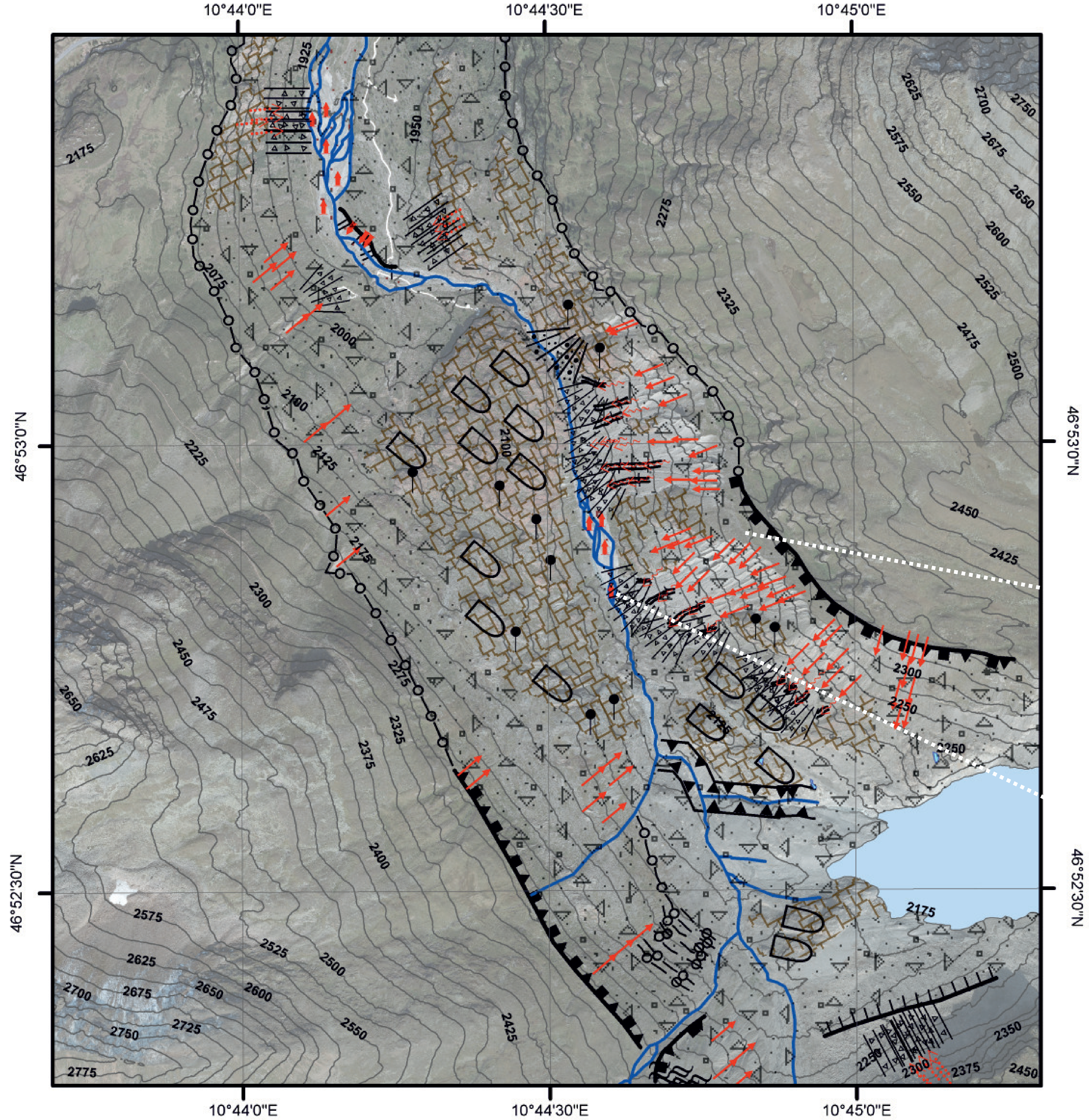
EGU 2012-14233

Proglacial area of the Gepatsch glacier

(Geomorphologic Map)



Legend

Active Processes

- Lateral erosion
- Sedimentation
- Debris flow
- Rock fall
- Linear fluvial erosion

Landforms

- Striations
- Glaciated knob
- Moraine ridge (Holocene)
- Land slide
- Debris flow cone
- Levée
- Scree slope
- Alluvial fan
- Fluvial reworked sediment
- Step > 20 m
- Step 2 - 10 m
- Step < 2 m
- Gorge
- Bedrock
- Glacial till

