communications earth & environment

A Nature Portfolio journal

Comment

https://doi.org/10.1038/s43247-025-02994-8

The 2025 Blatten disaster in the Swiss Alps followed exceptional warming and highlights the vulnerability of people and heritage in glaciated landscapes

Ulf Büntgen, Clive Oppenheimer, Daniel Farinotti, Tim Nahtz & Jan Esper

On 28 May 2025, twenty million tonnes of rock and ice buried the village of Blatten and nearby settlements in the Swiss Lötschen valley. In the wake of the warmest decade since at least 742 CE, the disaster underlines the potential impact of climate warming on people and heritage.

On Wednesday 28 May 2025, at 15:24 local time, a substantial part of the Birch glacier in the Lötschen valley of the Swiss Alps detached and triggered a catastrophic rock-ice avalanche that obliterated most of the village of Blatten[1]. An estimated 20 million tonnes of ice and rock, 2.9 and 6.4×10^6 m^3, respectively, travelled at a speed of up to 200 km h[1] over 1200 m vertical distance to the valley floor and then nearly 200 m up the opposite slope of the valley (Fig. 1A). Thanks to prior surveillance of the glacier's deformation and hazard assessment, the local population, along with animals, had been evacuated just nine days before the event between 17 and 19 May. A shepherd who had returned to the area outside the evacuation zone was the sole fatality. The estimated economic losses exceed 320 million Swiss Francs.

Anthropogenic climate change is recognised as a potential influence on the occurrence of rock and ice avalanches: for instance, higher temperatures and increased precipitation, can affect glacier mass balance and permafrost degradation[2], as well as snow cover and streamflow[3]. In addition to warming, intensification of convection-driven precipitation at higher elevation has increased the occurrence of hazardous flash floods, debris flows, and glacier lake outburst floods worldwide[4].

We note that the 2025 Blatten disaster followed the warmest decade in the European Alps since at least early medieval times[5]. Dendrochronological evidence from the Lötschen valley emphasises both the rarity and fragility, as well as the importance of high-resolution, long-term climate reconstructions for contextualising current trends and extremes against past changes.

Heritage loss

Parts of the Lötschen valley, together with the glaciated Jungfrau-Aletsch protection area surrounding Concordia Place, were inscribed on the UNESCO Natural World Heritage list in 2001 CE. More than 300 buildings were destroyed in Blatten and 70 in the nearby settlement of Ried (Fig. 1B). These include a unique ensemble of late medieval houses from the 16th and 17th centuries that were only recently mapped and dated[6]. While Blatten's oldest wooden construction dates back to 1516 CE, a few others date to the 16th century, and another 37 buildings date to the 17th and 18th centuries. Blatten was also home to eight late medieval residential houses with rare ridge-transverse main room beams[6]. More than 100 historical timber houses very close to the zone of destruction were spared in Eisten and Wyssried, of which the oldest are from 1455, 1502 and 1514 CE[6].

Blatten is not the only village in the Lötschen valley to have been destroyed. A fire in 1900 CE razed the entire settlement of Wiler, though it was rebuilt and is now the largest and fastest growing parish in the valley. Following the destruction of the oldest wooden buildings in Wiler and Blatten by fire and rock-ice in 1900 and 2025, respectively, the valley's exceptional cultural heritage is now restricted to Ferden and Kippel.

Climate backdrop

Annually resolved and absolutely dated maximum latewood density measurements from living and relict wood have yielded some of the world's longest and best replicated temperature records[7]. Using a network of five maximum latewood density chronologies from high-elevation sites in the European Alps[5], June-September temperatures have now been reconstructed for the past 1280 years (Fig. 1C). Site selection, network compilation and proxy calibration were optimised to preserve the full range of high- to low-frequency, interannual to multi-centennial variability, with the new pan-Alpine record exceeding the signal-to-noise ratio of any other climate reconstruction[5].

Pre-industrial Alpine summer temperatures were highest in the 970 s and between the 1130 s and circa 1200 CE (Fig. 1C). The warmest ten year period on record spans 2015 to 2024 CE. The Blatten disaster thus followed the warmest decade since at least early medieval times, with June-September temperatures across the Alps and much of central Europe 4.22 °C warmer than the coldest ten-year period of the Little Ice Age between 1812 and 1821 CE. Assuming a free-air temperature lapse rate of 0.5° per 100 m elevational change, the more than 4 °C amplitude over the past two centuries suggests a shift in freezing and snowline isotherms by circa 800 m (Fig. 1C).

