

Supplementary Material

Figs. S1–S4

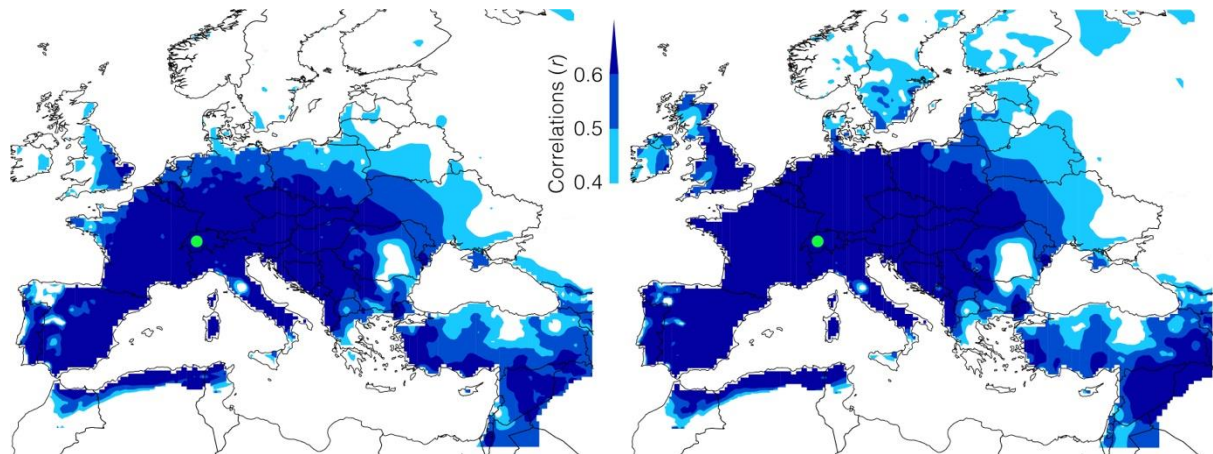


Figure S1. Extent of Alpine summer temperatures over Europe. Spatial field correlations of the reconstructed (this study; left) and measured (Berkeley; right) June-September mean temperatures against $0.25^\circ \times 0.25^\circ$ gridded data (E-OBS) calculated over 1950–2024 CE. Green dots show the Lötschen valley in the western Swiss Alps.



Figure S2. The Blatten disaster. Left picture shows the village of Blatten in the upper part of the Lötschen valley in the western Swiss Alps, taken before the rock-ice avalanche from the onsite, south-facing slope near Lauchernalp. Centre picture shows the devastating ice-rock avalanche, taken during the afternoon of 28 May 2025. Right picture shows the enormous rock-ice debris in the valley.

