

Anticipating cascading risks at the imminent Hochvogel peak failure

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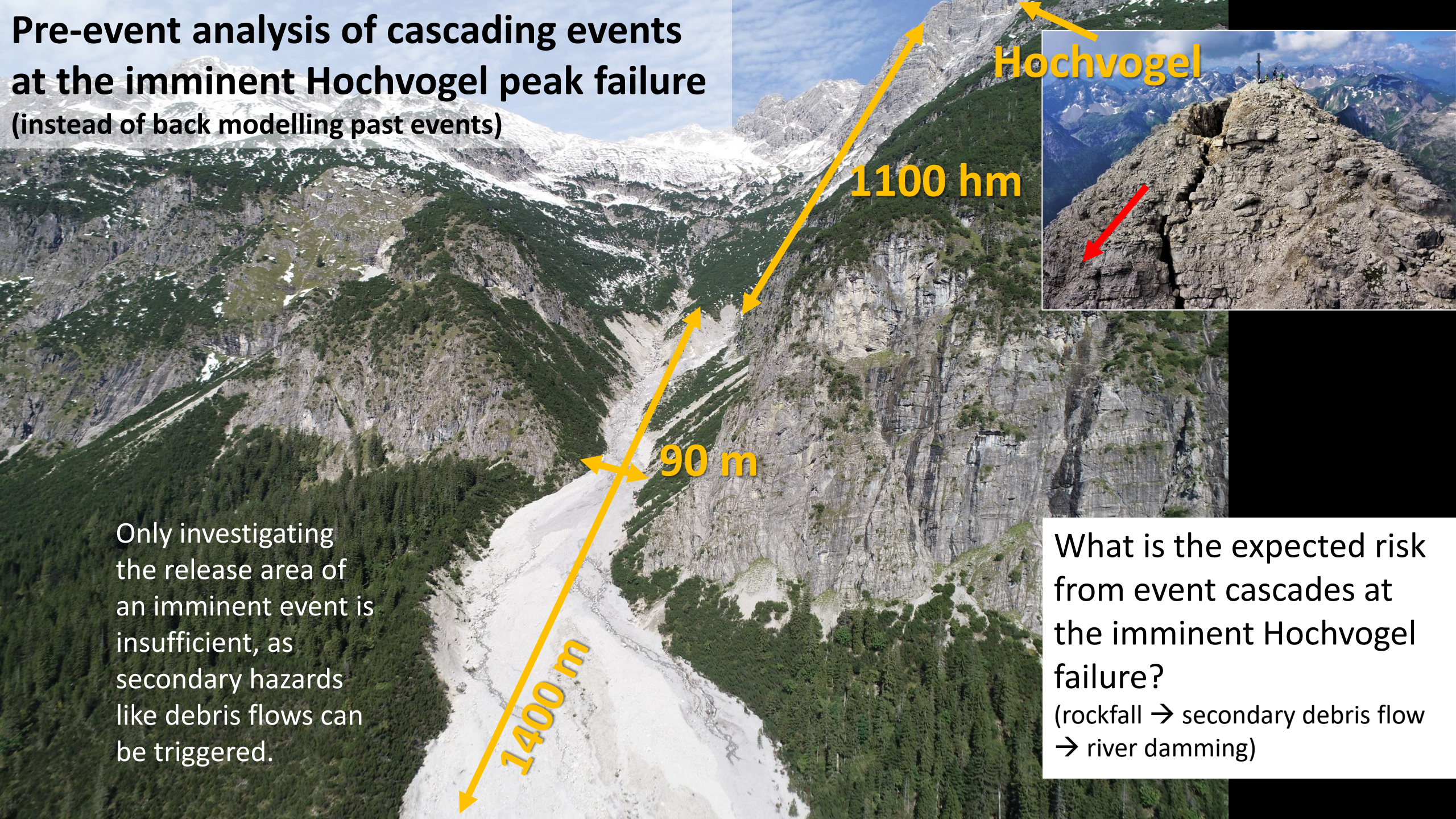
project

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Pre-event analysis of cascading events at the imminent Hochvogel peak failure (instead of back modelling past events)

