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Rockfall magnitude-frequency estimation: how data acquistion strategies influence methodological results

Antoine Guerin (1), Antonio Abellán (1), Manuel Jesús Royán (2), Dario Carrea (1), Joan Manuel Vilaplana (2), and Michel Jaboyedoff (1)

(1) Institute of Earth Sciences, Faculté des Géosciences et de l'Environnement, University of Lausanne, Géopolis (3129), 1015, Lausanne, Switzerland. (antoine.guerin@unil.ch), (2) RISKNAT Group, GEOMODELS, Departament de Geodinàmica i Geofísica, Facultat de Geologia, Universitat de Barcelona, C/ Martí i Franqués, s/n, 08028, Barcelona, Spain.

The modelling of rock cliff erosion rates through rockfall magnitude-frequency is a well-known technique extensively carried out before by many authors (e.g. Barlow et al., 2012; Guerin et al., 2014). These studies show how the relation between frequency (F) and magnitude (M) of rockfalls is well fitted by a negative power law [F = a*Mˆ(-b)], the value of its parameters varying considerably according to differences in type of material, structural settings, climate, etc. Nevertheless, little insight is given into how methodological and instrumental issues influence power law, typically into how data acquisition accuracy, minimum level of detection and spatio-temporal resolution influence this relationship.

Extensive Terrestrial Laser Scanner (TLS) campaigns were carried out during more than six years (from Nov.2007 to Dec.2013) in order to monitor a semi-circular rock wall of 150 m width and 25 m height, situated in Puigcercós (Pallars Jussà, Catalonia, Spain). The analysed cliff represents the main outcrop of a landslide that took place in 1881, the scarp being affected by a high number of rockfalls per year (Royan et al., 2013). The spatial-temporal rockfall frequency is determined by comparison of very dense point clouds (about 500 points/m2) acquired in 22 fieldwork campaigns at different dates.

The TLS data processing (data filtering, alignment, georeferencing, meshing and comparison) was carried out with the ImInspect module of Polyworks software. The analysis of the magnitude-frequency parameters was carried out for each period of comparison using a script specifically developed in Matlab software. We used the image processing toolbox aiming to extract rockfall areas (number of pixels) and centroids for each event. We carried out an exploratory analysis in order to investigate how certain parameters linked to data acquisition -spatial and temporal resolution, level of detection, etc.- influence the complementary cumulative distributions of the rockfall frequency. Furthermore, for each observation period, we have examined if there exists a correlation between the rockfall characteristics (magnitude and frequencies) and the associated weather conditions (precipitations, temperature, wind).

In this work we demonstrated how the acquisition strategies play a significant role on the exponent value of magnitude-frequency cumulative distributions. Moreover, the level of detection influenced the detected number of small rockfalls and therefore, the censoring effect linked to the presence of underrepresented volumes. Nevertheless, no clear correlation has been made regarding atmospheric conditions yet; a great quantity of parameters should be taken into account in order to clearly identify a trend.