Lessons learned

The complex, interacting and multi-seasonal rock mechanical, glacial and hydrological processes that led to the Birch glacier's detachment are now under detailed investigation. While the statistical basis for evaluating causes of large glacier detachments remains limited[8], global warming may be increasing the frequency and intensity of such events[9,10]. Alpine permafrost in Switzerland lost about 15% of its ice between 2015 and 2022 CE[11], and hot

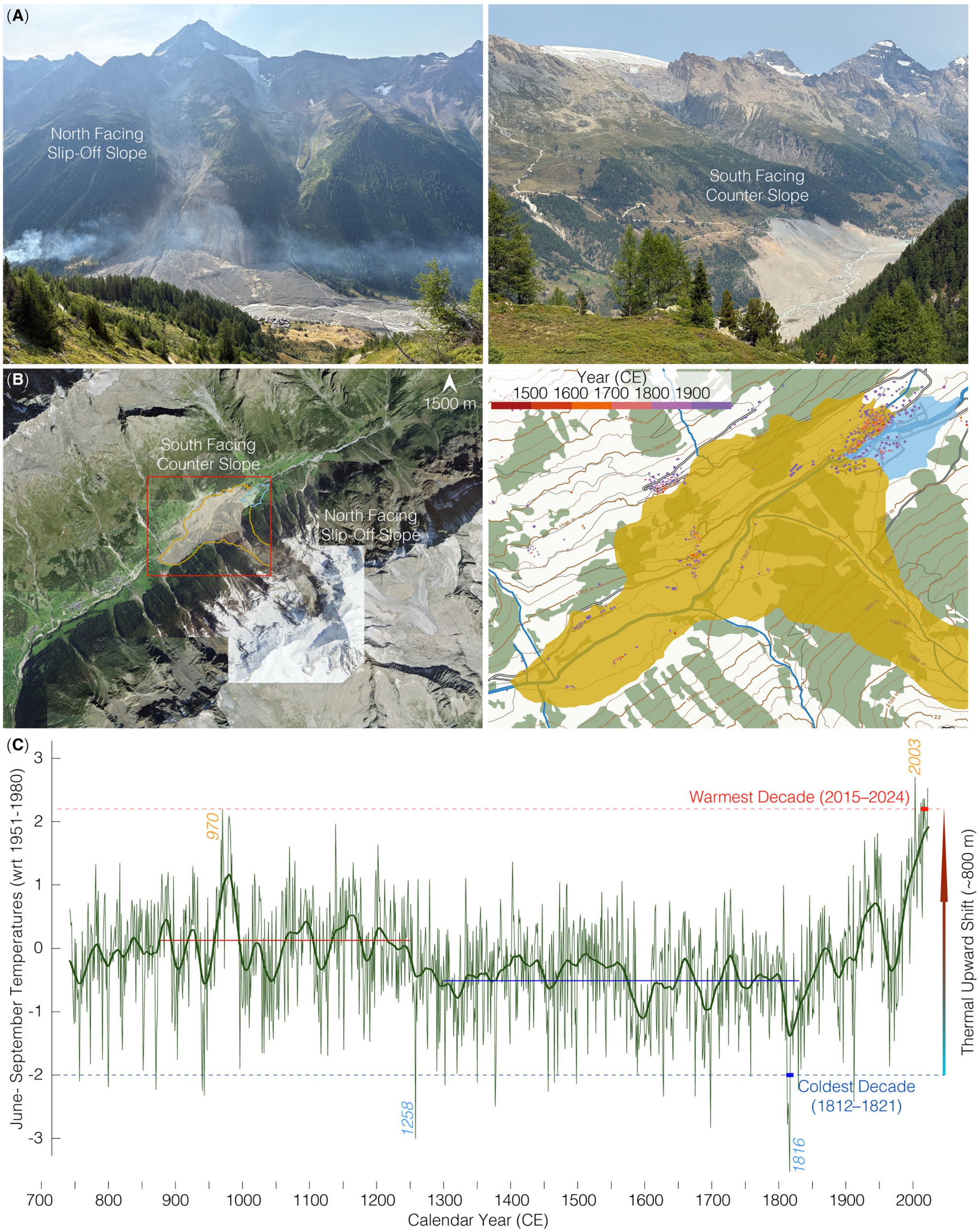
(A)
North Facing
Slip-Off Slope
South Facing
Counter Slope
(B)
1500 m
South Facing
Counter Slope
North Facing
Slip-Off Slope
Year (CE)
1500 1600 1700 1800 1900
(C)
June- September Temperatures (wrt 1951-1980)
3
2
1
0
-1
-2
-3
2003
Warmest Decade (2015–2024)
970
1258
1816
Coldest Decade
(1812–1821)
Thermal Upward Shift (~800 m)
700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000
Calendar Year (CE)

