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Identification, validation and assessment of Multiple Occurrence Regional Landslide Events (MORLE) in Catalonia (Spain) during the last one hundred years.

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Landslides in the Pyrenees cause periodical damage to infrastructure and human lives. The European PyrMove project aims to develop cross-border methodologies to manage and reduce risk associated with these geological hazards. One of its approaches are the study of Multiple Occurrence Regional Landslide Events (MORLE) generated by episodes of intense rainfalls that affect large areas. To prevent and manage MORLE crisis, an identification and categorization of the geological and meteorological factors determining the MORLEs that occurred in Catalonia during the 20th and 21st century were carried out, with special attention to the last 30 years. These events were contrasted to some relevant landslide events at worldwide scale. A new qualitative scale of magnitude multiple Regional Landslide event (mRL) has been conceived according two variables that provide the best reliability for the historical data: (1) the area of the affected region and (2) the magnitude of the largest inventoried landslide. To determine the magnitude of largest landslide we used the ICGC scale based on its size and the total mobilized energy (M). Finally, two MORLE that occurred in 1982 and 2003 in Catalonia have been studied in detail to collect basic information on geological phenomena. These preliminary works will make possible in the future to estimate the triggering precipitation thresholds that induce MORLE scenarios in Catalonia.

The magnitude scale of MORLE events allows contextualizing the Catalan MORLE in the World. In this approach, seventeen World's MORLEs events have been described for this work. The main triggering factor of studied regional events has been earthquakes (56%) and intense rainfall or typhoons (44%). Their extension normally do not exceed 50,000 km² and the number of landslides exceeds, in some cases, 50,000. MORLE's magnitudes, are mostly 3 or higher, due to their large extension, and to the magnitude of the largest landslide, which normally reaches over the maximum degree within the established magnitude scale for landslides in Catalonia by ICGC (M). Damages and human losses have been difficult to quantify, however, at worldwide scale, most of the MORLEs recorded human losses (> 600 in some cases). The most catastrophic MORLE was in Wenchuan region, China, in October 2008, with more than 87,000 fatalities, 52,194 landslides and 410,000 km² of affected regional area.

In Catalonia, 13 MORLEs have been registered from 1900 to present. Here, the main trigger factor has been intense precipitation and the affected areas usually do not exceed 10,000 km². However,

in some cases such as October 1982, which records the largest number of identified landslides (about 900), reached 20,000 km². The magnitude of the largest event rarely exceeds category M4 in ICGC scale, being the majority category M3. Damages have been considerable in these events such as the most recent, triggered by Gloria storm in January 2020. For Catalonia, three general characteristics are notable: (1) East storm situations are the main generators of MORLE's; (2) MORLEs usually reach magnitudes mRL3 o mRL4.

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