



Regional hydro-meteorological thresholds for shallow and deep-seated mass movements triggering in the South Eastern French Alps (Queyras, Ubaye, Mercantour)

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Rainfall is recognized worldwide as the main triggering factor of landslides. Numerous studies were conducted in order to (1) define qualitatively the relationships between the precipitations and the triggering or the reactivation of landslides and (2) determine quantitatively the amount of precipitation needed to trigger slopes failures. For rainfall-induced landslides, hydro-meteorological thresholds (expressed in terms of antecedent rain, intensity of the precipitation, soil moisture or ground water levels within the slope) can be defined as the rainfall, soil moisture or hydrological conditions that, when reached or exceeded, are likely to trigger landslides. Usually, the thresholds are based on the analysis of statistical relations among historical landslide catalogues (event dates) and antecedent hydro-meteorological conditions; other approaches based on conceptual or process-based models can also be used in specific cases such as limited information in landslide catalogues.

Further, both the large variety of landslide types and the extreme variability of climatic conditions in mountain regions limit the definition of regional relationships between landslide occurrence and the associated hydro-meteorological conditions.

The purpose of this work is to propose hydro-meteorological thresholds for the triggering of shallow (slides, debris/mud flows) and deep-seated mass movements for three mountainous massifs regions of the Southeast French Alps (Queyras, Mercantour, Ubaye) characterized by different rainfall patterns. For this purpose, we exploit for each study sites an historical landslide catalogue and rainfall data series to define a typology of rainfall induced-landslides for the relevant landslide types. For the analysis of the triggering of the deep-seated mass movements, slope hydrological time series (ground water levels, soil moisture) and simple water balance models are used to define hydrological thresholds for landslide reactivation.

The results of the analysis of the rainfall conditions associated to the triggering of the shallow mass movements at different time scale (yearly, monthly, daily and hourly) are presented. The proposed hydro-meteorological thresholds are different for the three massifs according to the geomorphology and the local climate context.