Fig. 1 | Contextualising the 2025 Blatten disaster against past temperature variability. A Two pictures showing the physical scale of the catastrophic rock-ice avalanche that obliterated most of the village of Blatten and nearby medieval settlements in the western Swiss Lötschen valley on 28 May 2025 (both pictures taken by U Büntgen, 19 August 2025). **B** Areal image of the Lötschen valley from Goppenstein in the southwest to Fafleralp in the northeast (https://s.geo.admin.ch/8l3lmei801dp), showing the rock-ice avalanche track from the former Birch glacier below the Kleines Nesthorn and the accumulated debris and subsequent damming of the Lonza river. Based on a 10 m resolution digital elevation model (https://www.swisstopo.admin.ch/en/height-model-swissaltiregio), the map reinforces the extent of destruction by debris and water (orange and blue, respectively). Collapse and movement of the northwest-facing Birch glacier were channelled by a predefined avalanche track[6]. **C** Pan-alpine summer temperature reconstruction back to 742 CE (thin green line)[5], together with a 30-year Gaussian filter (thick green line). The warmest summer on record is 2003 (+2.71 °C), and the warmest and coldest reconstructed pre-industrial summers are 970 (+2.19 °C) and 1816 (−3.94 °C). The period from 2015 to 2024 was the warmest decade (+2.17 °C; thick red box), whereas the coldest reconstructed decade was from 1812 to 1821 (−2.05 °C; thick blue box). The Medieval Warm Period (MWP; circa 880 to 1250 CE) and the Little Ice Age (LIA; circa 1300 to 1830 CE) are indicated by horizontal lines.

summers like those of the past decade have irreversible consequences as the thickness of the active layer that thaws in summer increases[12]. In the case of Birch glacier, permafrost degradation of the Kleines Nesthorn summit region around 3335 m asl, probably enhanced rockfall on to the lower and more voluminous section of the glacier, contributing to its gravitational instability and eventual collapse.

Comparable events have occurred in the Swiss Alps and elsewhere over the past decade: In 2017, a rock-ice avalanche at Pizzo Cengalo in eastern Switzerland caused severe downstream damage, destroying parts of the village of Bondo and claiming eight lives[13,14]; in 2024 also in eastern Switzerland, a rock-ice avalanche followed the collapse of Piz Scerscen[15]; in 2022, a glacier collapse in the Russian Caucasus buried the village of Nizhniy Karmadon and dammed local river systems, with the loss of 125 lives[16]; in 2018, the Sedongpu glacier detachment in southeast Tibet dammed the Yarlung Tsangpo river[17].

Glacier collapses were common on south-facing slopes in the Northern Hemisphere and at lower elevations under pre-industrial climate conditions[8], but global warming is shifting the locus of these events to aspects and altitudes that were previously less prone[10], such as the lower elevation, north facing Birch glacier in the Lötschen valley[1]. The most recent evacuation of the village of Brienz in the eastern Swiss Alps in June 2025 and growing concerns of the municipality of Kandersteg in the Bernese Alps further emphasise the vulnerability of closely intertwined natural and societal systems in mountainous regions. It is therefore imperative to reassess the safety of existing and planned settlements, agricultural zones, and infrastructure in alpine environments worldwide in light of the expanding regions affected by climate change.

The Blatten disaster will be preserved in Switzerland's collective memory as one of the largest and most devastating rock-ice avalanches in modern history. The event emphasises the urgent need to improve research-based policy guidance for detecting, preventing, and managing multi-hazard cascades in steep terrain, including avalanches, debris flows[18], and glacial lake outburst floods[19]. This task requires routine acquisition and interpretation of high-resolution in situ and remote sensing data and the integration of hazard assessments with robust early warning systems to enhance resilience and reduce risk in populated and remote mountain regions. While continuous monitoring and effective risk management in the Lötschen valley prevented mass casualties, other regions of the world lack the means and expertise to establish such early warning systems.

Reporting summary. Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Ulf Büntgen [1,2,3] ✉**, Clive Oppenheimer** [1]**, Daniel Farinotti**[4,5]**, Tim Nahtz**[6] **& Jan Esper** [2,6]

[1]Department of Geography, University of Cambridge, Cambridge, UK. [2]Global Change Research Institute (CzechGlobe), Czech Academy of Sciences, Brno, Czechia. [3]Department of Geography, Faculty of Science, Masaryk University, Brno, Czechia. [4]Laboratory of Hydraulics, Hydrology and Glaciology (VAW), ETH Zurich, Zurich, Switzerland. [5]Swiss Federal Institute for Forest, Snow and Landscape Research WSL, bâtiment ALPOLE, Sion, Switzerland. [6]Department of Geography, Johannes Gutenberg University, Mainz, Germany.

