Evaluation of Different Methods for Debris Flow Velocity Measurements at the Lattenbach Creek

Johannes HUEBL[1*], Andreas SCHIMMEL[1] and Richard KOSCHUCH[2]

[1] Institute of Mountain Risk Engineering, BOKU University, Austria
[2] IBTP Koschuch e.U., Austria
[*]Corresponding author. E-mail: johannes.huebl@boku.ac.at

INTRODUCTION

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 km². Due to the frequent debris flow and debris flood events the torrent is monitored by the Institute of Mountain Risk Engineering for 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 flow depth, flow surface topography, ground movement and velocities in the middle reach of the torrent. These recorded parameters should facilitate the comparative calculation of an instantaneous debris flow hydrograph at two nearby cross sections.

MONITORING SETUP

In the last years the monitoring equipment has been constantly improved. Additional to the standard sensors such as radar devices for flow level measurements at two sites with a distance of about 50 m, two detection systems based on a combination of infrasound and seismic sensors are installed in a distance of 90 m at the monitoring station in the middle reach. The signals of these systems can therefore be used to calculate the velocity of the debris flow front, using the time span between the onset of the signals as representative value (time-distance method, **Fig.1a**). Further a high frequency Pulse Doppler Radar has been installed, which provides the opportunity to measure the surface velocity distribution in all range gates, each with a length of 25 m, with a temporal resolution of one second. As significant values result from these velocity distributions the mode and the maximum value are considered for further calculation (**Fig. 1b**).

Together with a recently installed 2D-Laser scanner to record the digital surface model (DSM) of the debris flow and to calculate the cross section of the resulting flow, this setup provides the possibility to determine a rather precise approximation of the debris flow hydrograph with a temporal resolution of one second.

RESULTS

We use the data to compare the surge front velocity estimation by the time-distance method (water level and seismic signal) with an instantaneous surface velocity distribution in different range gates (Pulse Doppler Radar) for the September 16th, 2016, debris flow. The calculated front velocities range between 6 and 10.5 m/s for all the surges (**Fig. 2**). From the velocity spectrum within a range gate the maximum velocity value (max) and the most frequent value of the amplitude (mode) are considered as relevant parameters for discharge and sediment budget calculations. The mode values vary round 4 m/s, whereas the maximum values are about 8 m/s (**Fig. 2**).

CONCLUSIONS

The debris flow velocity estimation using high-frequency radar seems to be a practical way to estimate velocities and volumes, but there is still some effort needed to define the proper statistical parameters of the surface velocity distribution. The maximum velocity may produce the best result for discharge estimation of a debris flow, and the mode of velocity may result in the better estimation of the total load of a debris flow.

