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400 years of rockfall activity on a forested slope – a case study using dendrogeomorphology

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Over the last few years, rockfall research has increasingly focused on hazard assessment and risk analysis. Input data on past rockfall activity were gathered from historical archives and lichenometric studies or were obtained through frequency–volume statistics. However, historical records are generally scarce, and lichenometry may only yield data with relatively low resolutions. On forested slopes, in contrast, tree-ring analyses may help, generally providing annual data on past rockfall activity over long periods.

It is therefore the purpose of this presentation to survey the current state of investigations dealing with tree-ring sequences and rockfall activity, with an emphasis on the extent to which dendrogeomorphology may contribute to rockfall research. Results presented primarily focus on frequencies (*how often*), volumes (*how large*) and spatial distributions (*where*) of rockfall activity on forested slopes so as to (i) obtain detailed information on inter-annual differences in rockfall activity or to (ii) investigate spatial and decadal fluctuations in rockfall activity on forested slopes with tree-ring analysis.

A total of 564 increment cores from 135 severely injured *Larix decidua* sampled on the same slope allowed determination of long-term spatial and temporal variations of rockfall activity. Data cover four centuries (1600–2002) and permitted reconstruction of 741 growth disturbances such as scars, traumatic rows of resin ducts, reaction wood and abrupt growth changes. Spatial analysis clearly shows that evidence from past rockfall events can commonly be found in trees located in the southern part of the slope, where they recurred more than once per decade. In contrast, trees in the northern part were less frequently disturbed by rockfall and locally define recurrence intervals

of more than 150 years. Throughout the last four centuries, rockfall has caused growth disturbances to the trees sampled on the slope, most frequently in the form of low magnitude–high frequency events. In addition, analysis allowed identification of one high magnitude–low frequency event in 1720, which displaced the forest fringe of the northern sector a considerable distance downslope and eliminated an entire forest stand. Data further show that the forest recolonizing the southern sector after the 1720 event gradually improved its protective function, reducing the rate of reconstructed rockfall activity by a factor of 13 between the 1740s and the 1990s.

It may be concluded that on forested slopes, dendrogeomorphology has a large potential to provide new and very detailed insights on past rockfall activity, namely in the determination of the frequency or magnitude of past rockfall activity.