ASSESSMENT OF ROCKFALL HAZARD USING DATABASES AND CONSIDERING THE FREQUENCY OF TRIGGERING METEOROLOGICAL EVENTS

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ABSTRACT

Rockfalls are unpredictable sources of danger for transportation routes (roads and railways). Thus, assessment of their probability of occurrence is a major challenge for risk management. From a qualitative perspective, experience tells us that rockfalls occur mainly during periods of rain, snowmelt, or freezing-thaw. The careful analysis of rockfall databases can be considered as a way of quantifying the correlation between rockfalls and their possible meteorological triggering events. Unfortunately, such a correlation is often difficult to identify because i) rockfalls are too rare for the use of classical statistical analysis techniques and ii) all intensities of triggering factors do not have the same probability (e.g. days with heavy rainfall are less frequent than days with low rainfall).

In this study, we propose a new approach to investigate the correlation between rockfalls and factors such as rain, freezing periods, and strong temperature variations. This approach was successfully tested on three French rockfalls databases that come from (1) the national highway RN1 on La-Réunion Island, (2) a railway in the Bourgogne region, and (3) a railway in the Auvergne region. The first one exhibits an exceptionally high frequency of rockfalls (approximately 950 events over 11 years), whereas the other two databases are more classical (approximately 140 events over 11 years).

Figure 1 – Qualitative correlation between rockfalls and rainfalls for the La Réunion Island and Bourgogne databases

A basic correlation analysis is only able to highlight an already obvious correlation in the case of a “rich” database (Figure 1). The new methodology, which weights the number of rockfalls by the probability of occurrence of the studied triggering factor (rainfall, temperatures, and freezing period), appears to detect correlations in “rich” and “poor” databases. In the case of La-Réunion Island, a correlation between rainfalls (daily and cumulative) and rockfalls is highlighted. This correlation is maximal for the cumulative rains occurring during the previous day of the event (Figure 2). Regarding the Bourgogne region, the new approach also detects a correlation between the cumulated rainfall and rockfalls in spite of the scarceness of the database. More precisely, the method indicates that two days running with intense rainfall is the most favorable meteorological factor among those studied to trigger rockfall events (Figure 2). Finally, a correlation between the daily minimum temperature and the number of rockfalls was also identified for the Auvergne database. In that case, the maximal correlation occurred for the minimum temperature of two days before the event.
Figure 2 – Application of the method for a) the cumulated rain over two days (La Réunion Island database) and b) the cumulated rain over three days (Bourgogne database)

Our approach is easy to use and leads to identify the conditional probability of rockfalls, according to the selected meteorological factor. It will help to optimize risk management in the considered areas with respect to their meteorological conditions.

**KEYWORDS**

Rockfall, Hazard assessment, Database, Triggering factor