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Massive mobilization of toxic elements from an intact rock glacier in the central Eastern Alps

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Figure S1: Photographs of the Aua da Prasüra stream, Val Costainas, Switzerland, with white-colored streambed inherited from basaluminite precipitation.

Figure S2: Picture showing the upper part of the monitored catchment where flow direction of the stream is roughly from South to North.

S1 Tracer discharge measurements

The manual discharge measurements were carried out with the Sommer TQ-S Tracer System using the well-established tracer-dilution method with NaCl as tracer (e.g. Calkins and Dunne, 1970; Day, 1977; Leibundgut et al., 2009). The Tracer System consists of two electrical conductivity probes connected via Bluetooth to the Software TQ-Commander. For each site, the probes were calibrated with streamwater samples, allowing the calculation of NaCl concentrations based on electrical conductivity values (calculation is executed automatically by the software). When a fixed quantity of NaCl is added upstream, the system automatically quantifies the discharge based on the NaCl concentrations registered at the measurement site (integral of concentration curves). For each discharge quantification, we executed two measurements by using different amounts of salt, resulting in four measurements in total. The reported discharge values constitute the average of these four measurements. Based on the spread of the measurements, the uncertainty of the discharge quantification was well within ±5 %, which is consistent with the maximum measurement uncertainty estimated by the producer company (Sommer). In general, the uncertainty of discharge measurements using the salt dilution method depends on calibration, the amount of used salt and on the measurement setup, i.e. the length of mixing section. The better the salty water is mixed with the stream water, the higher the accuracy of measured discharge values. These aspects were taken into account during the measurements.

S2 Reconstruction of missing discharge and EC data at AP10 (downstream location)

In case of probe malfunctioning, different approaches were applied to reconstruct the missing discharge and concentration data. In the event of water table data loss, the data were handled differently based on the circumstances. In regular situations without any notable meteorological events, a linear interpolation method was employed to reconstruct the missing discharge data. If the data loss occurred immediately after a precipitation event, a typical recession curve equation (Maillet, 1905) was used:

$$Q_t = Q_0\, e^{-at} \tag{1}$$

$$a = \frac{\log Q_0 - \log Q_t}{0.4343\, t} \tag{2}$$

Where Q_t is the discharge at time t in $m^3\ s^{-1}$, Q_0 is the discharge at time 0 in $m^3\ s^{-1}$, t is the time between Q_0 and Q_t in seconds, and a is the recession coefficient with a unit of T^{-1}, collected after the data recording had been resumed. A slightly different approach was used in the event of electrical conductivity measurement problems to reconstruct for the missing data. Since we used these data to estimated solute concentrations, the chemical analyses of the biweekly samples were used to ensure the continuity of the concentration estimates via linear interpolation during such events.

S3 Discharge-water table relationship at AP10

The water table-discharge correlation obtained for the downstream location at AP10 is shown in Fig. S3. Above a discharge of ca. 60 L s^{-1}, the data nicely follow a polynomial correlation. Nevertheless, we consider discharge estimates below 100 L s^{-1} as unreliable because this is exclusively the case in winter when the stream is partially and periodically covered by ice and snow, strongly affecting the hydraulics (i.e. the relevant cross section of the stream) at the measurement location. Thus, for 2021 and 2022 continuous discharge estimates are only used for the period between May and October. The continuous discharge data are presented with the seasonal flux estimates in Fig. 7.

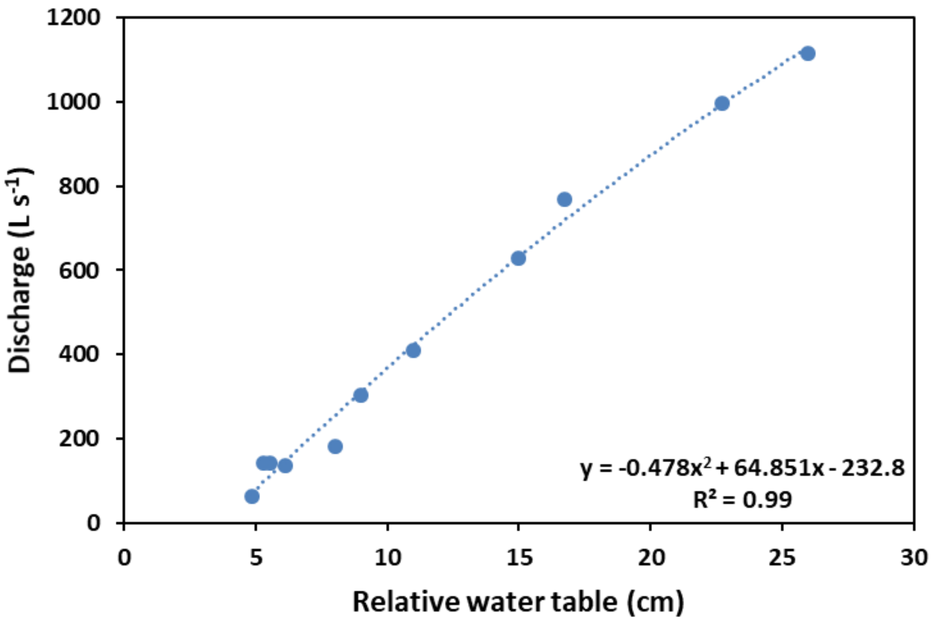

Figure S3: Correlation between water table and manual discharge measurements at the AP10 location and the derived polynomial correlation for water tables above 5 cm. At lower water tables, the correlation does not work, likely because such low values are observed in wintertime, when the hydraulics at the measurement location are strongly affected by freezing.