Hochvogel

1100 hm

90 m

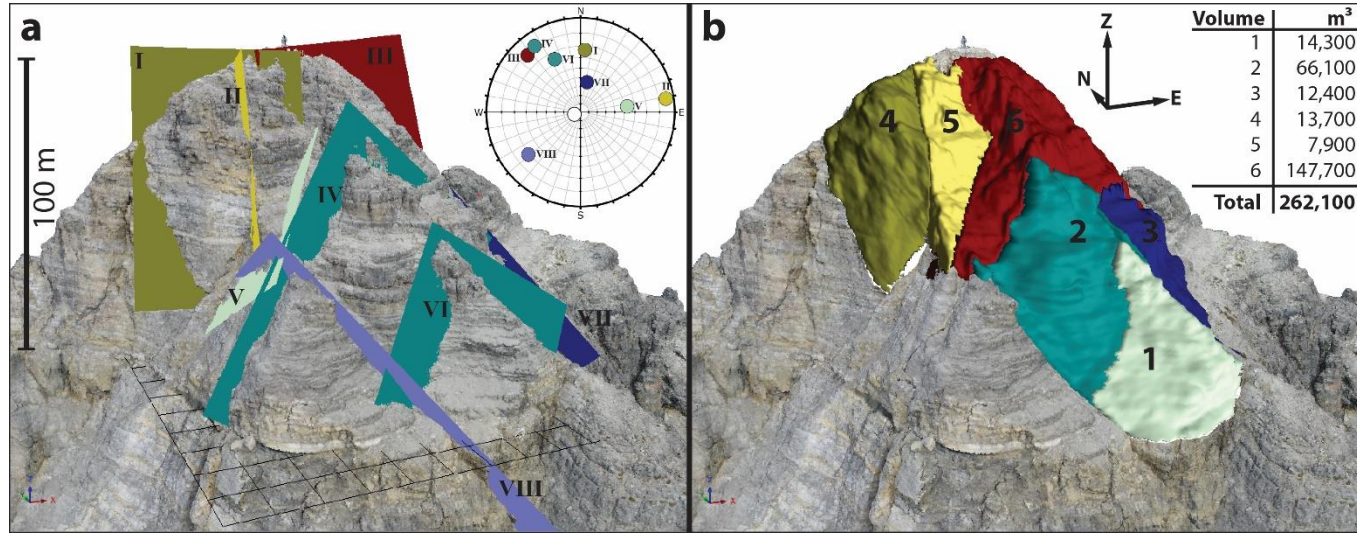
1400 m

Only investigating the release area of an imminent event is insufficient, as secondary hazards like debris flows can be triggered.

What is the expected risk from event cascades at the imminent Hochvogel failure?

(rockfall → secondary debris flow → river damming)

Definition of event scenarios



Leinauer et al. 2020

total potential instable
volume of 260,000 m³

divided into 6 blocks by
lateral cracks

4 single event scenarios:

Small = block 4

Big = block 4+5

Complete = all blocks

Extreme = 2 x total volume

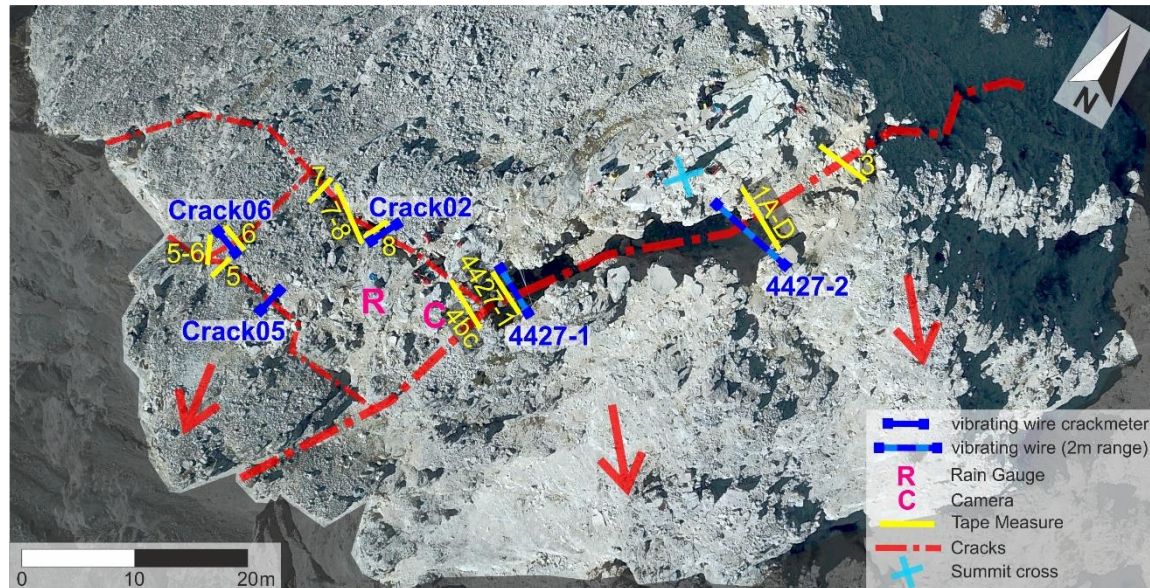
4 cascading scenarios:

Small on Small

Big on Small

Big on Big

Rest on Small



Leinauer et al. 2020

From continuous monitoring we
know that different cracks are
opening at different pace and react
differently to strong precipitation.

