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Memory effect triggered by exceptional event: the Rio Cordon study case

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In the mountain environment, the steep channels play a key-role in the drainage networks. Notably, the sediment transport processes that here occur, can affect aspects as the geomorphic changes, channel evolution, reservoir management, infrastructure design and hazard assessment. Due to the complex and changeable hydraulic and morphological features that characterize the mountain environment, the steep channels can exhibit fluvial and/or debris-flow transport with magnitude of sediment delivery that, in the same basin, may strongly vary from event to event. In the light of these challenging conditions, appears clear as an accurate monitoring and investigation of sediment dynamics is of critical importance in the steep mountain channels. Such monitoring has even more significance if it is maintained over long-period, enabling to investigate even the role of high magnitude/low frequency events. Using a dataset 29 years-wide, this work aims to investigate the temporal trend of sediment dynamic in the Rio Cordon (Eastern Italian Alps). The Rio Cordon is a steep mountain channel (mean slope = 13%) characterized by step-pool and riffle-pool morphology. The basin (5 km^2)exhibits a prevalent nivo-pluvial runoff regime. Since 1986, the catchment is equipped with a monitoring station, that continuously records water discharge, bedload and suspended load (at 1 hr intervals, and 5 min intervals during floods). In September 1994 an exceptional event (RI $>$ 100 years) occurred in the study site, mobilizing about 4000 tons of material. Currently, the structure is managed by ARPA Veneto – Regional Department for Land Safety. In terms of magnitude, the 31 floods recorded by the monitoring station show a wide range of hydraulic forcing (i.e. peak discharge and effective runoff) and amount transported. Specifically, Q_{peak} ranges within one order of magnitude (1.02 - 10.42 m^3 s^{-1}), while the amount of bedload and suspended load varies by more than 3 orders (i.e. 0.9 t $<$ BL $<$ 1541.7 t). The amounts transported by the floods are investigated as a function of Q_{peak}, using a power-law regression. Bedload (r^2= 0.739) and suspended load (r^2= 0.565) appear positively correlated with Q_{peak}, also showing that floods of a certain magnitude transported more sediments after the exceptional 1994 flood. A comparable behavior can be observed by the Q_{peak}/D_{50} relationship (r^2= 0.688). The ratio between sediment load and effective runoff of the events allowed the temporal trend of transport efficiency to be inferred. The results highlight that nearly a decade with high transport efficiency appears to have occurred subsequently to the September 1994 event. This result confirms that exceptional floods, rarely assessed by short-term monitoring programs, can strongly affect the long-term sediment fluxes. In the case of Rio Cordon, the exceptional event triggered a “memory effect” in the basin, altering the sediment dynamics for roughly 10 years. This research was supported by the Italian Research Project of Relevant Interest PRIN2010-2011, prot. 20104ALME4, ITSE; and by the University of Padova Research Project CPDA149091- WoodAlp.