A new debris-flow monitoring system in an Alpine catchment

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Introduction
Monitoring of debris flows in instrumented catchments permits collection of data on these phenomena and provides a valuable link with geomorphological and topographical observations of erosion, sediment supply and channel bed evolution. Numerous sites recently instrumented in various geographical regions show that field monitoring is receiving increasing attention in debris-flow research worldwide. This poster presents a new system for debris-flow monitoring in the Gadria catchment (Eastern Alps), installed and managed by the Department of Hydraulic Engineering of the Autonomous Province of Bozen-Bolzano.

Study catchment
The Gadria catchment is located in the upper Venosta-Vinschgau valley (Eastern Alps, Northern Italy). This catchment has been chosen mainly because of the relatively high frequency of debris flows (on average 1-2 per year).

The Gadria catchment has a drainage area of 6.3 km² and ranges in elevation from 1394 m to 2945 m. An important tributary (Strim, drainage area 8.5 km²), minimum elevation 1394 m, maximum elevation 3197 m) joins the Gadria channel close to a filter check dam located near the alluvial fan apex, which has been set as the outlet of both basins.

Bedrock geology of the Gadria catchment belongs to the western Austroalpine domain and comprises metamorphic units dominated by highly deformed mica-schist, gneiss, and quartz-phyllite. The basin is linked to the Venosta valley floor by one of the largest alluvial fans in Alpine valleys (almost 10 km²). This sedimentary linkage deflects the Adige-Etsch River to the opposite valley wall and dominates the Venosta glacial trough.

Hydrological monitoring
Rainfall is measured at three raingauges, two located in the headwaters, the third one in the lower part of the catchment. Two areas in the catchment were chosen to monitor the main hydrological variables associated to debris-flow triggering. Water pore pressure is measured on three steep channel heads in the upper part of the watershed (site A), characterized by no soil and coarse debris, in order to assess the possible control exerted by water pressure increase on sediment mobilization.

Piezometric levels and volumetric soil moisture are recorded (site B) above an erosion scar / past landslide, in order to describe the dynamics of soil wetness related to the initiation of mass movements.

First data
On August 5, 2011 a debris flow of small magnitude occurred in the Gadria channel. This event has represented a first test for the monitoring system recently installed. Video recordings have proved of the utmost importance for interpreting data measured by radar sensors and recognizing the features of the three surges.

The first surge was very fluid and turbulent: these features lead to classify it as a debris flood; the second and third surges display distinctive characteristics of debris flows (high density, absence of turbulence, high boulder concentration at the front). The mean propagation velocity of the front has been calculated as the ratio of the distance between the instrumented cross sections (78 m) to the time interval between the appearance of the peak of the debris-flow surges in the hydrographs recorded by the two radar sensors. Low values of mean flow velocity are consistent with low flow depth; the first, more fluid surge shows a higher value of propagation velocity.

Debris-flow monitoring
The debris-flow monitoring system has been installed near the fan apex, where an open retention check dam with a deposition basin of about 80,000 m³ has been working since the 1970s.

The rain gauges and the sensors of Station 4 transmit data via radio to a receiving station placed close to station 2. Here, a computer stores data transmitted via radio, as well as the videos and the data recorded from the wire-connected sensors (Stations 1, 2 and 3). This sedimentary evolution is monitored by the Department of Hydraulic Engineering of the Autonomous Province of Bozen-Bolzano.

Debris-flow monitoring system

Topographic surveys

Sediment deposition in the debris basin: difference between two TLS-derived DEMs. Accumulated volume: approximately 2000 m³. Part of the debris flowed through the filter check dam.

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