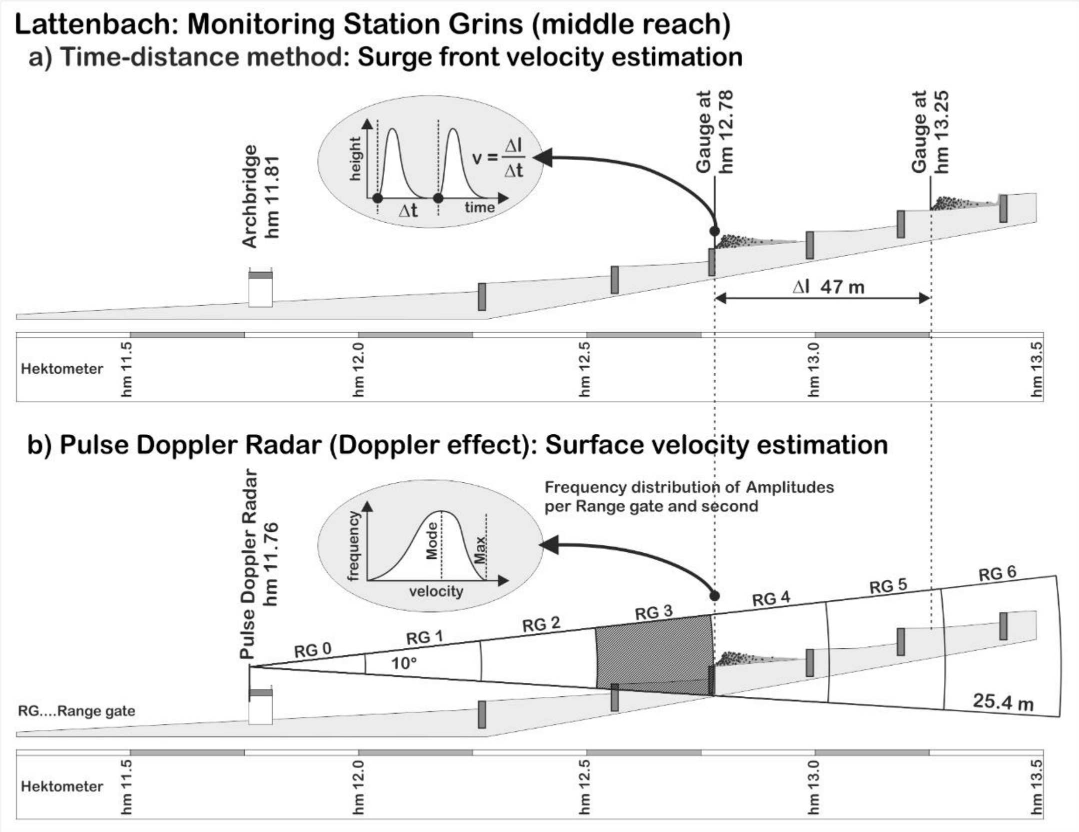

Fig. 1 Velocity estimation by a) time-distance method and b) application of the Pulse Doppler Radar

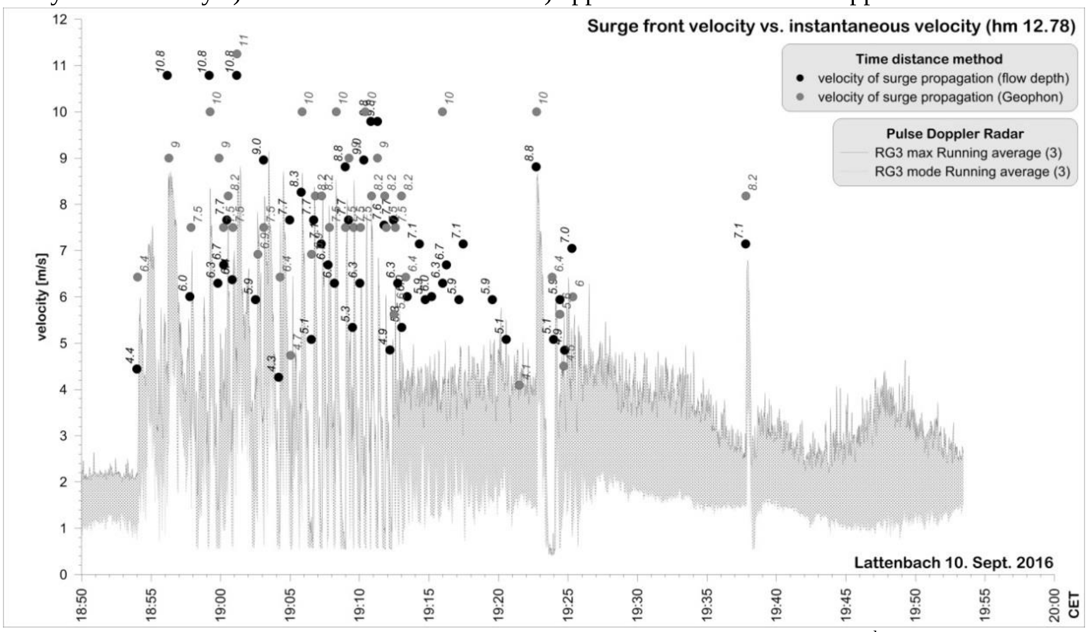

Fig. 2 Estimated velocities with the different methods for the debris flow on September 16th, 2016 at hm 12.78

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