Deposition into highly debris loaded channels

→ Debris flow or rockfall can entrain significant amount of material



Entrainment likely, but hard to quantify a priori
→ best – medium – worst case

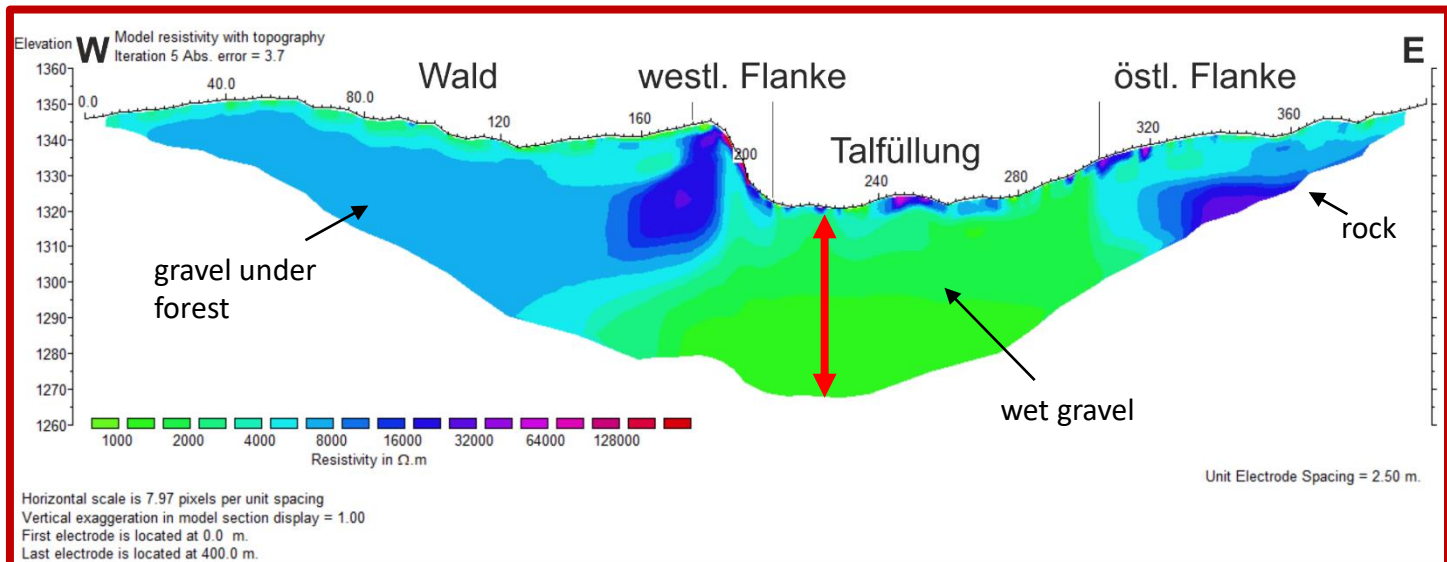
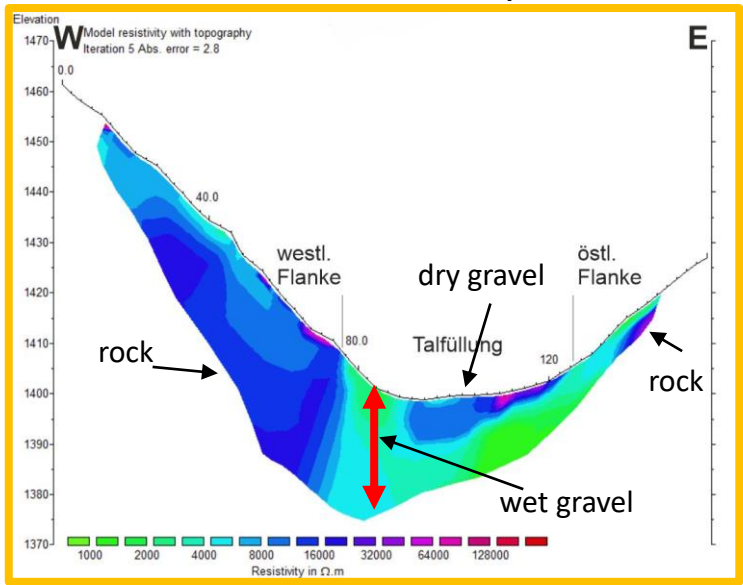
→ 3 erosion types:
implemented into RAMMS model