Hydrology

- Gepatsch glacier (2009)
- Glacial stream
- Standing water body
- Contour lines

Mapping: B. Brandlmeier, V. Pfaller (2011)
Carthography: B. Brandlmeier, V. Pfaller (2011) and L. Hilger (2012)

Geomorphological mapping of the proglacial zone of the Gepatsch glacier, Austria

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funded by DFG Deutsche Forschungsgemeinschaft

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Introduction

Glacier recession and its causes have lead, and will continue to lead, to changes in permafrost distribution, river runoff, soil development, vegetation and the activity of geomorphic processes, with all of these components generally interacting. The formation of paraglacial sediment storage landforms from the erosion or (re-)mobilisation of glacigenic 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. Knight & Harrison (2009) argue that paraglacial processes reworking stores of unconsolidated sediment will, under conditions of present and future climate change, be ranked among the most relevant processes of sediment and landscape dynamics in low- and mid-latitudes. While single processes have been the subject of several case studies, field studies of proglacial areas including multiple processes, their rates and interactions are rare (Warburton 1990, O'Farrell et al. 2009).

The **PROSA joint project** (High-resolution measurements of morphodynamics in rapidly changing **PRO**glacial **S**ystems of the **A**lps; 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. Hillslope-scale results will be upscaled using geomorphological maps and modelling approaches. Sediment output will be gauged at the outlet of the proglacial system and at a delta within the Kaunertal reservoir which can be LiDAR surveyed when the lake level is lowered in a controlled manner.

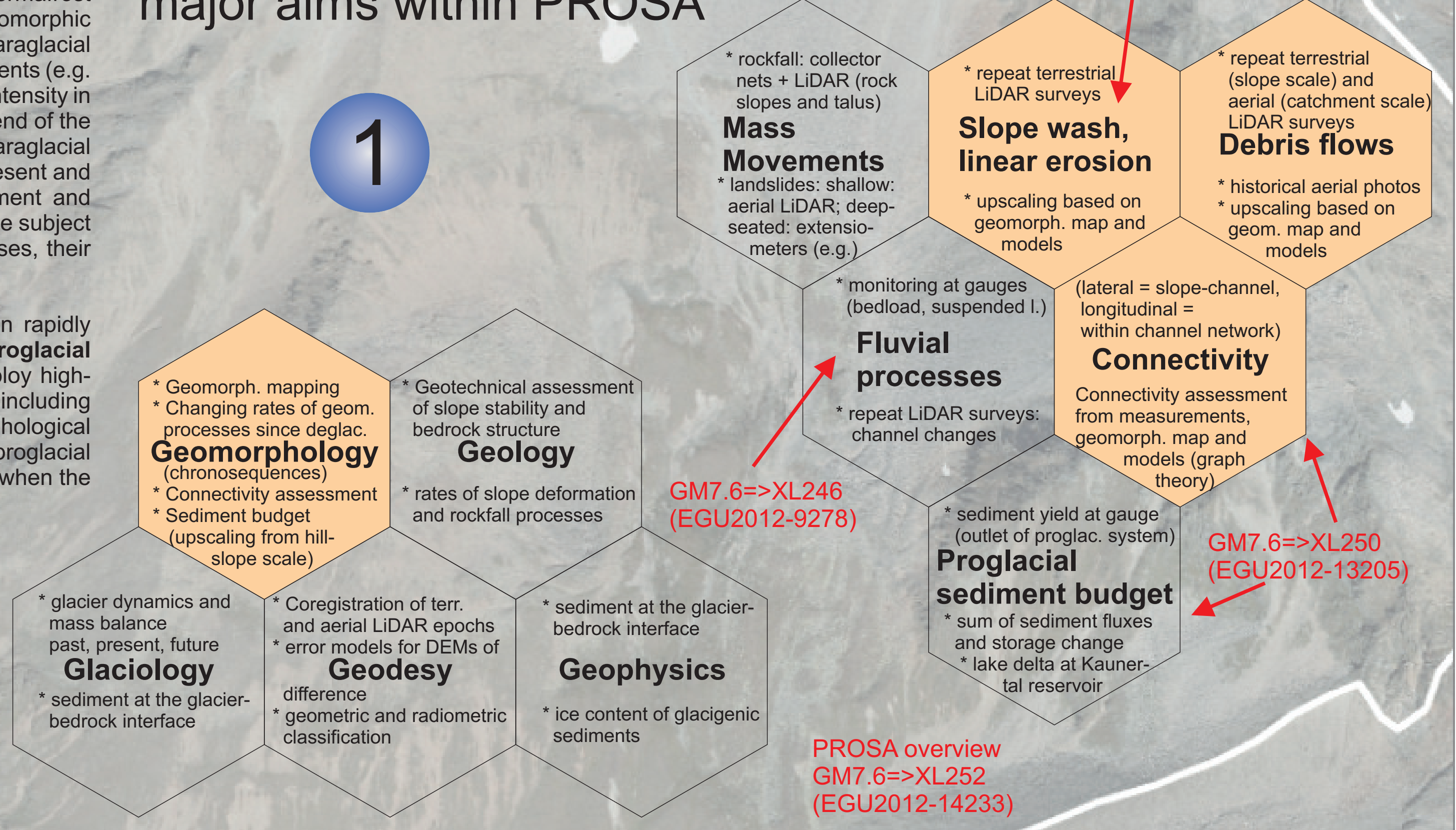
Geomorphological mapping, focusing on processes and sediment stores, forms an important basis for

