

Changes in the extent of a glacier based on topographic maps and satellite images - possibilities and limitations on the example of the de Ferpecle glacier

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Abstract:

Climate change is a fact, and the rate of its occurrence is monitored, among others things, by: in the Arctic zone - observing changes in the extent of glaciers.. Changes due to global warming are affecting glaciers in the Alps (<https://creamontblanc.org>), and in particular the glacier retreat we are currently observing in the study area. The authors propose tracing changes in the extent of a mountain glacier using the Swiss glacier de Ferpecle example. The Ferpecle Valley is located in southern Switzerland, on the border with Italy, in the Pennine Alps, in the Matterhorn massif. The upper part of the Ferpecle valley is occupied by three glaciers: the main Glacier de Ferpecle and two smaller ones, Glacier du Mont Mine and Glacier des Manzettes. This area is popular with tourists all year round. Therefore, a proper assessment of changes in glacier extent has implications for investments in the tourism sector, as well as for awareness of geohazards and attempts to mitigate them.

Topographic maps available on the Federal Office of Topography Swisstopo website and satellite images available on the USGS website were used for the analyses. The time range of available data is over 150 years. Special attention was given to the possibilities and limitations of using existing materials. The study shows a change in the extent of the glacier and a change in its surface area. The novelty of our research is the assessment of mass movement activity and other natural hazards associated with the rapid recession of the glacier. Proper interpretation of historical cartographic material allows us to estimate the impact of geohazards on the wide foreland of the melting glacier. One important aspect is the difference in interpretation between topographic maps and satellite imagery. This can affect the outcome of the analysis. Topographic maps were prepared using the principles of generalization, which constitutes a certain generalization of the glacier's extent. Satellite photos taken at different times of the year and the possibility of cloudiness require appropriate data preparation first, so that they can continue analyzes based on topographic maps developed at a specific level of detail. This issue was discussed in detail on the example of the de Ferpecle glacier in the Swiss Alps. Studies allowing the analysis of changes over a similar time interval were selected from the available topographic maps. Satellite photos were taken from different years and seasons, illustrating the differences in coverage on a seasonal and multi-annual basis. The variable activity of the geomorphic processes on the immediate forefield of the glacier and on the surrounding steep slopes has also been demonstrated.

The observed recession was compared to studies from other glacial areas presented in works on the Arctic (Owczarek P. et al., 2014). The obtained results, especially in relation to the last decades, were compared with the analyzes of Geyman et al. (2022) and the report on high mountains (Hock et al., 2019).

References

Climate change and its impacts in the alps (<https://creamontblanc.org/en/climate-change-and-its-impacts-alps/>)

Geyman, E.C., J. J. van Pelt, W., Maloof, A.C. et al. Historical glacier change on Svalbard predicts doubling of mass loss by 2100. *Nature* 601, 374–379 (2022). <https://doi.org/10.1038/s41586-021-04314-4>

Hock, R., G. Rasul, C. Adler, B. Cáceres, S. Gruber, Y. Hirabayashi, M. Jackson, A. Kääb, S. Kang, S. Kutuzov, Al. Milner, U. Molau, S. Morin, B. Orlove, and H. Steltzer, 2019: High Mountain Areas. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E.

Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)). Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 131–202. <https://doi.org/10.1017/9781009157964.004>.

Owczarek P., Nawrot A., Migala K., Malik I., Korabiewski B.; Flood-plain responses to contemporary climate change in small High-Arctic basins (Svalbard, Norway). *Boreas*. - Vol. 43, iss. 2 (2014), 384-402.

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Federal Office of Topography Swisstopo. <https://www.swisstopo.admin.ch>

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