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Evaluation of different methods for discharge measurement for debris flows at the Lattenbach creek

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The Lattenbach creek, District of Landeck, Tyrol is a very active torrent located in a geologic fault zone in the western part of Austria with a catchment area of 5.3 km^2. The channel separates the Northern Limestone Alps in the North from the Crystalline Alps in the South. The highest elevation in the watershed is around 2900 m above sea level (asl), the confluence with the river Sanna at 840 m asl. Aside from the regular flood events with bedload transport, the torrent produced five debris flows and three debris floods within recent years. Due to the frequent debris flows and debris floods events the torrent is monitored by the Institute of Mountain Risk Engineering since several years. The parameters that are currently measured during an event include meteorological data (rainfall, temperature, etc.) in the upper part of the catchment (station Dawinalpe) and run-off data from the middle and lower reach of the torrent at the villages Grins and Pians.
In the last years the monitoring equipment has been constantly improved. Additional to the standard sensors like several radar gauges for water level measurements, a first version of a detection system based on a combination of infrasound and seismic sensors is installed at the monitoring station closed to Grins. This system is build up on a minimum of one seismic and one infrasound sensor which are co-located and a microcontroller which runs a detection algorithm to detect debris flows and debris floods with high accuracy in real time directly on-site. Two of this system are installed in a distance of 90 m and can therefore be used to measure the surge velocity.
Further a high frequency Pulse Doppler Radar has been installed, which provides the opportunity to measure the surface velocity of a debris flow in different range gates. Together with a recently installed 2D-Laser scanner this setup provides the possibility to determine a very precise approximation of the discharge with a high temporal resolution by multiplying the scanned cross sectional wetted area with the surface velocity of the related range gate.
This works compares the different measurement methods (water level by radar, seismic and infrasound data and Pulse Doppler Radar with 2D-Laser scanner) for three debris flows, which occurred within eight days in August 2015 and for one debris flow which occurred in September 2016. The three different methods to determine the surge velocity and to calculate the discharge of the events are evaluated to show the advantages and restrictions of these methods.