



Landslide triggering thresholds for Switzerland based on a new gridded precipitation dataset

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In Switzerland floods are responsible for most of the damage caused by rainfall-triggered natural hazards (89%), followed by landslides (6%, ca. 520 M Euros) as reported in Hilker et al. (2009) for the period 1972-2007. The prediction of landslide occurrence is particularly challenging because of their wide distribution in space and the complex interdependence of predisposing and triggering factors. The overall goal of our research is to develop an Early Warning System for landsliding in Switzerland based on hydrological modelling and rainfall forecasts. In order to achieve this, we first analyzed rainfall triggering thresholds for landslides from a new gridded daily precipitation dataset (RhiresD, MeteoSwiss) for Switzerland combined with landslide events recorded in the Swiss Damage Database (Hilker et al., 2009). The high-resolution gridded precipitation dataset allows us to collocate rainfall and landslides accurately in space, which is an advantage over many previous studies.

Each of the 2272 landslides in the database in the period 1972-2012 was assigned to the corresponding 2x2 km precipitation cell. For each of these cells, precipitation events were defined as series of consecutive rainy days and the following event parameters were computed: duration (day), maximum and mean daily intensity (mm/day), total rainfall depth (mm) and maximum daily intensity divided by Mean Daily Precipitation (MDP). The events were classified as triggering or non-triggering depending on whether a landslide was recorded in the cell during the event. This classification of observations was compared to predictions based on a threshold for each of the parameters. The predictive power of each parameter and the best threshold value were quantified by ROC analysis and statistics such as AUC and the True Skill Statistic (TSS).

Event parameters based on rainfall intensity were found to have similarly high predictive power (TSS=0.54-0.59, AUC=0.85-0.86), while rainfall duration had a significantly lower predictive power (TSS=0.24 and AUC=0.65). Slightly better performances were obtained when considering a typical power law intensity-duration curve as threshold (TSS=0.6). The analysis was repeated for sub-regions of the country based on erosivity and climate, using MDP and erodibility (Kuehni and Pfiffner, 2001), or a combination thereof, in the classification. When defining regional maximum intensity thresholds, the performances were further improved in all cases: for erodibility (TSS +1.3%), for MDP (TSS +3%), and for a combination of the two (TSS +5.1%). The regional maximum daily intensity thresholds varied greatly among classes, with differences of up to 43 mm/day, and they increased with decreasing erodibility and increasing MDP. This result was confirmed by considering the conditional probability of a landslide, which showed that for a given rainfall intensity the probability of a landslide in a region with wetter climate (higher MDP) is lower than that in a drier climate (lower MDP). This suggests the existence of a landscape balance between climate, erosion and soil formation. In order to demonstrate the quality and robustness of the results, we also show reference cases obtained by randomization of landslides in space and time, and resampling the data to equal sample size between triggering and non-triggering events (prevalence).

Hilker, N., Badoux, A., & Hegg, C. (2009). The swiss flood and landslide damage database 1972-2007. *Natural Hazards and Earth System Science*, 9(3), 913–925. <https://doi.org/10.1002/asl.183>

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