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Changes and trends in debris-flow frequency since A.D. 1850 – results from the Swiss Alps

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Although studies have repeatedly focused on impacts of climate change on mass movements in the past, the interrelations between climatic variables and debris-flow occurrence remain widely unclear and ambiguous to date. In addition, most studies on past debris-flow occurrences remained rather isolated reconstructions for single torrents or they were restricted to short time periods. It is therefore the aim of this study to provide a regional chronology of past debris-flow events for the Zermatt Valley (Swiss Alps) and to go beyond the simple dating of events. Based on tree-ring reconstructed debris-flow histories of eight torrents, we shed light on changes and trends in debris-flow occurrence, climatic conditions prevailing during events and on potential evolutions in a future climate. Based on the analysis of tree-ring records of 2467 conifers (mainly Larix decidua and Picea abies), 417 events dated to the period AD 1600–2009. Decadal frequencies suggest peaks in debris-flow activity after the end of the Little Ice Age and for the period 1920–1929. In contrast, activity was rather low during in the most recent part of the record (2000–2009) which is in concert with the observed decrease in the number of triggering rainfall events. Long-term trends in debris-flow occurrence were analyzed for three time intervals between 1850 and 2009 with Student's t-tests. For the debris-flow frequency of the entire valley, no significant trends can be observed over the last 150 years. We conclude that the occurrence of debris flows would depend on rather short-term changes in triggering rainfall rather than on long-term climatic changes. Therefore, rainfall data from three stations in the valley were integrated to identify rainfall events responsible for the triggering of debris flows.