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Hydrological evaluation of precipitation intensity-duration thresholds for regional landslide hazard assessment

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The vast majority of shallow landslides and debris flows are precipitation initiated. Therefore, regional landslide hazard assessment is often based on empirically derived precipitation-intensity-duration (PID) thresholds and landslide inventories. Generally, two features of precipitation events are plotted and labelled with (shallow) landslide occurrence or non-occurrence. Hereafter, a separation line or zone is drawn, mostly in logarithmic space. The practical background of PID is that often only meteorological information is available when analyzing (non-) occurrence of shallow landslides and, at the same time, the conceptual idea is that precipitation information is a good proxy for both meteorological trigger and hydrological cause. Although applied in many case studies, this approach suffers from indistinct threshold, many false positives as well as limited physical process understanding. Some first steps towards a more hydrologically based approach have been proposed in the past, but these efforts received limited follow-up.
Therefore, the objective of our paper is to: a) critically analyse the concept of PID thresholds for shallow landslides and debris flows from a hydro-meteorological point of view, and b) propose a novel trigger-cause conceptual framework for lumped regional hydro-meteorological hazard assessment. We will discuss this based on the numerous (published) examples and associated discussion. We discuss the PID thresholds in relation to return periods of precipitation, soil physics and slope and catchment water balance. With this paper, we aim to contribute to the development of a stronger conceptual model for regional landslide hazard assessment based on physical process understanding and empirical data