1   **Supplementary material**

2   **Table S1.** Additional analytical details on ^{10}Be measurements of river-sediment samples collected

3   in the present study. Sample locations are reported in Table 1 in the main text.

Sample	Quartz dissolved (g)	Be carrier (mg)	^{10}Be/^{9}Be not blank corrected (10^{-14})	^{10}Be/^{9}Be blank corrected (10^{-14})[a]	^{10}Be concentration (10^4 at g^{-1})
DB01	50.2785	0.1997	5.16±0.26	4.87±0.25	1.29±0.07
DB02	49.8504	0.1967	4.39±0.25	4.10±0.24	1.08±0.07
DB03	49.7478	0.1977	9.15±0.53	8.85±0.51	2.35±0.14
DB04	49.9469	0.1968	8.64±0.40	8.34±0.38	2.20±0.11
DB05	49.9931	0.1872	8.49±0.40	8.20±0.39	2.05±0.10
DB06	50.1976	0.1939	6.25±0.29	5.96±0.28	1.54±0.08
DB07	20.0443	0.1914	3.82±0.40	3.53±0.37	2.25±0.26
DB08	49.6077	0.1962	18.66±0.80	18.37±0.79	4.85±0.21
DB09	37.7201	0.1975	9.86±0.52	9.56±0.51	3.34±0.18
DB10	50.0416	0.1868	5.69±0.28	5.39±0.27	1.35±0.07
DB11	32.9841	0.1969	9.00±0.50	8.70±0.49	3.47±0.20
DB12	50.1821	0.1903	5.26±0.32	4.97±0.30	1.26±0.08
DB13	49.7747	0.1930	11.07±0.46	10.77±0.45	2.79±0.12
DB14	51.4029	0.1881	11.85±0.53	11.55±0.52	2.83±0.13
DB16	17.8550	0.2000	5.47±0.46	5.18±0.44	3.88±0.35
DB17	49.9150	0.1904	10.94±0.51	10.64±0.50	2.71±0.13
DB18	49.8754	0.1788	9.89±0.49	9.59±0.48	2.30±0.12
DB19	46.7700	0.1975	15.12±0.51	14.83±0.50	4.19±0.15

4

5   [a] Calculated ^{10}Be concentrations were corrected for full process blank ^{10}Be/^{9}Be ratio of 2.96

6    $\pm0.32 \times 10^{-15}$.

7   **Table S2.** Mean catchment [10]Be production rates and denudation rates calculated by applying different correction factors (see main text

8   for each correction description). Uncorrected results refer to values obtained by including only mean catchment topographic shielding.