RAMMS model of secondary debris flows

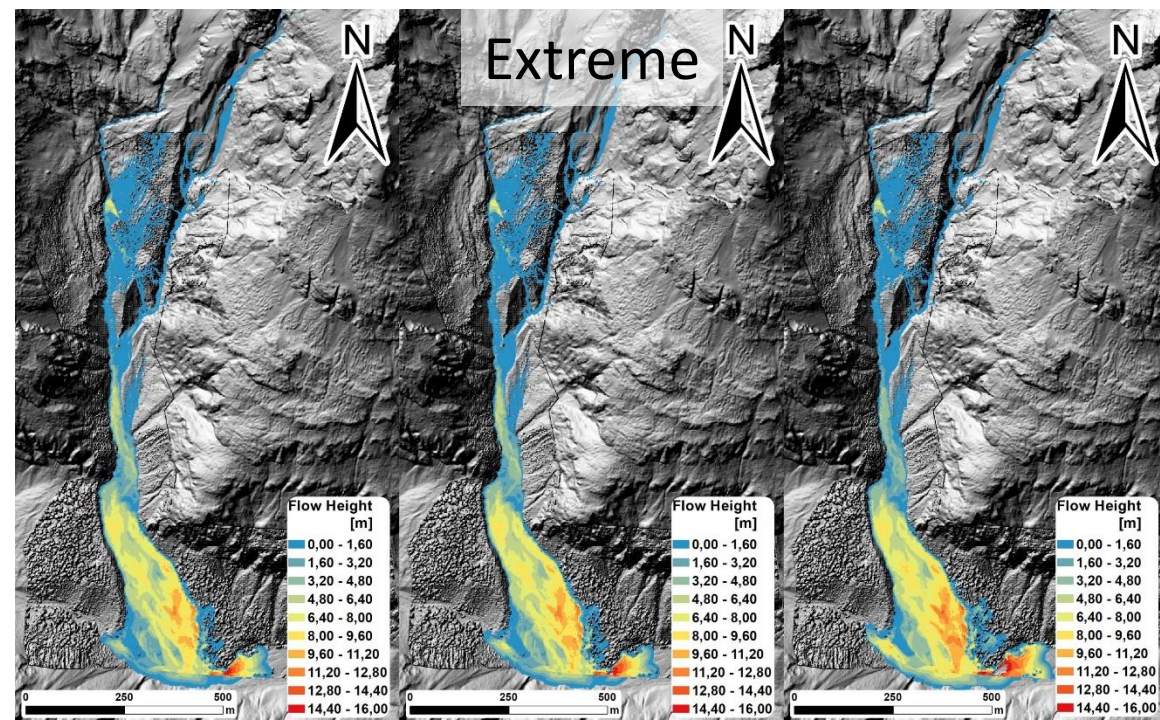
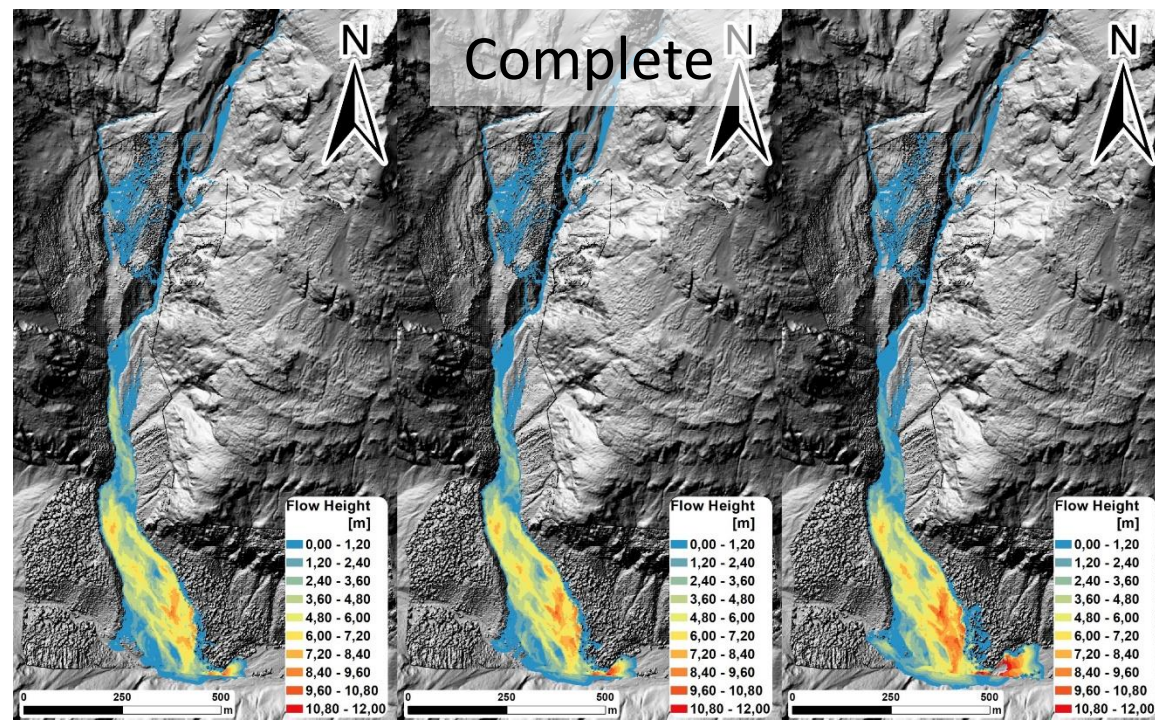
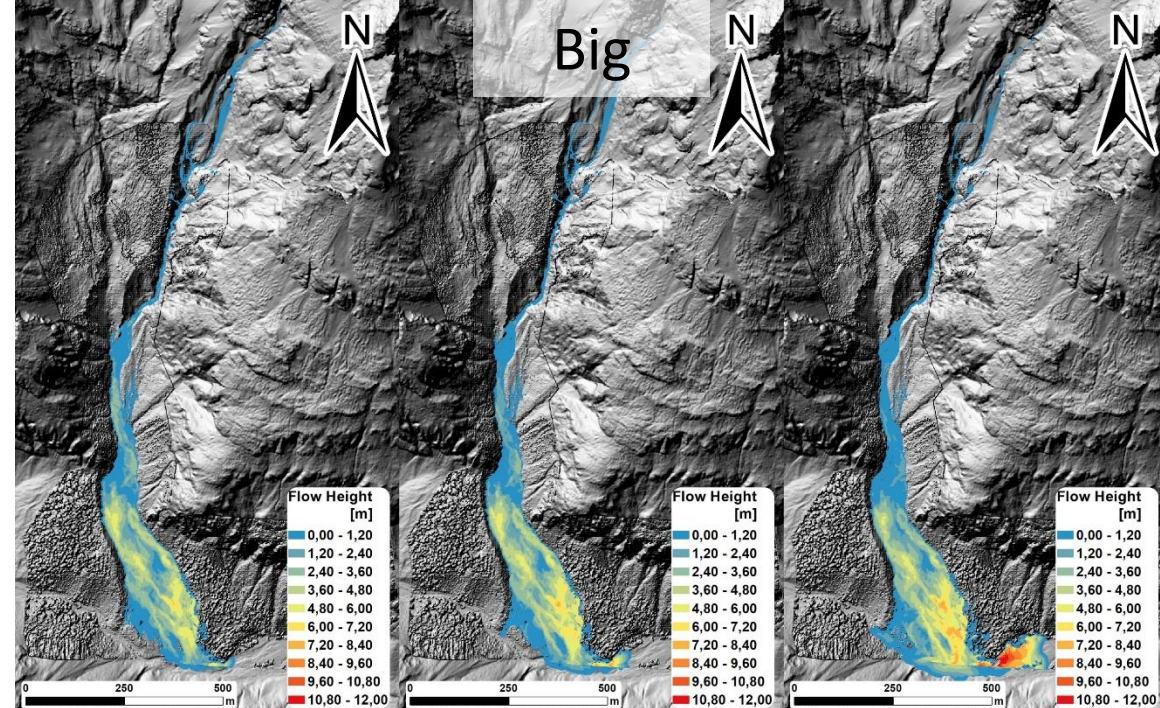
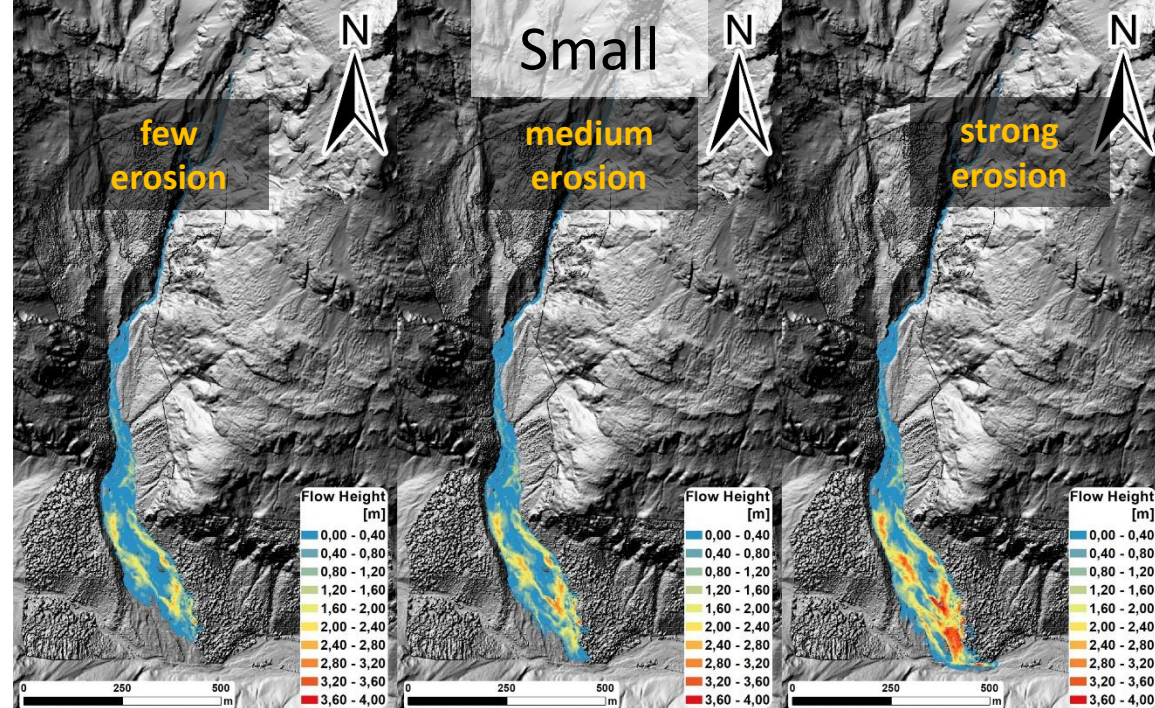
- Calibration at well-documented debris flow event at Roßbichelgraben (10 km NW and similar lithology)
- Up-to-date digital elevation model and orthofoto from UAV photos
- Field mapping
- Maximum erodible depth from Electrical Resistivity Tomography (ERT)

