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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 deeply thank Dr Hantz for his observations and comments to the discussion paper. In the following we answer each point raised in the comment posted on NHESS interactive platform on Oct 28, 2016.

The title will be changed in the final version of the manuscript in accordance to Dr Hantz's comment.

Referring to comment no.1, related to Section 2 (Power laws in rockfall analysis), we will update the manuscript following the suggestions proposed Dr Hantz. In particular, we will clearly state that the focus of the paper is on block volume distribution. This will be first highlighted in the introduction; in particular, we suggest to rewrite the first sentence of the last paragraph of the introduction (page 1, lines 15-16) as "*With the*

aim to contribute. . .for estimating the block volume frequency relationship that. . .".

Anyway, in presenting power laws in rockfall analysis we cannot avoid to speak about the studies on rockfall volume distribution. In this sense, we will mention the studies made with laser scanning technique in which very small rockfalls have been recorded (Rosser et al., 2005; Abellan et al., 2010; Dewez et al., 2013).

As suggested, the final paragraph of the section, the one discussing the values of the exponent b of Eqn. (2) will be totally rewritten including the observations made by Dr Hantz. In the following, we propose a possible text:

"*As mentioned, Eqn. (2) can be related to the distribution of the volumes of the fallen blocks. The values of the parameters a and b are variable. Parameter b could assume different values in the range 0.5 to 1.3. Various examples can be found in literature. Crosta et al. (2006) determined different fractal dimensions in analyzing grain size curves obtained from different spots of the deposit of a large rock avalanche occurred in 1987 in Central Italian Alps. Ruiz-Carulla et al. (2015) performed a detailed survey in order to highlight the differences in blocks distribution in various portions of the deposit of a rockfall and found a b value ranging from 0.89 to 1.28. The same authors analyzed the dependency between the free fall height and the value of b for various well documented rockfall events in Spain. They got that b increases as much as the falling height of the blocks increases (Ruiz-Carulla et al., 2016). Observing the data reported in the previously mentioned paper, it emerges that the lithology of the rock mass affects the value of parameter b. For similar free fall heights, b = 0.72 was computed for rockfall in limestones and b = 0.92 for rockfall in schists. The larger the b-value, the more comminuted the deposit. Hantz et al. (2016) surveyed four deposits around Grenoble, France, and found b-values ranging from 0.63 to 1.12. Parameter a exhibits relevant variability from one site to another and it is essentially linked to the number of blocks counted on the deposit of the rockfall.*"

Referring to comment no.2, the notion of representative area will be better detailed.

In particular, we propose to add in page 5, line 2 the following text: "*A representative area is defined as the portion of deposit beyond a defined line, in which the hazard is computed.*" The need of including in catalogue $\mathcal{C}$ only the events recorded in the representative area will be pointed out at page 5, line 4: "*(i) a catalogue of the observed events in the representative area...*".

Referring to comment no.3, we will update the manuscript according to the suggestions of Dr Hantz, both in the explanation of Eqn. (5) and in the removal of the sentence at page 6, line 1.

Referring to comment no.4, the Equation (6) will be explained as follows (page 8, line 21): "*The value of the threshold volume influences the temporal length of $\mathcal{C}^*$. Since the decision of monitoring a rockfall prone slope usually begins after the occurrence of an event larger than the threshold volume, it is possible to consider that, in a previous time interval of about half the annual mean frequency of the events of the reduced catalogue, i.e t/n^*, no events were recorded. This means that the temporal length of the reduced catalogue is*

$$t^* = \tau(\mathcal{C}^*) = t + \frac{t}{2n^*}. \qquad "$$

Referring to comment no.5, the geological context of the site is described in the following as it will be added to the manuscript (page 8, line 19): "*The source area is composed of gneiss, which are fine to medium grained rocks with the dominant bedding plane orientation 195/35. Discontinuity sets are observed along 270/85 and 320/80 planes, the latter being the orientation of the slope face.*"

Referring to comment no.6, it is important to notice that: "*Generalized Pareto Distribution has been chosen for fitting the values of the list $\mathcal{F}$ for various reasons:*

- *Pareto family distributions are very similar to power law distribution except for the fact that the former are bounded distributions. The bound is represented by the*

location parameter μ in Equation (9);

- *GPD differs from the classical Pareto model for the introduction of a location parameter, which does not affect the slope of the right part of the plot, being governed by the exponent $-1/\xi$;*
- *GPD is suitable for extreme value analysis. Pickands (1975) introduced it in the extreme value framework, as the distribution of a sample of exceedances above a certain high threshold.*

In rockfall studies, the main distinction between GPD and power law can be observed when the value of the volume tends to zero. GPD is finite for $v \to 0$, while power law diverges to ∞, as required by scale invariance (Turcotte, 1997). That is, for the calculations proposed in the present paper, GPD and power law have the same right tail (linear in a log-log plot), while for small volumes, the former is able to catch the fact that, as much as the volumes are close to the threshold value, V_t, a finite number of blocks is counted in the representative area." The previous text will be inserted in page 13, line 6.

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