Introduction

Rock falls, rock avalanches and rock slides are a common hazard in alpine terrain and are major factors of alpine landscape evolution. They are characterized by a complex combination of geological, hydrological, geomechanical and meteorological processes. In the Alps in particular, landslides have the potential to cause serious damage to both humans and infrastructure. As global warming progresses, the meteorological and climatological factors that influence landslide formation will change. Especially, in high mountain environments, climate change related factors like, the rise in mean and extreme temperature, the change in the precipitation characteristics, thawing of permafrost and the retreat of glaciers are progressing rapidly (IPCC, 2021).

Structure of the project

- Analysis of the local meteorological conditions before rock fall and rock avalanche events, which were determined from the event inventory.
- Creation of an event database for the period 2006 to 2017. Carrying out statistical analyses to identify events in which permafrost, glacier retreat or meteorological extremes could have led to slope failure.
- Building of an in-situ rock slope laboratory for long-term monitoring of rock slopes, equipped with various types of sensors, and carrying out remote sensing campaigns with TLS and UAV as well as geological surveys.
- Creation of an inventory of buildings exposed to natural hazards and assessment of the population at risk in the case studies. Assess the economic effects of landslide impacts on the local level of remote alpine valleys by examining commuter flows and considering the evolution of resident populations.

Examples of preliminary results

- Rock fall inventory (Fig.2) documents 700+ events from 2006 to 2017, exceeding 50 m³ in volume.
- Seven locations report volumes reaching 100,000 m³.
- Analysis of regional inventory highlights increased rock falls in areas impacted by glacier retreat and permafrost degradation.
- High rock fall activity observed on north-western slopes (Fig.3) of Schaufelspitze.
- Installation of measuring instruments (Fig.1) in June 2023, with first data readout (Fig.4) in fall.
- Preliminary results show there is a common interest in ensuring the resilience of mountain communities facing climate change and finding ways to deal with resulting uncertainties.
- Stakeholders are indicating they want comprehensive risk management alongside disaster prevention plans.

Outlook and conclusion

- The location of the in-situ rock slope laboratory (Fig.4) on the Stubai Glacier has proven to be excellent, as a large number of changes in the high alpine terrain can be observed there (Fig.5).
- Additional temperature, UAV and TLS measurements.
- Comprehensive statistical analyses of the meteorological data in relationship to the events.
- Installation of temperature loggers (1m depth), fiberglass-extensometer and crack meter to measure deformation in-situ.
- Detailed geological surveys will be conducted
- Further search will be conducted for rock fall and rock avalanche inventory event dates.
- Organisation of a third stakeholder workshops and evaluation of the data.
- Vulnerability assessment of selected areas.

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Literature