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Topographic maps – an important data source for investigating long-term glacier variations

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The mountain cryosphere has been disproportionately affected by climate warming and changing precipitation conditions since the 19th century. This has caused intense and multiple reactions in high mountain hydrosphere, lithosphere, relief sphere, biosphere and pedosphere. Although there is general knowledge on climate-related changes of glaciers, little is known about the high-resolved temporal and spatial development of glaciers in the last century. These knowledge gaps further implicate limitations by simulating past and future development of the mountain cryosphere difficult, as important calibration and validation data are missing.

Topographic maps contain important information, as they are among the most reliable area-wide representations of past landscape for the time before airborne data acquisition. Thus, they offer the opportunity to extract former glacier extents and to close the information gap between the LIA extent, reconstructed from moraine extent, and aerial derived glacier information in the recent past.

However, as maps represent entities of a real world generalized depending e.g. on the intension of mapping, we consider map uncertainties as a crucial aspect for the reconstruction of glaciers from historical data.

In order to assess the accuracy of glacier area and front position from topographic maps, we reconstruct glacier extents under consideration of a comprehensive systematic examination of the uncertainty with regard to position, time and attribute. For this purpose, we use information of 12 topographic maps with a scale of 1:75,000 or larger from Kaunertal, covering a time span of 139 years (1871 – 2010) and analyse the accuracy of the maps focusing on production-related and transformation-oriented uncertainty.

The comparison between the glacier changes, derived from the maps and the original data (if available) as well as those measured in situ, shows that topographic maps are a reliable data source for the reconstruction of glacier front variations and provide vital key information when studying long time series.