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Sediment delivery in debris-flow torrents: two case studies in the Italian Alps

Gabriele Bertoldi and D'Agostino Vincenzo

Department TESAF – Land, Environment, Agriculture and Forestry, University of Padova, Italy
(bertoldigabriele.tn@gmail.com)

Flood-risk mitigation strategy is moving from fixed, structural and costly mitigation measures to more effective proactive solutions. This change is driven both by Flood Directive 2007/60/EC and limitations of financial resources and it requires a deep knowledge of the involved processes. In mountain catchments debris flow and debris floods are the most important sources of hazard and their impact on the fan areas is heavily conditioned by the sediment dynamics along the 'transport' reaches of the torrents. Last advances show how many cases of erosion and deposition within the transport reach greatly affect the total volume that is delivered to the fan as well the overall dynamics of the debris flow/flood event. Due to logistic and practical constraints this intermediate phase of the process has been scarcely investigated and the complex behavior of the sediment budgeting in torrent-streams is emerging.

The objective of this work consists of collecting information on the evolution of the debris-flow sediment budget along Alpine torrents in order to provide novel data about erosive, depositional and recharging processes under different geological conditions. Two high frequency debris-flow catchments have been selected: the Rio Rudan basin in the geological setting of the Dolomites (near Cortina d'Ampezzo, Veneto Region, Italy) and the metamorphic dominated catchment of the Rio Gadria (near Lasa, Trentino Alto Adige, Italy), which has been recently instrumented (EU project Monitor II).

Periodical field monitoring has been carried out since summer 2011. 25 cross sections have been observed in the Rio Rudan catchment along a 480 m torrent reach (slope of 36%) where additional sediment entrainment after debris-flow initiation takes place. 20 cross sections have been selected in the upper Rio Gadria basin and more precisely in two reaches close to debris-flow triggerring areas. Other 31 cross sections have been also monitored of the Rio Gadria main channel covering a stream length of 1.4 km downstream of the source areas. Topographical survey of these cross sections have been repeated periodically regardless the occurrence of rainstorm events, so directly detecting morphological changes and tracks of new flow depths on the banks. To monitor the recharging rates from the hillslopes surrounding the channel, some sediment traps have been also installed in the Rio Rudan and in the Rio Gadria (8 and 6 sediment traps respectively).

Thanks to the time comparison of the cross sections under observation a sediment budget was conducted both for successive flood events and/or for silent periods. This budget has been related to morphological, geometric and flow dependent variables in order to detect the forcing and, in case it exists, a trend of the phenomena. The debris recharge of the channels from the directly connected sediment source areas resulted lowly dependent on the rain storms causing debris flows, and more related with the year rainfall, local bank instabilities and failures, which might be amplified by the channel bed moisture before/after the debris-flow occurrence.