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A bedload tracer experiment in a high-elevation mountain basin (Strimm basin, Eastern Italian Alps)

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In many applications in engineering, ecology and river management, rates and timing of bed load transport in mountain rivers are of primary importance, yet of difficult prediction. Field measurements of bedload transport rates are rare, especially in high-mountain basins, and factors controlling the sediment fluxes have not been completely understood yet. Results offered by semi-empiric transport capacity equations proposed so far are heavily dependent on the experimental setup of the flumes in which they were developed originally. Direct methods for assessing bedload transport are time-consuming and practically challenging at high flows. Therefore, indirect surrogate methods for estimating bedload transport, such as the use of tracers, represent a good alternative.

This study presents results on bed sediment mobility and travel distances obtained in the Strimm Creek, a high-elevation watershed in the Eastern Italian Alps (8.5 km2). From July 2011 to June 2012 a total of 431 PIT-tagged clasts (b-axis ranging from 22.6 mm to 229.3 mm) were deployed in two contrasting channel reaches, an upstream one located within a gentle hanging valley floor and a downstream on flowing along a steep and narrow valley step. Tagged clasts were surveyed from August 2011 to October 2013 by means of a portable antenna after each main flow event, and immediately before and after the spring freshet. Motion thresholds for the different grain sizes, particle travel distances and differences in sediment mobility existing between the two reaches were hence identified. Unit stream power rather than shear stress was used to analyse particle displacement due to the extremely rough geometry of the channel which makes the estimation of water depth at different sections subject to great uncertainties.

In the lower channel reach, results showed how most of the PIT-tagged clasts movement happened during snowmelt periods, with travel distances often exceeding 500 meters, and displacements during the remaining summer months were by at least one order of magnitude lower. In the upper channel reach, even if on average tagged clasts moved across much shorter distances (order of magnitude of 10 meters), the same trend was identified, with bigger displacements happening during the snowmelt period, and only sporadic events linked to convective summer storms and Atlantic fronts were identified during the other months. Finally, tracers showed that in the upper part of the basin, even during snowmelt, transport was size selective, with bigger clasts (b-axis greater than 128 mm) remaining stable, while in the lowest part of the basin, featuring higher flows, equimobility conditions occurred for a wide size range.

Keywords: bedload monitoring, indirect methods, Passive Integrated Transponders, tracers, formerly glaciated topography