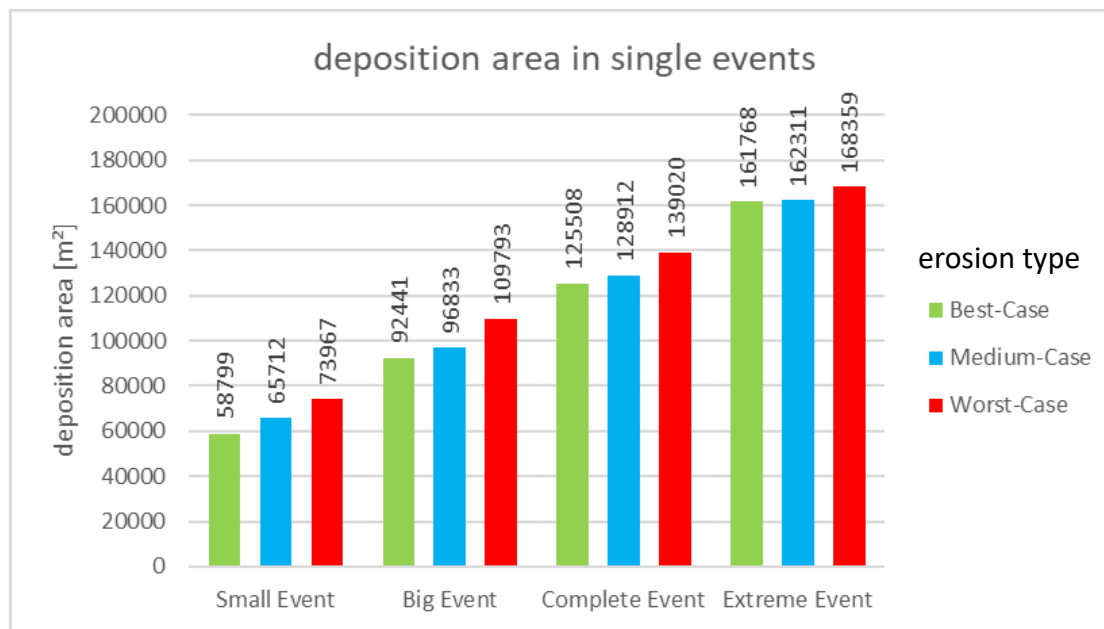
Plenty of erodible material available

Maximum erosion depth not confined by bedrock in the middle of the channel

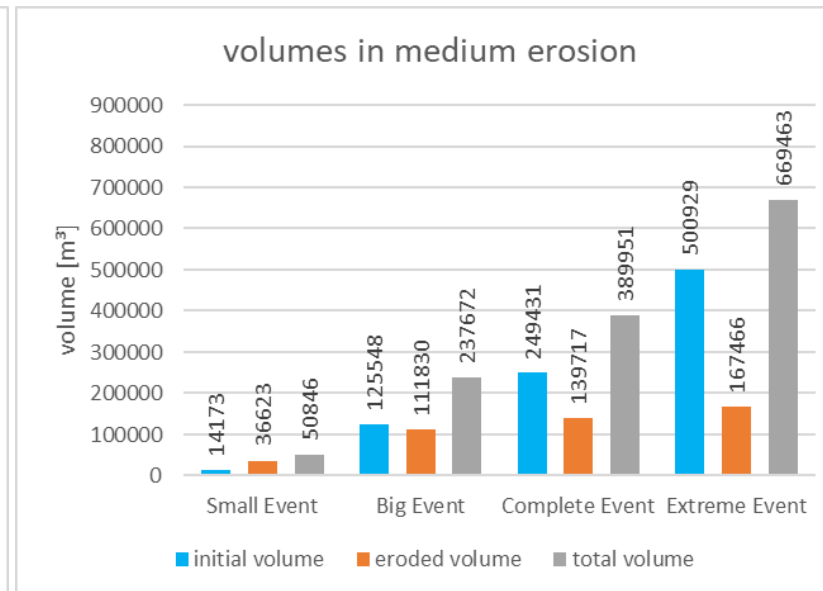
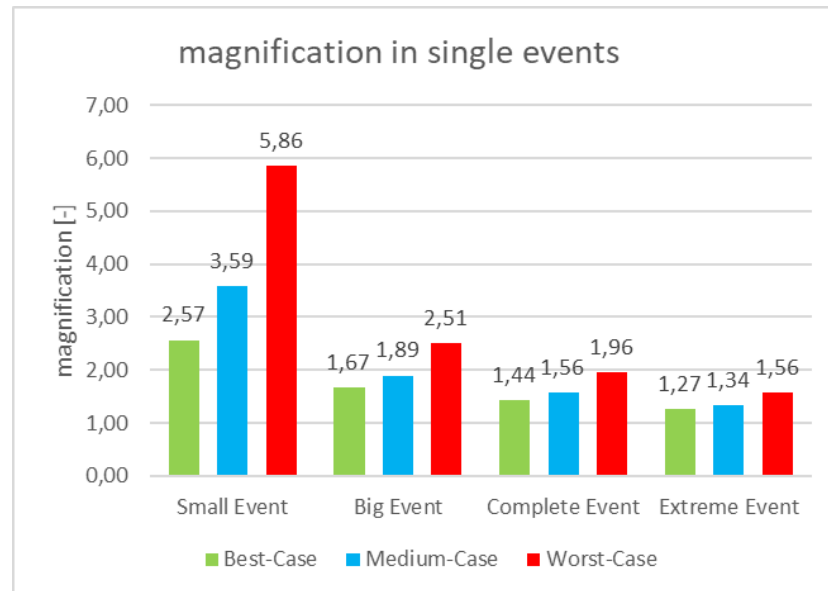


