



Landslides induced by seismic events in Portugal mainland: identification and characterization

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Portugal mainland is located in a tectonic environment responsible for a relevant neotectonic and seismic activity. However, the information available regarding earthquakes that induced landslides in Portugal is few and dispersed. Most of Portuguese landslide studies have been focused on slope movements triggered by precipitation reflecting their high frequency of occurrence. In addition, significant earthquakes that triggered landslides in Portugal mainland occurred long time ago. In fact, the last important seism occur in 1909, the Benavente earthquake. Therefore, the analysis of earthquake-induced landslides has to be focused on historical records, which makes difficult the field recognition of these landslides.

Considering the dispersion of information, and the little work on these subject, until now, the main purpose of this work was: (i) to identify landslides induced by seismic events in Portugal mainland, (ii) to recognize the current morphology of these landslides and their main geomorphologic features; (iii) to analyze the spatial distribution of landslides triggered by earthquakes and to compare it with the spatial distribution of landslides induced by rainfall.

The adopted methodology includes the identification of landslides triggered by earthquakes through historical records, then, afterwards, these were included into a database and mapped, as rigorously as possible. The identification of landslides in the present morphology was based in the analysis of cartographic, photographic, historical and archaeological documents, and was supported by digital elevation models (DTM) and fieldwork.

As result, 29 earthquake-triggered landslides were identified, dated from the year 309 to 1969. However, the terrain recognition of these landslides was very difficult because of their old age and the morphologic modifications. In most cases, it was not possible to accomplish the accurate identification of landslides at the slope level. Consequently, the relationship between landslides, the conditioning factors and the seismic parameters was not always possible to establish. Despite these limitations, it was possible to conclude that for the identified rockfalls the slope are below the 35-40°, reported by Keefer (1984). In addition, considering the relation between earthquake magnitude and maximum distance of landslide to epicenter, the vast majority of the analyzed landslides (triggered by the 26th January of 1531, 1st November of 1755, 23rd April of 1909 and 28th February of 1969 earthquakes) are included in envelopes proposed by Keefer (2002).

Finally, the earthquake-triggered landslides are concentrated in the southern and central areas of Portugal mainland, close to the main seismic sources, contrasting with the recurrent occurrence of landslides induced by precipitation in the northern and central parts of the country.