9   The last two columns report the results obtained by applying all the corrections and used in the main text.

| Catchment	Uncorrected		Snow correction		Lithology correction		LIA-glacier correction		All corrections	
	Mean production rate (at g^{-1} yr^{-1})^a	Denudation rate (mm yr^{-1})^b	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})
DB01	29.4	1.45±0.11	24.3	1.19±0.09	30.0	1.47±0.12	17.1	0.85±0.07	13.7	0.68±0.05
DB02	25.1	1.49±0.13	21.2	1.26±0.11	25.1	1.49±0.13	18.3	1.10±0.09	15.3	0.91±0.08
DB03	28.6	0.76±0.06	23.7	0.63±0.05	28.5	0.76±0.06	22.7	0.60±0.05	18.0	0.48±0.04
DB04	27.5	0.78±0.06	22.9	0.65±0.05	26.4	0.75±0.06	21.4	0.61±0.05	17.8	0.51±0.04
DB05	27.8	0.85±0.06	23.1	0.70±0.05	27.2	0.83±0.06	21.9	0.67±0.05	17.4	0.53±0.04
DB06	22.6	0.94±0.07	19.4	0.81±0.06	22.6	0.95±0.07	18.8	0.79±0.06	16.1	0.68±0.05
DB07	22.2	0.61±0.07	19.2	0.53±0.06	22.0	0.61±0.07	18.5	0.51±0.06	15.3	0.42±0.05
DB08	20.2	0.27±0.02	17.5	0.23±0.02	18.4	0.24±0.02	19.9	0.26±0.02	15.9	0.21±0.02
DB09	24.4	0.46±0.04	20.8	0.39±0.03	24.5	0.46±0.04	20.6	0.39±0.03	17.5	0.33±0.03
DB10	23.5	1.12±0.09	20.1	0.96±0.08	23.4	1.12±0.09	19.3	0.93±0.07	16.5	0.79±0.06
DB11	24.5	0.44±0.04	20.8	0.38±0.03	22.1	0.40±0.03	20.0	0.36±0.03	16.0	0.29±0.02
DB12	25.6	1.30±0.11	21.6	1.10±0.10	25.1	1.28±0.11	19.8	1.01±0.09	16.4	0.84±0.07
DB13	24.4	0.56±0.04	20.7	0.47±0.03	24.2	0.55±0.04	20.5	0.47±0.03	17.2	0.40±0.03
DB14	22.1	0.50±0.04	19.0	0.43±0.03	21.9	0.50±0.04	21.7	0.49±0.04	18.5	0.42±0.03
DB16	23.6	0.38±0.04	20.0	0.32±0.03	22.8	0.37±0.04	22.8	0.37±0.04	18.7	0.30±0.03
DB17	27.2	0.63±0.05	22.6	0.52±0.04	25.6	0.59±0.05	19.9	0.46±0.04	17.3	0.40±0.03
DB18	27.0	0.75±0.06	22.5	0.62±0.05	26.9	0.74±0.06	20.9	0.58±0.05	17.2	0.48±0.04
DB19	25.8	0.39±0.03	21.6	0.33±0.02	25.3	0.39±0.03	19.2	0.29±0.02	16.0	0.25±0.02

10   [a] Catchment-averaged ^{10}Be production rates were calculated with Basinga (Charreau et al., 2019), based on SLHL total ^{10}Be production rate of

11   4.18±0.26 at g^{-1} yr^{-1} (Martin et al., 2017) and the Lal/Stone time-dependent scaling model (Lal, 1991; Stone, 2000).

12   [b] ^{10}Be-derived catchment denudation rates were calculated with Basinga (Charreau et al., 2019), using default attenuation length values of 160, 4320,

13   and 1500 g cm^{-2}, for neutrons, fast muons, and slow muons, respectively (Charreau et al., 2019, after Braucher et al., 2011), and assuming a rock

14   density of 2.7 g cm^{-3}. Denudation-rate uncertainties are estimated only based on values and relative errors of ^{10}Be concentrations and cosmogenic

15   production rates from neutron and muons (Eq. 5 in Charreau et al., 2019).

Table S3. Statistical significance of investigated linear correlations between tributary-catchment denudation rates and metrics. Correlations were calculated both including (in red) and excluding (in black) sample DB01 (see text for details). Linear trends were considered significant (bold) if p-value < 0.05. Some representative correlations are represented in Figures 3 and 4.

