Rainfall thresholds for the initiation of landslides in the CADSES area, central and southern Europe

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We describe an attempt to establish rainfall intensity - duration (ID) thresholds for the initiation of landslides in the CADSES area. The CADSES area extends for more than 2.7 million square kilometres in central, eastern, and southern Europe, and comprises regions belonging to 19 European countries. To determine the ID thresholds we compiled a database of rainfall conditions that resulted in slope failures in the CADSES area and the neighbouring regions. The rainfall and landslide information was obtained by searching the literature, including international journals, proceedings of regional, national and international conferences, and national, regional, and local technical and event reports describing single or multiple rainfall-induced landslides. We further obtained climatic information for the areas affected by the rainfall and landslide events, including values for the mean annual precipitation (MAP) and the average number of rainy-days (RDs), from the Global Climate Dataset compiled by the Climate Research Unit (CRU) of the East Anglia University. The dataset is available through the Data Distribution Centre of the Intergovernmental Panel of Climate Change (IPCC). Our database lists 663 rainfall events that resulted in landslides, and 190 rainfall events that did not result in slope failures. Collectively, the 853 rainfall events listed in the database cover the period between 1841 and 2002, with the majority of the events in the period from 1954 to 2002. For each rainfall event in the database, the available information includes: (i) the location of the area affected by the rainfall and the landslide event, (ii) the rainfall conditions that resulted (or did not result) in slope failures, including the rainfall intensity and duration, the total event rainfall, and measurements of the antecedent rainfall, (iii) the type and number of the triggered landslides, (iv) the main rock types cropping out in the region, and (v) climatic information for the area affected by the rainfall events, including values for the

mean annual precipitation (MAP) and the average number of rainy-days (RDs), and a classification of climate based on the Köppen climate classification system. We use the available rainfall and climate information to determine general ID thresholds, and normalized-ID thresholds. We perform two types of normalization. The first normalization consists in dividing the rainfall intensity by the MAP. The second normalization is performed dividing the rainfall intensity by the rainy-day normal (RDN), i.e., a climatic index represented by the ratio between the MAP and the average number of rainy-days (RDs). To determine the ID and normalized-ID thresholds we adopt a rigorous procedure based on a Bayesian statistical method. The procedure avoids subjectivity in the determination of the thresholds, a problem that affects several of the published rainfall thresholds for the initiation of landslides. The work was completed in the framework of the RISKAWARE project (Risk - Advanced Weather forecast system to Advise on Risk Events and management), a research initiative partly financed by the European Commission through the Interreg IIIB - CADSES programme.