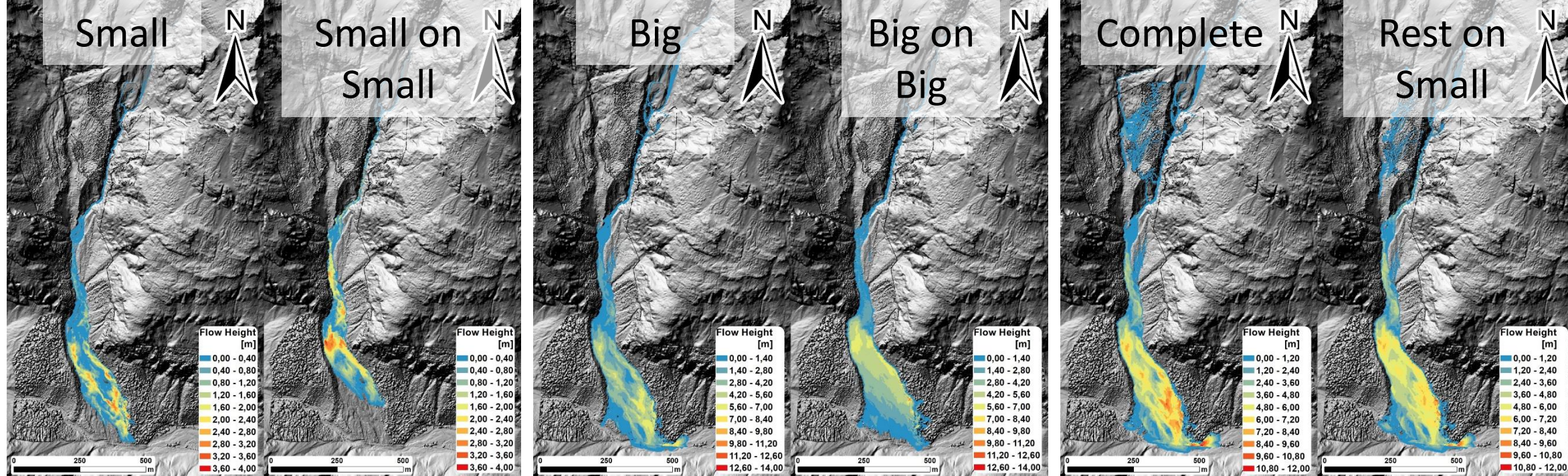
Results single events



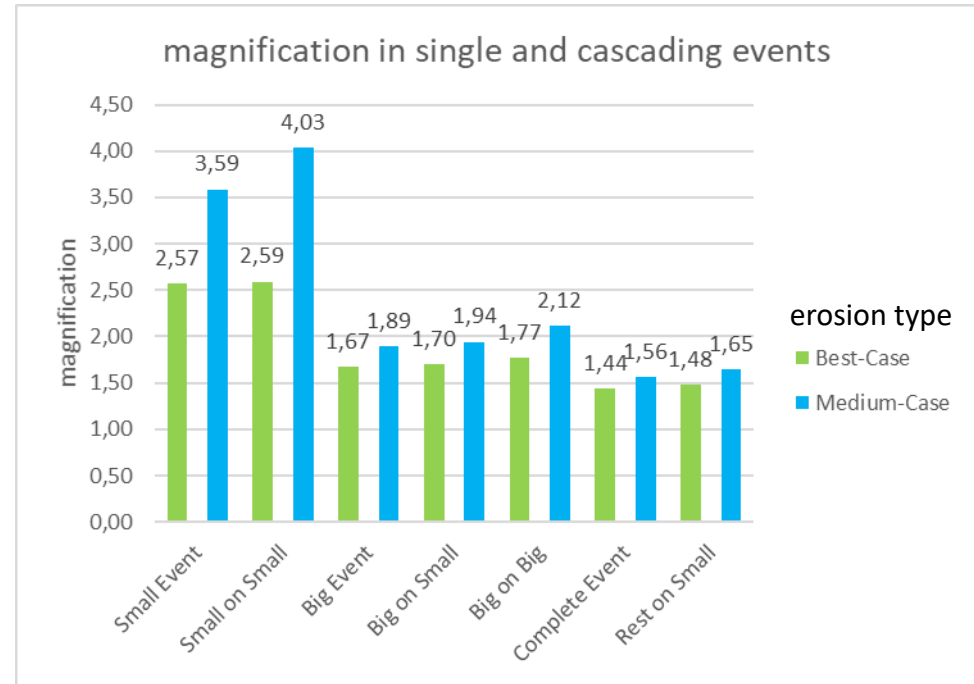


- deposition area (and height) increases with increasing initial volume and stronger erosion
- this effect is stronger with smaller initial volumes
- smaller events can magnify significantly
- bigger events reach entrainment limits and valley confinement

