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The effects of antecedent flows on sediment entrainment in a mountain stream

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The difficulty for predicting bedload transport and identifying incipient motion thresholds in high mountain streams is well-known, especially during flood events. Surrogate methods aiming at quantification of sediment transport rates and sizes have been developed thorughout the last decades; among those, tracers in general, and PITs (Passive Integrated Transponders) in particular are a good alternative in particle dynamics study. Usually, the recovery of PITs after flood events is done by means of a portable antenna; however an alternate valid option is represented by antennas fixed on the channel bank or on the river shores. The use of stationary antennas allows to know the actual discharge at the moment of motion.
This study focuses on incipient motion of tracers measured by means of a stationary antenna system in the upper part of a mountain basin (Saldur River, drainage area 18.6 km2, Italian Alps) where significant daily fluctuations in summer – due to the part of the basin (2.3 km2) being glacierized – are monitored. From 2011 to 2013, flow discharge varied between 1 and 10 m3s-1. A total of 587 clasts equipped with PITs ranging from 35 to 580 mm were released along the main channel, in a confined reach with bed morphology transitional from plane-bed to step-pool (6% slope). PIT-tagged clasts were gently deployed on the riverbed, few meters upstream of an antenna anchored to the channel bed. Flow stage data were acquired at 10 min interval by means of a pressure transducer installed near the fixed antenna.
The analysis of preliminary results showed that the relationship between the size of transported tracers and the discharge measured at the time clasts were passing above the antenna is weak. Hence, it was investigated the influence of antecedent flows on incipient motion, by dividing the peak discharge recorded between each PIT deployment and the subsequent entrainment by the actual critical discharge at the time of movement (ratio Qmax/Qc). Results show that only 45% of tracers moved at Qmax/Qc $\sim$ 1, and that 70% of tracers moved at Qmax/Qc < 1.5. Therefore, about 30% of tracers had to previously experience a discharge substantially higher than the one which actually mobilized them. Interestingly, coarser particles moved at higher Qmax/Qc ratios, suggesting that higher antecedent flows may be needed for destabilizing the bed, likely at the scale of clusters rather than morphological units as steps. These preliminary results highlighted the importance of antecedent flows on incipient motion of coarse particles in a mountain stream, revealing that the magnitude of previous flows seems to impact their entrainment. Because the duration of antecedent flows could be as relevant as their magnitude, especially for explaining the higher Qmax/Qc ratio needed for the coarser fractions, a detailed analysis of the duration curves of overthreshold flows for each mobilized PIT tag is undergoing.