a) identifying sediment stores and areas of recent process activity,
b) selecting plots for field measurements and terrestrial laserscanning,
c) assessing lateral (hillslope-channel) and longitudinal (along the channel network) sediment connectivity,
d) calibrating or validating spatial models. The latter complement the geomorphological map for the purpose of up-scaling the results of hillslope-scale measurements to the catchment scale.

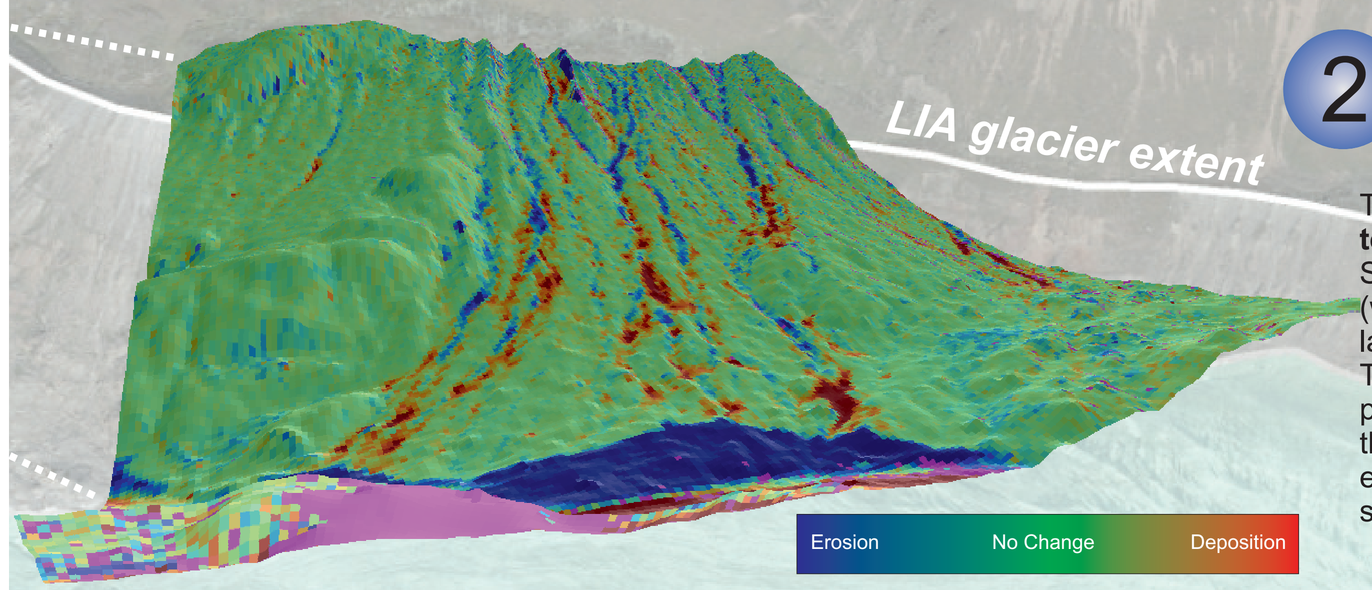
Hence, the geomorphological map is an indispensable tool in establishing the sediment budget of the Gepatsch proglacial area.

