Mass balance study of gravitational mass movements in proglacial systems

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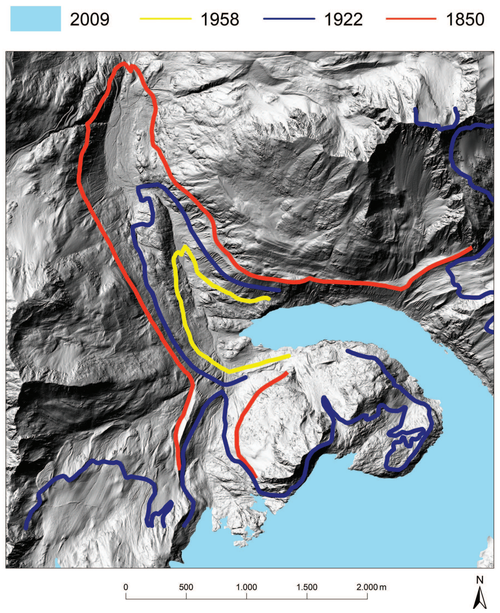
1. Introduction

In the framework of the DFG joint research project PROSA (high resoluted measurements of morphodynamics in rapidly changing PROglacial Systems of the Alps), mass movements are investigated geotechnically and process rates will be determined. As result, the actual mass balance for gravitational mass movements will be investigated exemplarily in an alpine glacier foreland in this PROSA sub-project. Because of the recent deglaciation (s. figure below), the glacier foreland exhibits a rapid morphodynamic development. Mass movements like landslides and rock falls contribute a remarkable portion to total sediment transport in this area.
The study area encompasses 62 km², lies at altitudes between 1759 and 3539 m a.s.l. and around 30 % are covered by glacier.

Historical glacier recession



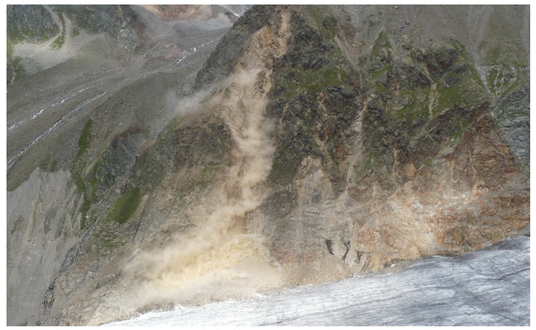
Contemporary and historical glacier extension (partly after Brunner, 1978). The tongue of the Gepatsch glacier has been shrinking more than two kilometers since 1850.

References

Brunner, K. (1978): Zur neuen Karte „Gepatschferner 1971" Maßstab 1:10000. Zeitschfrift für Gletscherkunde und Glaziologie 14(2): 133-151.

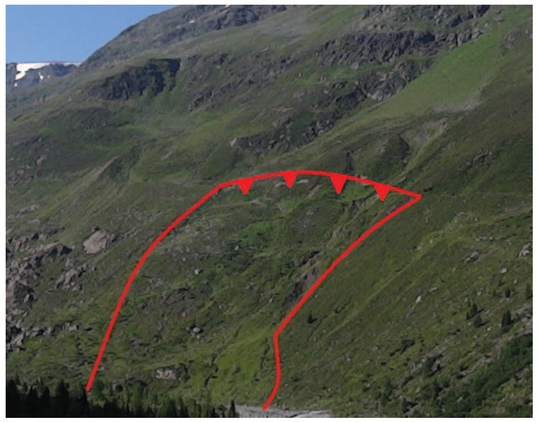
2. Mass movements

mass movements in bedrock

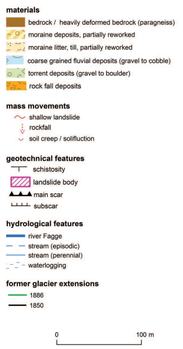


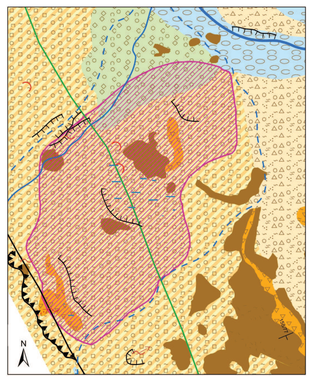
Highly active rockfall scar directly above the shrinking glacier tongue. The foto was taken in a warm summer afternoon in 2012. The rock fall deposition takes place on the glacier.

mass movements in soils



Deeper seated large landslide (above) in the 1850 moraine deposits of the gepatsch glacier and the associated section of the Arc-Gis based geotechnical map.



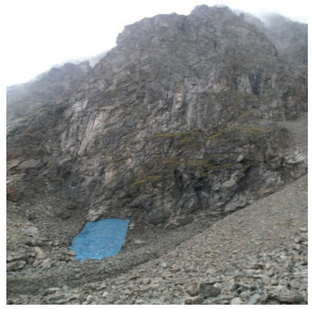


3. Determination of mass balances

Five rockfall gathering nets

no.	net size (m²)	altitude (m a.s.l.)	exposition	lithology
1	70	1950	W	paragneiss
2	230	2200	S	mica schist / orthogneiss
3	150	2320	N	paragneiss / orthogneiss
4	160	2680	N	orthogneiss / amphibolite
5	145	3100	SE	paragneiss

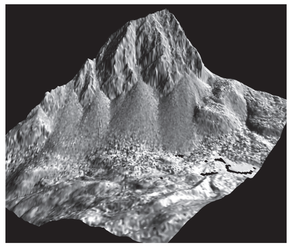
Direct measurements of rock fall activity are conducted by rock fall collector nets at locations with different lithological and topoclimatical conditions to facilitate the regionalization of rock fall activity, done by TP 5 / University of Eichstätt. Further, the collected rock fall particles are investigated regarding grain size and shape.



Rockfall gathering net no. 4 below a steep north facing rock wall

High resoluted terrestrical and airborne laserscanning data

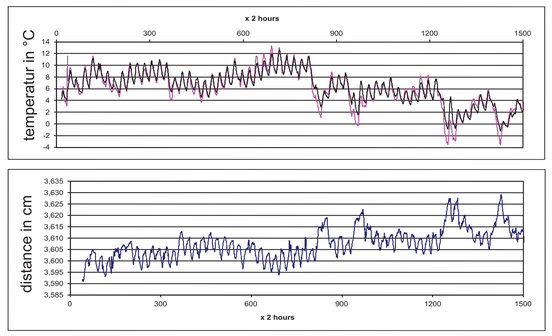
The results of repeated high-resolution airborne laser scanning (ALS) will contribute to a complete area-wide detection of surface changes and facilitates geomorphic mapping. Detailed periodical terrestrial laser scanning (TLS) of steep rock walls and their scree cones will complete the data set. Spot tests with rock fall colector nets, constructed on elected scree cones, allow the verification of the TLS data.



Steel tape extensometer and high resoluted electrical crackmeter measurements

Steel tape extensometer measurement at a scar of a deep seated sagging of mountain slope.

electrical crackmeter at al large joint directly above the contemporary glacier margin.



Displacement and temperature at a large joint in the late summer months in 2012.

4. Prospect

The study will be continued in the next three years. All these investigations will allow us to determine the actual mass balance of gravitational mass movements in an alpine glacier foreland. In a world with changing climate, this will provide the base for the study of future scenarios.