Quantifying proglacial morphodynamics and sediment budgets - the PROSA approach

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Objectives

We expect important results with respect to these research problems:

- Contribution and relative importance of different geomorphic processes, e.g. glacial vs. non-glacial processes, to sediment budget
- Dependence of sediment flux/yield on time since deglaciation
- Potential impact of continuing glacier retreat on process activity and processes, e.g. glacial vs. non-glacial processes, to sediment budget

Preliminary results (Haas et al. 2012) show that debris flows are triggered by heavy rain. The figure below shows a summary of surface changes and the sediment budgets on two slopes (c. 0.3 km² in total), quantified using scan-and-fill analysis of two terrestrial LiDAR DEMs (August 25th, 2010 and September 24th, 2011). The investigation period contains, among others, a rainstorm which triggered a flood with a return period of c. 50 years. The same event triggered small debris flows on the steep lateral moraines which amount to c. 3560 m³. Lateral cohesivity appears to be low, resulting in 71% of this volume being redeposited on secondary paraglacial fans at the footslope of the lateral moraine, while only 29% reached the channel network.

The PROSA approach to establishing the proglacial sediment budget

Methodology:

- Repeat terrestrial LiDAR measurements will be conducted in order to detect and quantify surface changes on the heavily dissected lateral U.A. moraines. Monitoring will also reveal the degree to which slopes and channel are coupled.

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The PROSA approach to establishing the proglacial sediment budget

**Objectives**

**Tools**

- Field methods
- Remote sensing
- LiDAR, ALS data
- TLS epochs
- Extensiometers
- Gauges
- Surveys

**Challenges**

- Quantification of the sediment flux within the study area
- Comparison of rates of different geomorphic processes
- Morphodynamics depending on time since deglaciation

**Research disciplines**

- Geology
- Geomorphology
- Geodesy
- Geophysics
- Glaciology
- Geography

**Background**

The formation of paraglacial sediment storage landforms from the erosion or re-inobilisation of glacial sediments (e.g. moraines), and the successive reworking of the latter, are being witnessed at great intensity in the forefields of alpine glaciers, within the area that has become ice-free since the end of the LIA, which we refer to as the proglacial area.

While processes have been the subject of several case studies, field studies of proglacial areas including multiple processes, their rates and interactions are rare.

The PROSA joint project (High-resolution measurements of morphodynamics in rapidly changing proglacial Systems of the Alps; 2011-2015) aims at establishing the proglacial sediment budget with respect to different geomorphic processes. It will employ high-resolution surveying methods to quantify surface changes and sediment fluxes, including terrestrial and aerial LiDAR. The study area is the lateral moraine of the Weißseeferner, which is part of the Gepatsch reservoir. We expect to have an annual sediment budget derived from long time series of aerial LiDAR data.

**Study Area**

**Research domains**

- Glaciology
- Geomorphology
- Geodesy
- Geophysics

**Objectives**

- Establishing the proglacial sediment budget
- Proglacial system and at a delta within the Kaunertal valley
- Proglacial area
- Process rates and budgets along the channel network

**Upscaling of local findings to catchment scale**

- LiDAR surveys
- Repeat LiDAR surveys:
- Debris flows, till erosion, slope wash
- Repeat terrestrial LiDAR measurements will be conducted in order to detect and quantify surface changes on the heavily dissected lateral U.A. moraines.

**Process rates and budgets along the channel network**

Marked channel changes following a 50-year flood (August 2011) are visible on photographs. While in- and output of this reach are unknown, these results indicate that the floodplain acted as a sediment storage (Morche et al., 2012). The results will be monitored by repeat LiDAR surveys.

**2009 glacier extent**

**Objectives**

- Establishing the proglacial sediment budget
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