Research disciplines and major aims within PROSA

1



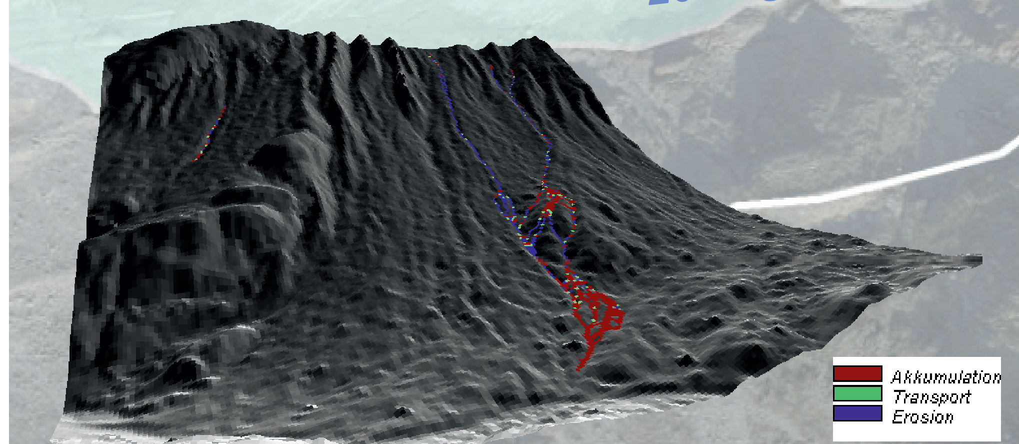
2 Quantifying morphodynamics on a steep lateral moraine using repeat terrestrial LiDAR



The figure on the left shows a **DEM of difference created from two terrestrial LiDAR surveys** c. one year apart (August 2010, September 2011). Within this period, at least one major rainstorm (which caused a 50 year flood) triggered debris flows on the steep lateral moraines which had become ice-free since the 1960ies.
The results confirm the (qualitative) **connectivity assessment** previously made on the basis of the geomorphological map: Only 29% of the sediment mobilised by the debris flows (total volume c. 3560 m^3) was exported to the channel network, while 71% were deposited on secondary paraglacial storage landforms beneath the steep moraine.

3 Using a debris flow model to support geomorphological mapping and upscaling of local findings

2006 glacier extent



The figure above shows the result of a debris flow simulation model on the same lateral moraine as shown above (section 2). The sediment budget of debris flows on the catchment scale will be established by

a) DEMs of difference generated from repeat aerial LiDAR surveys
b) multitemporal geomorphological maps focusing on debris flow activities, on the basis of historical aerial photos
c) applying numerical models that are able to delineate the spatial extent of potential debris flow activity, including a geomorphological zonation (erosion, transport, deposition). These models will also be employed in the assessment of hillslope-channel coupling.

4 Preliminary conclusions from work in progress and outlook

In course of the mapping process, landforms and process domains were identified, interpreted and represented. Our mapping is supported by 1m-DEMs (from aerial LiDAR surveys) and digital orthophotos. Different land surface parameters derived from the DEM are being consulted for the mapping of morphologically complex or ambiguous areas. We make use of basic local (i.e. slope, aspect and curvature), regional (i.e. height above channel network) and statistical parameters (i.e. terrain roughness) (cf. Seijmonsbergen, Hengl & Anders 2011).
Only parts of the whole investigation area have been mapped so far. The study area being so large, semi-automated approaches will support the generation of an area-wide map.

The symbology used here is based both on the GMK 25 (cf. Barsch & Liedtke 1980) and the set presented by Kneisel et al. (1998). The corresponding GIS style sets include symbols for geomorphologic features, processes and material as point and line symbols and polygon filling patterns. Their strength are their flexibility due to a low number of discrete landform signatures which can be combined to represent different elements of the alpine geomorphic system (Otto & Dikau 2004). Despite these representational advantages, we found that the qualitative resolution of the thematic layer of process domains to be too coarse for our purposes. Where the symbol set provides a polygon symbol for the process domain "gravitative", we would need a differentiation between rock fall, debris flows, etc. For mapping the latter, point markers are intended in the symbol set. The reason for our need of polygon symbols is that we aim to use the mapping results for a grid based modelling of these processes. As a result, it was necessary to map these process areas twice, i.e. once for representation on a geomorphologic map using point markers and once as input and test data for modelling of these processes and the coupling of their process areas.
Nevertheless, it was possible to select interesting and geomorphologically dynamic observation sites alone from the "representational" geomorphologic map.