✉e-mail: ulf.buentgen@geog.cam.ac.uk

Received: 24 July 2025; Accepted: 4 November 2025;
Published online: 08 December 2025

References

1. Islam, S. et al. A growing threat of multi-hazard cascades highlighted by the Birch Glacier collapse and Blatten landslide in the Swiss Alps. *Geol. Today* **41**, 200–205 (2025).
2. Noetzli, J. et al. Enhanced warming of European mountain permafrost in the early 21st century. *Nat. Commun.* **15**, 10508 (2024).
3. CH2018. *CH2018 – Climate Scenarios for Switzerland, Technical Report, National Centre for Climate Services*. (Zurich, 2018).
4. Jacquemart, M. et al. Detecting the impact of climate change on alpine mass movements in observational records from the European Alps. *Earth-Sci. Rev.* **258**, 104886 (2024).
5. Esper, J. et al. Pan-alpine summer temperatures since 742 CE. *Dendrochronologia* **94**, 126432 (2025).
6. Büntgen, U. et al. 700 years of settlement and building history in the Lötschental/Switzerland. *Erdkunde* **60**, 96–112 (2006).
7. Büntgen, U. et al. Summer temperature variations in the European Alps, AD 755–2004. *J. Clim.* **19**, 5606–5623 (2006).
8. AghaKouchak, A. et al. Climate Extremes and compound hazards in a warming World. *Ann. Rev. Earth Planet. Sci.* **48**, 519–548 (2020).
9. Kääb, A. et al. Sudden large-volume detachments of low-angle mountain glaciers – more frequent than thought?. *Cryosphere* **15**, 1751–1785 (2021).
10. GLAMOS. Swiss Glacier Bulletin 2024. *Ann. Rep.* **145**, 1–30 (2024).
11. Morard, S. et al. 20-year permafrost evolution documented through petrophysical joint inversion, thermal and soil moisture data. *Environ. Res. Lett.* **19**, 074074 (2024).
12. Hauck, C. & Hilbich, C. Preconditioning of mountain permafrost towards degradation detected by electrical resistivity. *Environ. Res. Lett.* **19**, 064010 (2024).
13. Mergili, M. et al. Back calculation of the 2017 Piz Cengalo–Bondo landslide cascade with r.avaflow: what we can do and what we can learn. *Nat. Hazards Earth Syst. Sci*. **20**, 505–520 (2020).
14. Walter, F. et al. Direct observations of a three million cubic meter rock-slope collapse with almost immediate initiation of ensuing debris flows. *Geomorphology* **351**, 106933 (2020).
15. Petley, D. A large rock avalanche on Piz Scerscen in Switzerland. *EOS* https://eos.org/thelandslideblog/piz-scerscen-1 (2024).
16. Haeberli, W. et al. The Kolka-Karmadon rock/ice slide of 20 September 2002: an extraordinary event of historical dimensions in North Ossetia, Russian Caucasus. *J. Glaciol.* **50**, 533–546 (2004).
17. Kääb, A. & Girod, L. Brief communication: Rapid ~ 335 × 106 m3 bed erosion after detachment of the Sedongpu Glacier (Tibet). *Cryosphere* **17**, 2533–2541 (2023).
18. Aaron, J. et al. Detailed observations reveal the genesis and dynamics of destructive debris-flow surges. *Commun. Earth Environ.* **6**, 556 (2025).
19. Satter, A. et al. The Sikkim flood of October 2023: Drivers, causes, and impacts of a multihazard cascade. *Science* **387**, eads2659 (2025).

Acknowledgements

Supported by the Czech Science Foundation Grant Hydro8 (23-08049S), the co-funded OP-JAK project AdAgriF (CZ.02.01.01/00/22_008/0004635), the ERC Advanced Grant Monostar (882727), and the ERC Synergy Grant Synergy-Plague (101118880).

Author contributions
U.B. wrote the manuscript together with C.O. and J.E. Glaciological expertise was provided by D.F. Mapping and visualisation was supported by T.N. All authors contributed to discussion.

Competing interests
The authors declare no competing interests.

Additional information
Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s43247-025-02994-8.

Correspondence and requests for materials should be addressed to Ulf Büntgen.

Reprints and permissions information is available at http://www.nature.com/reprints

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.