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Assessing the spatial dynamics of debris-flow activity on a forested cone using dendroecological methods

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Dendrogeomorphology has widely been used to reconstruct past debris-flow activity as well as frequencies or magnitudes of past events. However, this method has mostly been limited to cones where trees recorded former impacts in their tree-ring series. Extraordinarily big events may eliminate entire forest stands and therefore render the application of dendrogeomorphological methods impossible. Nevertheless, assessing real age of the oldest post-event trees allows determination of the latest possible moment of past activity. The aim of this study was to combine these two approaches – dendrogeomorphology and minimum age dating – so as to reconstruct the spatial dynamics of past debris-flow activity on a forested cone in the Swiss Alps. The reconstruction is based on a detailed geomorphic map in a scale of 1:1000 representing all forms related to debris-flow activity (lobes, levees, channels). In total, 29 formerly active debris-flow channels could be identified. Based on this map, 71 disturbed *Larix decidua* Mill. and *Picea abies* (L.) Karst. trees growing in the deposits were sampled. The analyses of 150 samples allowed reconstruction of 49 events between AD 1782 and 2005. In combination with the geomorphic map, the spatial extent of past events could be determined. In addition, 71 undisturbed trees for minimum age dating were sampled from the formerly active channels in the parts of the cone where trees do not show obvious signs of past activity. The combination of real ages of post-event trees with data on the reconstructed events allowed approximation of the minimum time elapsed since the last debris-flow event for 23 of the 29 channels on the cone. In general, channels closer to the currently active debris-flow channel show signs of recent activity with last events in the 1970s to 1980s. In contrast, channels in the southern sector and in the outermost part of the cone did not show signs of activity since the

end of the 19^{th} century. Similarly, channels located closer to the currently active flow path show higher debris-flow activity for the reconstructed period than the channels farther away.