Simulations of the occurrence of runoff-generated debris flows by means of hydrological models in headwater rocky basins

Martino*, Matteo, Leonardo, Matteo, Alessandro, Carlo

1 Introduction

The debris flows are generated when rainfall intensity exceeds infiltration rate computed according to [1], rainfall thresholds, hydrological models can emulate the timing of debris flow monitored sites are those of Rovina di Dolomites. Rocky Mountain Scree at their base. Cliffs are incised by several chutes where runoff usually concentrates. At their base rocky cliffs generate notable discharges during summer by the erosive activity of flow channels start, originated by the transit timing of the first debris flow monitored sites are those of Rovina di Dolomites.

2 Material and methods

2.1 The rainfall-runoff model

Parameter | Rocky surface | Mountain pine slopes | Scree slopes | $f_c = \frac{P}{\text{CN}}$ | $K = \frac{S}{9}$ | \(f_c = \frac{0.85}{(1 - C)} + 0.1\) | $U = \frac{S}{2} + 1/3$ |
<table>
<thead>
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<td>$P$</td>
<td>(\text{mm} \cdot \text{day}^{-1})</td>
<td>(\text{mm} \cdot \text{day}^{-1})</td>
<td>(\text{mm} \cdot \text{day}^{-1})</td>
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<td>(\text{mm} \cdot \text{day}^{-1})</td>
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<tr>
<td>$C$</td>
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<td>$S$</td>
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<td>$f_c$</td>
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2.2 The debris-flow sites with the monitoring activities

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minutes overpasses
portion of rainfall
- 

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DFHM8

Fig. 1.

Table 2. Characteristics of the precipitations that triggered debris flows in the monitored catchments.

<table>
<thead>
<tr>
<th>Area</th>
<th>Cancia</th>
<th>Rio Gere</th>
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<tbody>
<tr>
<td>Duration</td>
<td>0.5000</td>
<td>0.8333</td>
</tr>
<tr>
<td>1st Stage</td>
<td>0.5833</td>
<td>0.8333</td>
</tr>
<tr>
<td>2nd Stage</td>
<td>0.6500</td>
<td>0.8333</td>
</tr>
<tr>
<td>3rd Stage</td>
<td>0.9300</td>
<td>0.8333</td>
</tr>
<tr>
<td>Max Elevation</td>
<td>34.3</td>
<td>34.3</td>
</tr>
<tr>
<td>Mean Elevation</td>
<td>28.2</td>
<td>28.2</td>
</tr>
<tr>
<td>Slope</td>
<td>17.2</td>
<td>17.2</td>
</tr>
<tr>
<td>Rock Type</td>
<td>23%</td>
<td>23%</td>
</tr>
<tr>
<td>Heathland</td>
<td>28%</td>
<td>28%</td>
</tr>
<tr>
<td>Land use</td>
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<td></td>
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</tbody>
</table>

2.3 The recorded debris flows

Since August 1, 2015, the monitoring of rainfall has been carried out with the use of a network of 13 rain gauges, some of which are part of the monitoring stations. Rainfalls have been identified as concentrated events that occurred in Cancia on July 23, 2020, as recorded by the monitoring stations. D and I are the max intensity recorded in a consecutive rain gauge, with reference to the Dimai basin where the monitoring stations and standalone rain gauges. In the monitored headwater basins represent the typical dolomitic catchments, differing from the upper part and active erosion, the locations of the basins in the province of Belluno.

Table 3. Characteristics of the precipitations that triggered debris flows in the monitored catchments.

<table>
<thead>
<tr>
<th>Date</th>
<th>August 1st, 2018</th>
<th>July 1st, 2020</th>
<th>July 8th, 2021</th>
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<td>Duration</td>
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<td>0.8333</td>
<td>0.8333</td>
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3 Results

![Graphs showing hydrographs simulated by the model against measured data.](https://doi.org/10.1051/e3sconf/202341502002)
4 Conclusions

The impervious morphology of dolomitic headwater catchments makes monitoring activities challenging. The knowledge of discharge behaviour is fundamental both for improving the comprehension of debris flow triggering and for modelling the initiation dynamics on the scree slopes at the base of rocky cliffs. We documented the hydrological response of two catchments to three convective rainfall events. Observed debris-flow hydrographs exhibit an impulsive character. A hydrological model has been tested to reproduce this behaviour. Simulated discharges have been compared to the stage hydrographs of observed debris flows in the Cancia and Rio Gere catchments. The robustness of the model has been tested by comparing the simulated runoff peak times and the timing of debris flows. Differences in timing result in a few minutes. Moreover, runoff replicates quite entirely the recorded stages, except when discharges decrease below the triggering threshold of debris flows. These results ensure reasonably good predictability of the model, permitting its potential use in the evaluation of debris-flow solid-liquid waves in early warning systems.

The authors wish to thank the Regional Agency for Environmental Prevention and Protection of Veneto for the meteorological data; the association "Regole d'Ampezzo", which permitted to set up of rain gauges and monitoring stations; the Public Work Department of Veneto Region for the LiDAR data.

References