Geophysical Research Abstracts
Vol. 20, EGU2018-6630-1, 2018
EGU General Assembly 2018

Impacts of the uncertain knowledge of the timing of landslide occurrence on rainfall ID thresholds

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Assessment of landslide triggering thresholds is subject to many sources of uncertainty, a significant part of them being related to imprecise knowledge of rainfall and landslide information. In our investigation, we perform a quantitative analysis of the possible impacts of the uncertain knowledge of landslide initiation instants on the assessment of rainfall intensity-duration (ID) landslide early warning thresholds.

The analysis is based on an ideal synthetic hourly dataset of rainfall and landslide information, generated by an hydrological and slope stability landslide model. Then the ideal dataset is perturbed according to three schemes which mimic a range of possible realistic scenarios of rainfall landslide dataset collection and analysis. Scenarios are conceptualized as a combination of delayed landslide observation and approximated reporting of landslide triggering instants, which generate indirectly random errors $e = t' - t$, where t' is the imprecise triggering instant assumed by the analyzer who is interested in determining triggering thresholds, and t is the correct triggering instant. In particular, the three schemes are: 1) small delay reporting, where errors range from 0 to 30 hours; 2) large delay reporting, with errors spanning from 0 to 54 hours; 3) anticipated reporting ($-18 \leq e \leq 6$ hours). Each scheme is analysed by considering different criteria to single-out rainfall events and different temporal aggregations of rainfall (hourly and daily).

The analysis shows that the impacts the above uncertainty sources are almost negligible until the errors do not exceed one day in the positive direction (landslides triggered at instants prior to the erroneous ones). In case of negative errors, and positive errors exceeding one day – indeed quite common in real data sets – the impacts on threshold assessment and performance can be significant. In general, errors influence thresholds in a way that they are lower that the correct ones. The amount of threshold underestimation can be enough to induce an excessive number of false positives, hence limiting possible landslide mitigation benefits.