

# Historical Maps as Source for Glacier DEM Reconstruction

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### EXTENDED ABSTRACT

#### Introduction

The comparison of repeated digital elevation models (DEM) of glaciers provides information on changes in volume. The evaluation of contour lines on topographic maps is often the only available source of surface topography in times before 1950. Digitizing and attributing these contour lines manually is time consuming and error-prone. For this study, parts of the manual processes have been automated. The method has been conducted for a total catchment area of about 205 km<sup>2</sup> in the Swiss Alps. However, manual intervention is still necessary and unavoidable.

#### Method

The historical maps used in this study are available from the Swiss Federal Office of Topography (swiss-topo) as scanned and georeferenced raster images. In glacierized catchments, contour lines are drawn in blue, brown, and black. The first step uses standard image processing software to achieve a separation of the respective colors.

The three color separated images can now be used for automated vectorization (step two). However, the images do not only contain the contour lines, but also all other map elements that are symbolized in the same color. This makes a manual post-processing stage necessary, in which all unwanted elements must be deleted, such as labeling or river networks.

The contour lines are used as input for DEM interpolation, but they must receive their respective height as an attribute first (step three). To support the operator, an algorithm has been developed, which firstly determines the spatial order of contour lines in a selected area and secondly attributes these lines.

With the attributed contour lines available, DEM interpolation software can be used to interpolate the historic surface (step four).

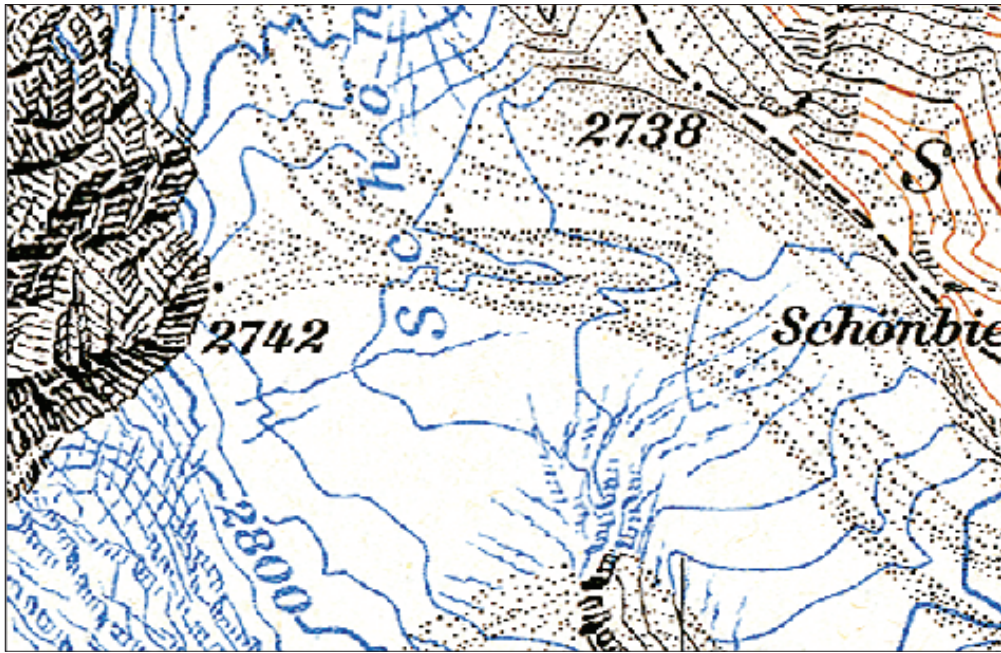
#### Results

Tests showed that the process is as far as possible operator-independent. Furthermore, in one test area it was possible to compare the semi-automated results with the fully manually-processed results. The two resulting DEMs fit very well.

The resulting DEMs are visualized with different techniques and visualization methods: 2D, 3D, and over the Internet to make it accessible to a broader audience.

#### Discussion

To exploit the historic data stored in old maps, semi-automated processes may support the operator in order to achieve a more efficient workflow. However, manual steps will be necessary in any case.



*Figure 1: Original colored map (top) and map after processing for target color blue (bottom).*

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