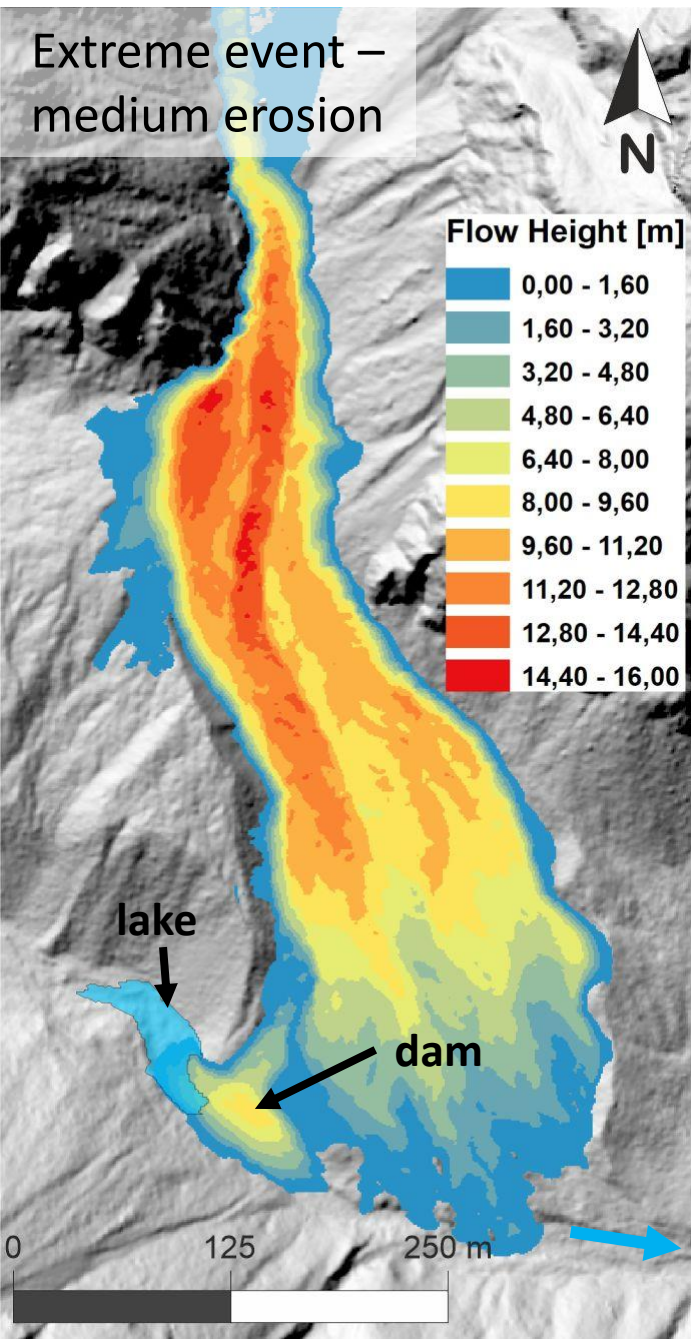




- cascading deposition more regular
- second debris flow dammed slightly by previous event
- cascading events mobilize more volume, but overall deposition similar to single event



Can a debris flow dam the Jochbach river and exacerbate the risk?



→ (small) lake formation possible in *small scenario* – *worst case* erosion and all bigger ones

Left example:

→ dam height: 3.2 m

→ lake area: $\sim 2000 \text{ m}^2$

→ water volume: $4,100 \text{ m}^3$

→ relatively small lake volume + unconfined valley downstream

→ additional endangering of the downstream village through landslide dam breach is unlikely according to our simulations

Summary

- comprehensive scenario-based assessment for anticipating cascading risks at the Hochvogel from initial rock failure volume estimation to debris flow evolution and potential river damming = recent case study from an alpine calcareous peak
- 3D-analysis reveals up to 260,000 m³ instable volume in 6 blocks
- Continuous near real-time monitoring shows different pace of blocks and different reaction to heavy rain → successive failure likely
- Deposition into highly debris loaded channels → entrainment!
- RAMMS model of 4 rock fall scenarios and 4 cascading scenarios with 3 different sets of erosion parameters
- RAMMS model calibrated and supported by field assessment
- Most of the material will be deposited into the empty Weittal valley
- Smaller events can magnify through entrainment to a greater extend than bigger events
- Cascading events mobilize more volume, but overall deposition is similar to single event
- Dammed lake formation is possible, but probably not dangerous

