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Impact of Circulation Weather Types in the study of Landslides in the Northern Lisbon region

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ABSTRACT

Landslides in the region north of Lisbon during the last 60 years have been induced almost entirely by rainfall, and landslide activity has been confined to very wet periods. Previous results obtained using empirical relationships between rainfall intensity and slope instability show that critical rainfall conditions for failure are not the same for different types of landslides (Zêzere et al, 2008). Shallow translational soil slips have been related to intense rainfall periods ranging from 1 to 15 days, while deep slope movements (translational slides, rotational slides and complex and composite slope movements) have been occurred in relation to longer periods of less intense rain, lasting from 30 to 90 days. The different time span is consistent with the distinct hydrological triggering conditions related to different types of landslides. Intense rainfall is responsible by the rapid growth of pore pressure and by the loss of the apparent cohesion of thin soils, resulting in failure within the soil material or at the contact with the underlying impermeable bedrock. Long lasting precipitation periods allows the steady rising of the groundwater table, thus resulting in deep failures in soils and rocks by the reduction of shear strength.

Rainfall information regarding 19 important landslide events occurred between 1958 and 2001, and the knowledge of the circulation weather types (CWTs) affecting those days, allow us to study the relationship between the CWTs frequency and the occurrence of landslide episodes. We have identified 10 basic CWTs (Cyclonic, Anticyclonic and 8 directional types) following the methodology previously adopted (Trigo and DaCamara, 2000).

The composites and anomalies of several meteorological fields associated to landslide events show a large precipitation anomaly in the central region of Portugal and an anomalous low-pressure system located northwest of Iberia. This pattern is similar for both shallow and deep landslides events. However, for shallow landslide events, the rainfall and sea level pressure anomalies are stronger in the first 5 and 15 days anteceding the event and practically nonexistent in the 30 days previous to the event, while deep landslide events show higher anomalies that extent backwards 30 days prior to the event. The CWTs most associated to the days with landslide events are the “wet” weather types: cyclonic (C), westerly (W) and southwesterly (SW) with 76% of the days with events having at least one of these types associated. Looking at the 30 days that antecede an event, the shallow landslides are preceded by 44% days with wet CWTs pattern, while for the deep events this number rises to 69% of wet CWTs. In any case for both type of landslide events the frequency of wet CWTs is considerably above the climatological values observed that amount just up to 28% of wet CWTs.

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Zezere JL, Trigo RM, Fragoso M, et al. (2008). Rainfall-triggered landslides in the Lisbon region over 2006 and relationships with the North Atlantic Oscillation. NATURAL HAZARDS AND EARTH SYSTEM SCIENCES, 8, 3, 483-499.