DEBRIS FLOW MONITORING IN THE GADRIA CATCHMENT (UPPER ADIGE BASIN, EASTERN ITALIAN ALPS)

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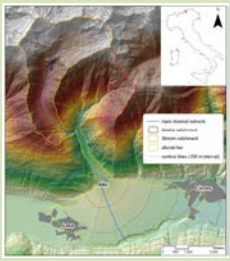
Introduction

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 evolution. 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.

The Gadria catchment



The Gadria catchment is located in the upper Vinschgau (Venosta) valley (Northern Italy). This catchment has been chosen for monitoring 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 km^2 and ranges in elevation from 1394 m to 2945 m. An important tributary (Strimm, area 8.5 km^2) joins the Gadria channel close to a filter check dam located near the alluvial fan apex, where the main monitoring station has been installed.

Bedrock geology of the Gadria basin belongs to the western Austroalpine domain and comprises metamorphic units dominated by highly deformated mica-schist, gneiss, and quartz-phyllite. Thick Quaternary deposits (glacial and fluvio-glacial) are widespread in the basin.

Monitoring activities and instrumentation (2011-2012)

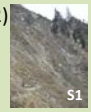
Hydrology

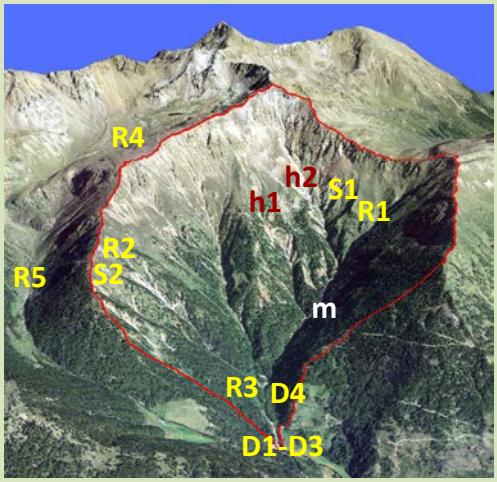
- Precipitation

Rainfall is monitored by 3 raingauges (R1, R2, R3) within the Gadria basin (radio-transmitting to the server), plus two additional stand-alone raingauges in the adjacent Strimm basin (R4, R5). In summer 2012, a XPOL Radar has been deployed with 3 disdrometers and additional raingauges.

- Soil water pressure and moisture

Water pore pressure is measured on three steep channel heads in the upper part of the watershed (S1). In one of this channel, the free surface level is also monitored. Piezometric levels and moisture in the soil are recorded just above a shallow landslide scar (S2)





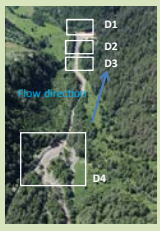
Channel morphology and hillslope erosion

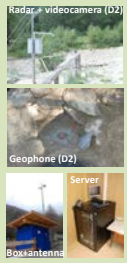
Erosion and deposition patterns are periodically monitored by surveying 35 cross sections along 1.6 km of the main stream (m), and other 20 cross sections located in two headwater channels (h1, h2). Hillslope erosion is measured using 6 sediment traps on active sediment source areas.

Debris flow observation and detection

4 stations along the channel:

(D1) 2 videocameras (with spotlights)
(D2) 1 videocamera, 1 radar sensors, 2 geophones
(D3) 1 radar sensors and 2 geophones
(D4) 1 radar sensor, 1 geophone (+2 avalanche pendulum from 2013)

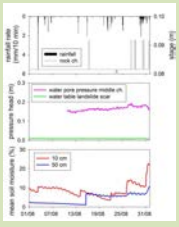




Because the basin is not covered by GSM, raingauges and instruments at station 4 radio-transmit data to a server (8 TB capacity) placed beside station 2, which also stores data and videos from the other stations and send them to the Internet.

Observations in the period 2011-2012

In summer 2011 two debris flows have occurred in the Gadria channel. The first, small event (<1000 m^3) on July 13th did not reach the monitoring station and caused aggradation in all cross sections. In contrast, a slightly larger event on August 5th has caused bed erosion in all the channels. No debris flows occurred in 2012.

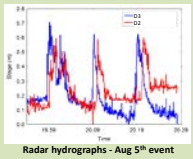


Water pressure and volumetric content in the upper soil layers has shown a clear response to rainfall events, which marked delay and attenuation at the lower depth, in contrast to variations in the (ephimeral) groundwater level which have not been detected by our instruments.

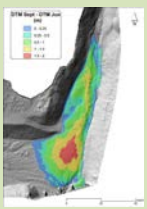
Soil saturation has not been reached, neither during the two small debris-flow events in 2011.

On August 5th, 2011, a debris flow of small magnitude occurred in the Gadria channel. The first surge was very fluid and turbulent (front velocity 2.5 ms^{-1}), and more similar to a debris flood; the second (1.7 ms^{-1}) and third (1.0 ms^{-1}) surges display distinctive characteristics of debris flows (high density, very low turbulence, boulders concentration at the front).

Videoframes from D2


Radar hydrographs - Aug 5th event

Videoframe from D1 (retention basin)



Sediment deposition (~2000 m^3) in the retention basin has been evaluated as difference between two TLS-derived DTMs.

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