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A toolbox for rockfall Quantitative Risk Assessment

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Rockfall Quantitative Risk Analysis for mitigation design and implementation requires evaluating the probability of rockfall events, the probability and intensity of impacts on structures (elements at risk and countermeasures), their vulnerability, and the related expected costs for different scenarios. A sound theoretical framework has been developed during the last years both for spatially-distributed and local (i.e. single element at risk) analyses. Nevertheless, the practical application of existing methodologies remains challenging, due to difficulties in the collection of required data and to the lack of simple, dedicated analysis tools.

In order to fill this gap, specific tools have been developed in the form of Excel spreadsheets, in the framework of Safeland EU project. These tools can be used by stakeholders, practitioners and other interested parties for the quantitative calculation of rock fall risk through its key components (probabilities, vulnerability, loss), using combinations of deterministic and probabilistic approaches. Three tools have been developed, namely: QuRAR (by UNIMIB), VulBlock (by UPC), and RiskNow-Falling Rocks (by ETH Zurich). QuRAR implements a spatially distributed, quantitative assessment methodology of rockfall risk for individual buildings or structures in a multi-building context (urban area). Risk is calculated in terms of expected annual cost, through the evaluation of rockfall event probability, propagation and impact probability (by 3D numerical modelling of rockfall trajectories), and empirical vulnerability for different risk protection scenarios. Vulblock allows a detailed, analytical calculation of the vulnerability of reinforced concrete frame buildings to rockfalls and related fragility curves, both as functions of block velocity and the size. The calculated vulnerability can be integrated in other methodologies/procedures based on the risk equation, by incorporating the uncertainty of the impact location of the rock block and the subsequent damage level. RiskNow–Falling Rocks allows the probabilistic calculation of the risk on rockfall protection galleries, providing a specialised tool for rockfall risk analysis and mitigation along roads. The analysis accounts for rockfall detachment, falling, gallery failure, and consequences to road traffic, and calculated risk using Bayesian Probabilistic Networks (BPN) both in an aggregated form and separately for property damage or expected fatalities.

This contribution aims to facilitate the consistent use of information gathered through different means of observations and information, as a first step towards the development of automatic procedures for the quantification of risk in landslide exposed areas.