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Changes in spatio-temporal patterns of rockfall activity on a forested slope over the last 50 years
A case study using dendrogeomorphology

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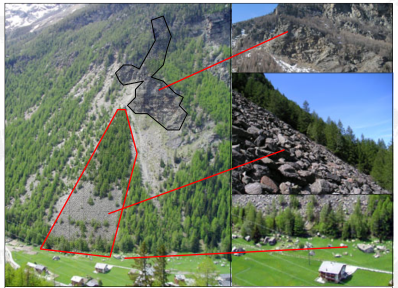
Introduction

Risk analysis and hazard assessment have become one of the major topics in geomorphic research. To assess present and future hazards and risks it is indispensable to reconstruct past rockfall frequencies and to identify zones of major activity. Dendrogeomorphology offers the potential to reconstruct past activity with a high resolution in space and time and provides persons in charge with the maximum of information to take appropriate decisions.

Aims

- Reconstruct past rockfall activity and possible event years
- Analyze the spatial behavior of rockfall aspects
- Determine the spatial behavior of bounce heights

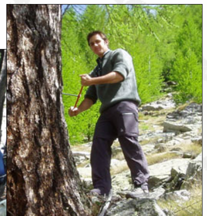


Slope angle: 36 °
Rockfall volume: < 1 m³
Bedrock: micaceous schists
Investigated area: 20'000 m2

Methods

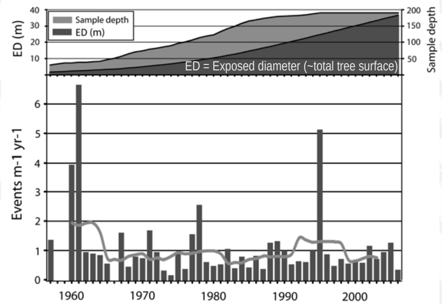
Only trees with visible injuries were sampled. In order to obtain good quality data for the spatial analysis, we aimed for an even distribution of sampled trees. Therefore, the sampling was performed along horizontal transect with a distance of 15 m between each transect. The distance between each tree within the transects was approximately 10 m.

If the basal diameter of the investigated tree was < 15 cm, the sampling was performed with an increment borer (sampling in overgrowing tissue, at least one core per injury). If the basal diameter was > 15 cm, a stem disc was taken (one disc per injury)



Identification of past rockfall events was based on wood anatomical features (i.e. injuries, tangential rows of traumatic resin ducts, growth suppression / release, callus tissue and compression wood).

Results



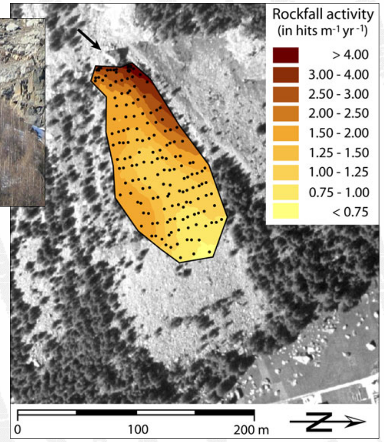
Past rockfall frequency reveals three years with major rockfall activity, namely in 1960/61 and 1995. The 7-year moving average is mainly influenced by those years with high activity and does not show any significant long-term trend.

191 trees sampled
90 % *Larix decidua*
10 % *Picea abies*

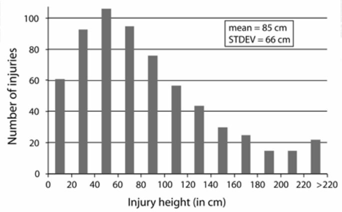
937 Samples
141 cross-sections
796 increment cores

Average age: 36 yrs
max. 96 yrs
min. 12 yrs

775 injuries dated

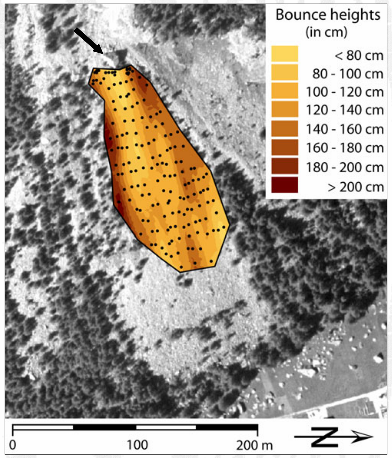


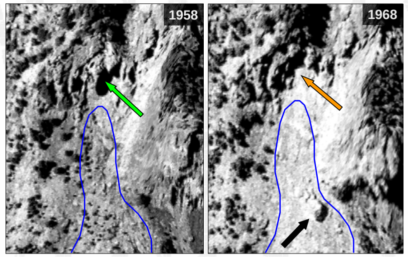
The spatial analysis of rockfall activity indicates highest values on top lateral (north) position and lowest activity in the central bottom part.
Notice the shielding effect of the big boulder (black arrows) in particular and of the forest in general.



The bounce heights show a normal distribution with a mean of 85 cm, 67 % of all injuries are below 1 m.

The highest bounce height values occur at the lateral boundaries of the study site (and of the dense forest). Notice again the shielding effect of the big boulder (black arrow).





Original position
Boulder detached
Boulder deposited
Deforested area

Detailed analysis of aerial photographs indicate the detachment of the big boulder between 1958 and 1968. Referring to the reconstructed rockfall frequency, this major even most probably occurred on 23 March 1960, when a magnitude 5.3 earthquake (Mercalli intensity VIII, 12 km depth) occurred 18 km northeast of the study area.

Conclusions

All applied methods were appropriate and delivered good results

- No significant long-term trend in rockfall activity
- Single years with major rockfall activity
- Higher activity at the lateral boundaries (→ shielding effect of big boulder)
- Determination of one major event with visible changes in the source area in 1960

Further reading

Schneuwly, D. M., Stoffel, M. (2008): Tree-ring based reconstruction of the seasonal timing, major events and origin of rockfall on a case-study slope in the Swiss Alps. *Natural Hazards and Earth System Sciences* 8: 203–211.

Schneuwly, D. M., Stoffel, M. (in press): Spatial analysis of rockfall activity, bounce heights and geomorphic changes over the last 50 years - A case study using dendrogeomorphology. *Geomorphology.*

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