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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Estimation of the return period of rockfalls according to the block size" *by* Valerio De Biagi et al.

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The authors acknowledge Anonymous Referee 1 for his interesting comments and observations. First of all, as he underlined, the quality of the time-magnitude distribution depends on the quality of the initial data. In order to highlight the importance of having precise input data, the authors intend to modify the following paragraphs in the manuscript (page 5, line 3).

"*As described in detail in this section, the required data for deriving a volume-frequency relationship are:*

(i) a catalogue of the observed events, i.e., events with quantitative rockfall volume estimates. The catalogue is denoted as C. Referring such input, at present, no

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real-time automatic systems able to detect the occurrence of a rockfall event are diffused. Few examples of monitoring through sensors able to detect microseismic activity are present in the literature. Unfortunately, the calibration of such systems is difficult and the results largely depends on the environmental noises. Other non-real-time methodologies exist. For example, if the phenomena occur in a forested area, the continuous growing of plants can give information about potential impacts (and tree damages) occurred in the past (Dorren et al., 2007). Anyway, this method suffers many epistemic uncertainties: the same rockfall event can damage more than one tree, or, is not possible to distinguish between one or more events occurred during the same plant growing season (Moya et al., 2010). In alternative, topographical approaches, e.g., laser scanning, are largely used to monitor rock faces (Abellán et al., 2011), but a lasting survey campaign is required to get a robust catalogue of events. The direct observation is still the most common, being a simple and cheap solution for drawing up a catalogue of rockfall events. Usually, local government, road supervisors or forestry service agents are involved in the collection of data related to rockfall events, as reported by Dussauge et al. (2002). Since direct observation is affected by errors, in the proposed procedure, a threshold volume is considered, as described in the following.

(ii) *a list of measured volumes that may have fallen down in any time. The list is denoted as F. Referring to such input, different counting procedures have been developed. The simplest method consists in counting the fallen blocks and classifying them into volume classes. Different approaches have been proposed, depending on the size of the rockfall. For example, Corominas et al. (2012) directly counted (and classified) all the fallen blocks in small-size rockfall events occurred in Andorra. For larger phenomena, Ruiz-Carulla et al. (2015) proposed a methodology for obtaining a rockfall block size distribution (RBSD) essentially based on block counting in small sampling plots and homogenization to the whole* *debris cover. More complex methods make use of topographic techniques (Digital Elevation Models, orthophotos) to identify the existing discontinuity sets and to compute the volume of the unstable rock blocks on the slope face (Jaboyedoff et al., 2009; Mavrouli et al., 2015). In such cases, the time-magnitude relationship would refer to the release of blocks and fragmentation and comminution should be considered in the propagation analysis. In order to avoid this problems, the authors suggest to consider a distribution of volumes obtained from surveys in the representative area.*

Obviously, both the catalogue..."

Referring to the second observation raised in AR1 comments, the authors propose to add the following paragraph in the Introduction of the manuscript (end of page 1).

"*The magnitude-frequency relationship is at the basis of the probabilistic hazard analysis. In seismic analysis, Gutenberg-Richter's law expresses such relationship. Straub and Schubert (2008) proposed a probabilistic risk approach for rockfall hazard based on a frequency law, but not investigating about its nature. Lari et al. (2014) considered the annual frequency of occurrence of a rockfall volume as a "given" data. The proposed approach intends to be the base for more complex and complete probabilistic hazard assessments.*"

Additional references

A. Abellán, J. M. Vilaplana, J. Calvet, D. García-Sellés, and E. Asensio (2011) Rockfall monitoring by Terrestrial Laser Scanning – case study of the basaltic rock face at Castellfollit de la Roca (Catalonia, Spain), Nat. Hazards Earth Syst. Sci. 11: 829–841

J. Corominas, O. Mavrouli, D. Santana, and J. Moya (2012) Simplified approach for obtaining the block volume distribution of fragmental rockfalls. Landslides and Engineered Slopes. Taylor and Francis 2:1159-1164

L. Dorren, F. Berger, M. Jonsson, M. Krautblatter, M. Molk, M. Stoffel, and A. Wehrli

(2007) State of the art in rockfall – forest interactions. Schweizerische Zeitschrift fur Forstwesen 158(6):128-141

C. Dussauge, J. Grasso, and A. Helmstetter (2003) Statistical analysis of rock fall volume distributions: implications for rock fall dynamics. J Geophys Res B 108(B6):2286

M. Jaboyedoff, R. Couture, and P. Locat (2009) Structural analysis of Turtle Mountain (Alberta) using digital elevation model: toward a progressive failure. Geomorphology 103:5-16

S. Lari, P. Frattini, and G.B. Crosta (2014) A probabilistic approach for landslide hazards analysis. Engineering Geology 182:3-14

O. Mavrouli, J. Corominas, and M. Jaboyedoff (2015) Size Distribution for Potentially Unstable Rock Masses and In Situ Rock Blocks Using LIDAR-Generated Digital Elevation Models. Rock Mech Rock Eng 48:1589-1604

J. Moya, J. Corominas, and J. Pérez Arcas (2010) Assessment of the Rockfall Frequency for Hazard Analysis ad Solà d'Andorra (Eastern Pyrenees). In: Tree rings and natural hazards: a State-of-Art, Stoffel et al. (Eds.): 161-176

D. Straub, and M. Schubert (2008) Modeling and managing uncertainties in rockfall hazards. Georisk, Assessment and Management of Risk for Engineered Systems and Geohazards 2:1-15

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