RECONSTRUCTION OF ROCKFALL ACTIVITY ON A SLOPE IN THE INN VALLEY

AN APPROACH USING TREE RING- AND SCAR COUNT DATA

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INTRODUCTION

Over the past decades, numerous studies revealed the great potential of dendrogeomorphic techniques for the analysis of natural hazards. In this contribution, classical tree-ring reconstructions were used to assess past rockfall activity focusing on conifers (*Picea abies* (L.) Karst. in the present case). This "classic method" allows a very accurate dating of historic events; however it represents a very time-intensive method. With the aim to reduce time and effort of tree ring studies dealing with rockfall, we also applied a new practitioner-oriented method requiring less effort; the new approach is illustrated with samples taken from broadleaves (*Fagus sylvatica* L.).
The study site selected for analysis has a surface of 3ha, an inclination of 40° and is covered with a mixed forest composed of *Picea, Fagus* and *Pinus sylvestris*. It is located in the Inn valley near the city of Innsbruck (Tyrol, Austria). A roughly 200m high, south facing limestone cliff is the release area for the rock fragments, which are generally stopped by the forest or by the rockfall nets above the railway line.

METHODS

Increment cores were taken from 33 *P. abies* and 50 *F. sylvatica*. Different sampling strategies were applied for the different species: three to four cores (144 in total) were taken for *P. abies* and only one core per tree (50 samples) for *F. sylvatica*.
Special care was taken to evenly distribute the beech trees (20 × 20m raster), whereas transects parallel to the contour line were defined for the sampling of spruce trees, with one tree being selected every ten meters. Events in the spruce trees were identified by typical growth disturbances in the tree-ring series such as tangential rows of resin ducts, scars, callus tissue or reaction wood and dated with yearly precision. As mechanical impacts remain clearly visible on the bark of beech trees, the events were derived by simply counting visible rockfall impacts on the stem surface. Recurrence intervals were calculated for each individual tree by dividing the age by the number of impacts and visualized by spatial interpolation.

RESULTS

The analysis of the spruce increment cores yielded a total of 431 growth disturbances corresponding to 277 rockfall events since AD 1819. The systematic observation of injuries on the stem surface of the beech trees allowed the identification of 1140 rockfall impacts.
Comparison of the results obtained with the different approaches clearly shows that the spatial pattern or return periods are comparable independently of the approach used (Fig. 1): in both cases, higher rockfall frequencies are observed in the upper part of the study area as well as a canalizing effect of activity stemming from the relief.

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Differences become apparent as soon as return periods of rockfall are calculated. With the "classic" dendrogeomorphic approach used for the analysis of the spruce trees, a mean return period of rockfall events for the entire study area of 17.8 years was computed. In contrast, an average recurrence interval of 8.7 years was derived from the beech trees. Differences were less marked for observed average jump heights with 0.9m for spruce and 0.7m for beech trees, respectively.

CONCLUSION

Both methods yield reliable data on the spatial distribution of rockfall frequencies and jump heights in the study area, but results vary considerably for different reasons. Due to the bark properties of beech, smaller rocks or rocks with lower kinetic energy will not damage spruce trees but still leave scars in the thin bark of beeches. Differences in return intervals can be due to the differences in tree locations as well as to the fact that multiple impacts in the same year would only be counted one event in spruce whereas each injury in the beech trees would constitute an individual event. Hence, a reconstruction solely based on increment cores from spruce trees in transects runs the risk of underestimating absolute recurrence intervals whereas impact counts on beech trees may lead to some overestimation of rockfall activity and resulting return intervals in case that the impact of individual rocks leaves multiple scars on the stem surface.

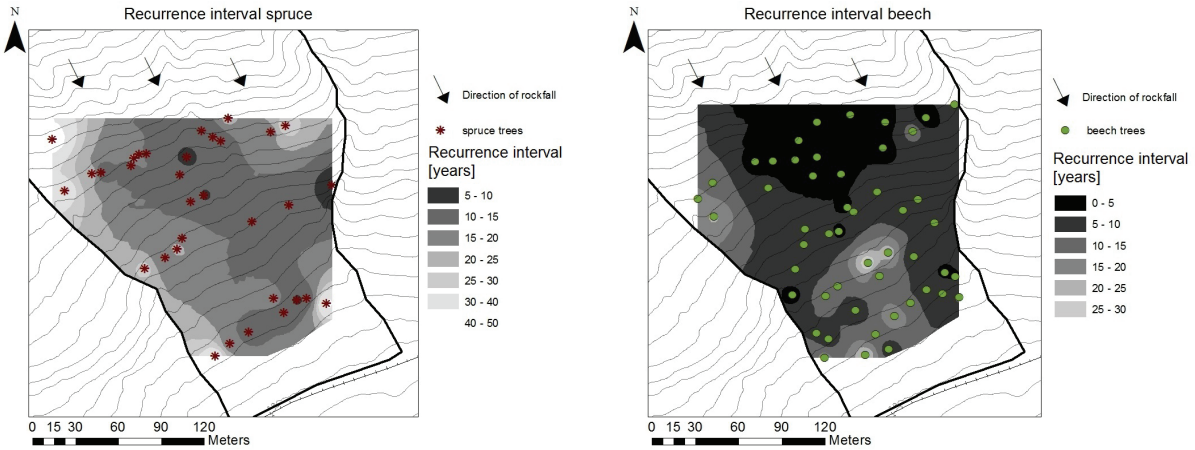

Fig. 1 Interpolated (inverse distance weighting) recurrence intervals (in years) for spruce trees (left) and beech trees (right)

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