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Debris Flow risk assessment: a case study

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In mountain torrents, intense and localised storms may cause flash floods with important sediment transport. In steep torrents, the sediment discharge may increase so that the solid concentration often exceeds figures of 40-50%. This is the case of the debris flows that transport downstream huge volumes of sediments that are then deposited on the alluvial fans, often highly populated. In recent years debris flow have been recognized as one of the major natural risks.

The analysis of the procedures actually in use for risk assessment (Disaster Prevention Research Institute, FEMA-FDA) highlighted the great exemplifications made in the representation of phenomena and consequent limits of these models.

As well known, the assessment of risk involves the evaluation of both hazard and vulnerability.

To quantify debris flow hazard mathematical models simulating triggering and propagation of debris flow and the deposition of solid fraction are available, but significant uncertainties affect the results. More specifically, the mathematical models triggering mechanism and separation of the solid phase from the liquid phase in the deposition area requires a very detailed calibration.

The definition of the vulnerability function is also a relevant problem since few applications are available in literature and in many cases Authors adopt vulnerability functions derived from other applications (snow avalanches or flood waves). These functions usually relate vulnerability to flow velocity or to flow depth: these variables do not seem appropriate to fully describe debris flow.

All these uncertainties in both mathematical models and definition of vulnerability suggest the application of a Monte Carlo analysis by defining a large number of sce-

narios.

A set of different mathematical models are applied in cascade:

- simulation of a series (1000 years long) of hourly rainfalls and disaggregation of hourly rainfalls in short intervals (5 min long) during storms,
- a very simple triggering model based on threshold values of rainfall intensity and duration,
- rainfall-runoff analysis to estimate total liquid and solid discharge hydrograph,
- simulation of the debris flow propagation and deposition.

Different vulnerability functions are used to estimate the specific risk and main differences in the results are emphasised and discussed.

This procedure is applied to evaluate specific risk in the alluvial fan of Ardenno, located in Valtellina valley, in Italian Alps.