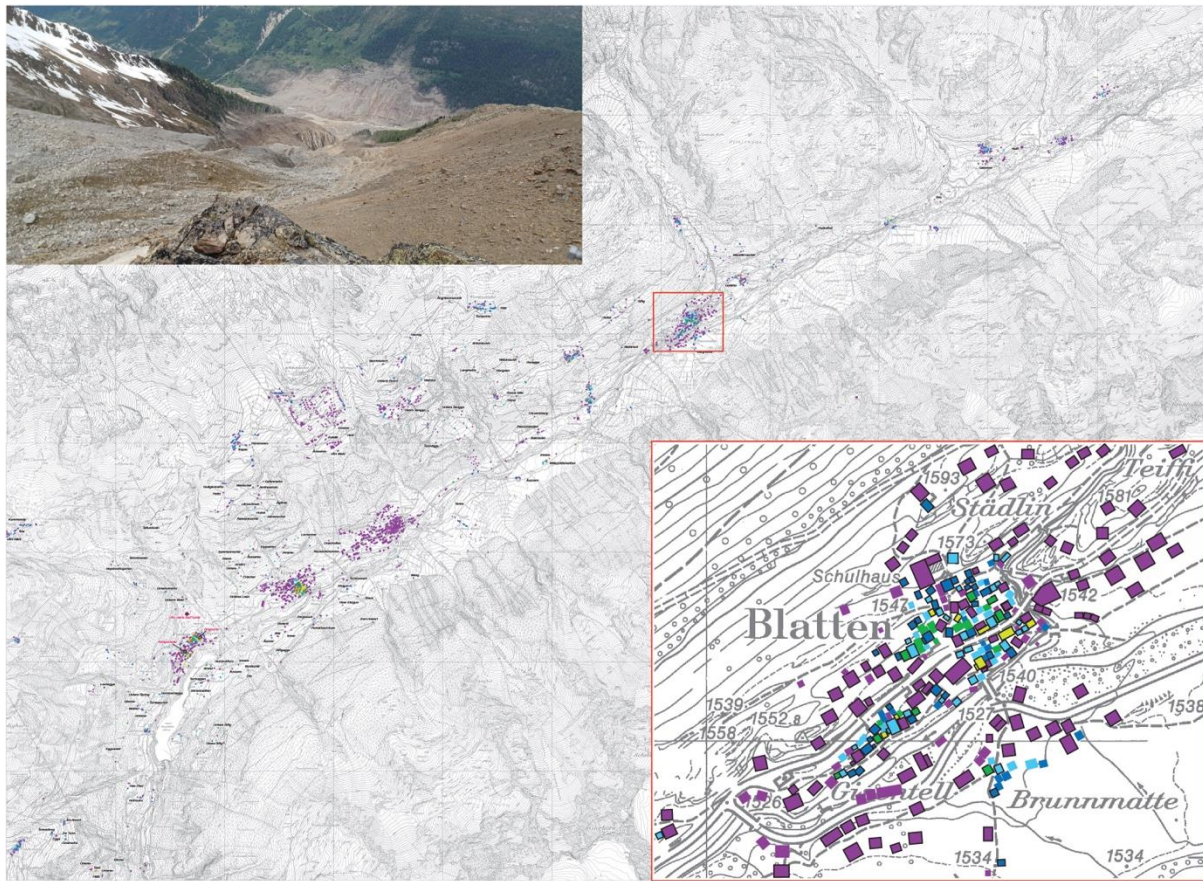


Figure S3. Settlement and building history in the Lötschen valley since medieval times. Spatial distribution of 2,317 residential and non-residential buildings in the Lötschen valley, in the western Swiss Alps (adapted from Büntgen et al. 2006a). Construction dates range from 1299–2004 CE, and buildings span an elevational range from 1,230–2,565 m asl (Goppenstein to Bietschhornhütte). Annual dates of 1,432 constructions are based on inscriptions, dendrochronological dating and/or documentary evidence, whereas century-resolved construction dates for the remaining 885 buildings were estimated (<1400 = red, 1400–1500 = orange, 1500–1600 = yellow, 1600–1700 = green, 1700–1800 = light blue, 1800–1900 = blue, >1900 = purple). Reflecting natural and man-made hazards, such as avalanches, floods, and fire outbreaks, and emphasising both the dynamic and persistence of high mountain settlements, this map is the only inventory of building ages of an entire Alpine valley that includes 116 local area names. The upper left inset shows the view from the source region of the rock-ice avalanche at circa 3000m asl into the valley bottom where Blatten and Ried (at circa 1500m asl) are buried under up to 120 debris that also affected the counter-slope up to Wyssried (circa 1700m asl) where around 70 historical buildings thankfully survived.

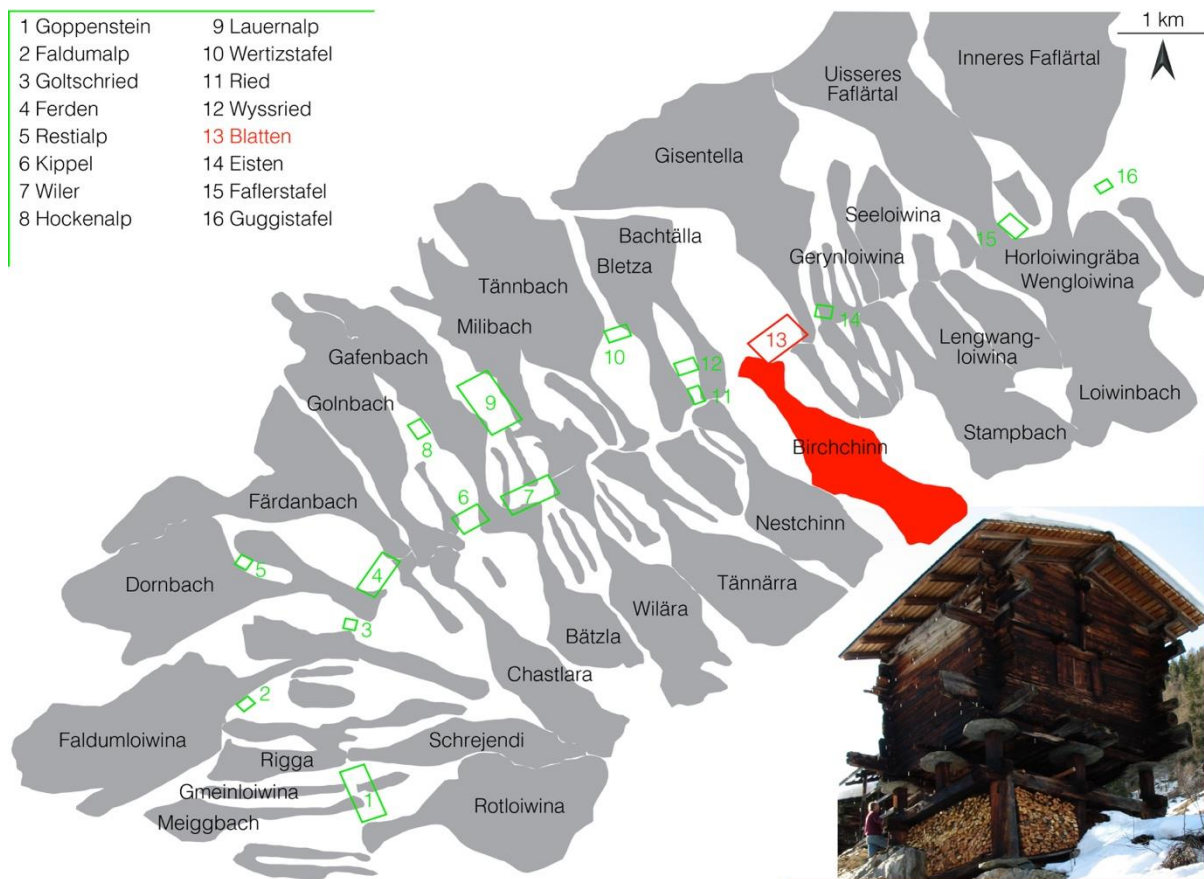


Figure S4. Avalanche tracks in the Lötschen valley. Spatial distribution of the 63 most frequent avalanche tracks in the Lötschental (grey shadings), together with the 16 most important agglomerations (green), which include the four villages in the valley bottom (1, 4, 6, 7, and 13), as well as smaller settlements at different elevations⁵. The village of Blatten (13), the “Birchchinn” avalanche track below the Birch glacier, and a late medieval wooden construction from Blatten are in red.