaluate hydrologic thresholds for bedload entrainment; (ii) constrain volumetric bedload transport rates in relation to varying sediment supply and hydro-meteorological forcing.
Study sites are Rio Grigno (contributing area at study reach = 7 km^2), and its tributary Rio Tolvà (7 km^2) in Valsugana and Rio Val Ussaia (2.3 km^2) in Val di Sole. They are all step-pool and boulder-cascade channel reaches underlain by granitoid lithology. Grigno and Tolvà are characterized by higher Mean Annual Precipitation (MAP = 1511 mm) than in in Ussaia (MAP = 844 mm). In terms of sediment supply, study reaches in Grigno and Tolvà are decoupled from hillslope sediment inputs, whereas Ussaia is strongly fed by actively eroding till mantled slopes. Median channel slope in the study reaches is 7.5 % in Grigno, 10 % in Tolvà, and 12 % in Ussaia.
During the study period, which lasted from December 2013 to December 2016, we monitored precipitation, water discharge and the travel distance of 761 PIT tags (211 in Grigno, 199 in Tolvà and 351 in Ussaia). B-axis of tracer particles ranged from 31 mm to 149 mm. Particle tracking was performed through post flood field surveys using RFID (Radio Frequency Identification) portable antennas. Cumulatively, we conducted 27 surveys in Rio Grigno, 22 in Rio Tolvà, and 28 in Rio Ussaia. Volumetric bedload transport rate for each inter-survey period was calculated by integrating peak flow competence (to establish threshold of motion) and the virtual velocity method on the active channel bed. We classified the hydrologic regime of each inter-survey period in snowmelt (S), rainfall (R) and mixed (M).
Monitoring year 2014 was the wettest: 2730 mm in Grigno and Tolvà, 1540 mm in Ussaia. By contrast, monitoring years 2015 and 2016 were much drier, in line with the respective long-term annual means: 1357 mm in Grigno and Tolvà, and 799 mm in Ussaia (2015); 1484 mm in Grigno and Tolvà, and 832 mm in Ussaia (2016). This variability in hydro-meteorological forcing enabled us to investigate a wide array of bedload transport regimes.
Preliminary results show that bedload transport chiefly occurs in rainfall-dominated periods (90% in Grigno-Tolvà; 94% in Ussaia), with snowmelt accounting for only 2% (Grigno-Tolvà) and 5% (Ussaia) of the total bedload volume. Despite much wetter conditions in Grigno-Tolvà than in Ussaia, estimated annual bedload volumes in the three monitoring years display consistently much higher values in the latter:
1) 2014: 56.9 m^3 in Grigno, 26.3 m^3 in Tolvà and 355 m^3 in Ussaia;
2) 2015: 5.7 m^3 in Grigno, 1 m^3 in Tolvà and 53.9 m^3 in Ussaia;
3) 2016: 7.2 m^3 in Grigno, 1.5 m^3 in Tolvà and 11.1 m^3 in the Ussaia.
We propose that these patterns of contrasting channel bed stability are chiefly associated with different styles and rates of hillslope sediment supply.