Catchment metric	p-value (with DB01)	R^2 (with DB01)	p-value (no DB01)	R^2 (no DB01)
Drainage area (km^2)	0.28	0.10	0.13	0.20
Mean elevation (m)	**0.01**	**0.49**	**0.03**	**0.37**
Mean slope (°)	**0.02**	**0.38**	0.10	0.23
Relative abundance of slopes > 40° (%)	**0.05**	**0.28**	0.20	0.13
Geophysical relief (5-km, m)	**0.00**	**0.62**	**0.02**	**0.39**
Hypsometric integral	0.12	0.19	0.61	0.02
Mean annual Precipitation (mm)	0.08	0.23	0.74	0.01
Relative abundance of bare-rock (%)	**0.02**	**0.40**	**0.02**	**0.38**
Basin area covered by LIA glaciers (%)	**0.01**	**0.43**	0.18	0.16
Mean LGM ice-thickness (m)	0.08	0.24	0.11	0.22
Basin area above LGM ELA (2103 m a.s.l.) (%)	0.06	0.27	0.10	0.23
Mean geodetic rock uplift (mm yr^{-1})	0.89	0.00	0.92	0.00
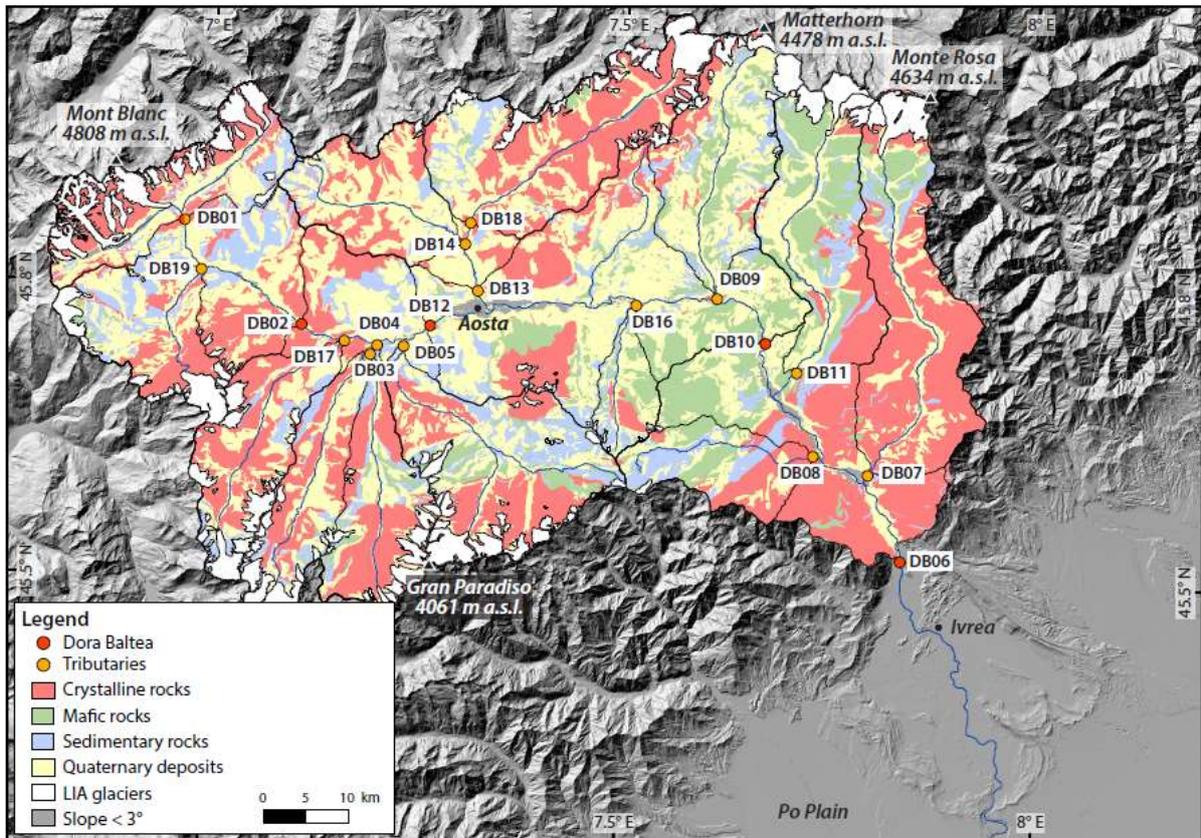
Figure S1. Spatial map of lithological/geomorphic correction factors employed for [10]Be production/denudation rate calculation, in addition to topographic and snow shielding. Crystalline rocks and Quaternary deposits (1/100,000- and 1/250,000-scale digital geological maps from Regione Autonoma Valle d'Aosta and Regione Piemonte) were considered as quartz-bearing lithologies and included in catchment production rate calculation. Mafic and sedimentary rocks were instead excluded based on assumption of no to minor quartz content. Low-lying areas (slope < 3°) were excluded from the calculations (no geomorphic link with stream network; Delunel et al., 2010). For LIA-glacier correction, [10]Be production rates were assumed to be null for areas covered by LIA glaciers (GlaRiskAlp Project, http://www.glariskalp.eu).