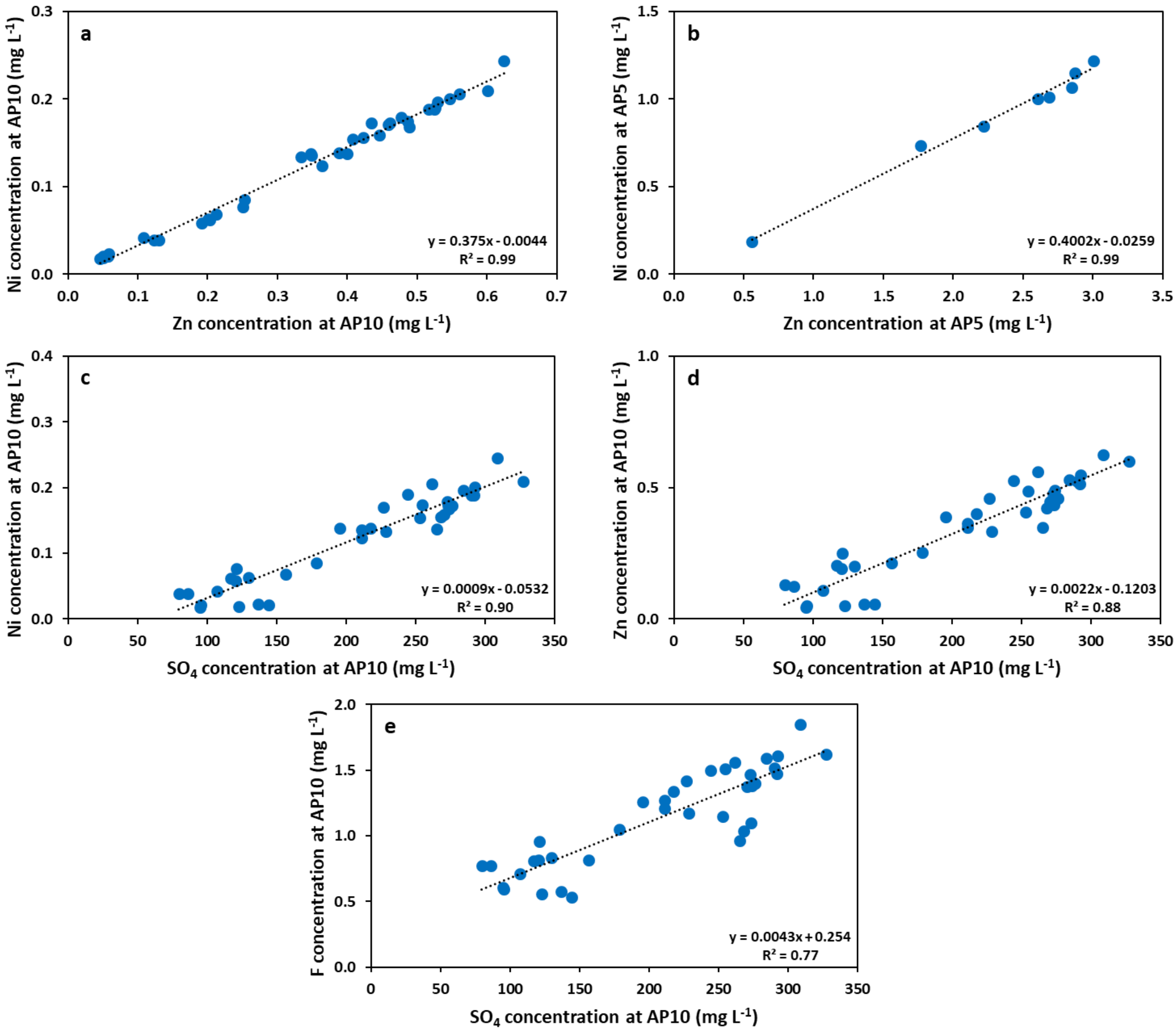

Figure S4. (a) (b): Concentrations of Ni and Zn recorded at AP10 and AP5 respectively. The correlation between the two solutes is excellent and the Ni/Zn concentration ratio is similar at the two locations and very constant throughout the entire monitoring period, demonstrating the conservative behavior of these two solutes. (c), (d), (e): Concentrations of SO_4 at AP10 plotted vs. those of Ni and Zn and F^-, respectively. The rather strong linear correlation indicates that the Ni/SO_4 and Zn/SO_4 ratios were very constant throughout the entire monitoring period.

Table S1: Flux measurements at the two monitoring locations, AP1_2 and AP5, and the relative contribution of fluxes AP1_2 / AP5.

Date	Fluxes at AP1_2 (kg day^{-1})		Fluxes at AP5 (kg day^{-1})		Fluxes at AP10 (kg day^{-1})		Relative contribution AP1_2/AP5 (%)		Relative contribution AP10/AP5 (%)	
	Ni	Zn	Ni	Zn	Ni	Zn	Ni	Zn	Ni	Zn
11 Jun 2021	-	-	2.4	7.4	3.8	12.5	-	-	-	-
09 Jul 2021	-	-	17.0	41.0	13.3	33.9	-	-	78.2	82.7
20 Aug 2021	4.1	9.5	5.0	13.0	4.9	13.8	82.8	73.0	97.9	-
23 Sep 2021	2.0	4.7	2.7	7.0	1.8	5.1	75.4	66.3	67.4	73.0
20 Oct 2021	2.1	4.6	2.3	7.1	1.5	5.1	88.4	64.1	65.1	71.9
02 Apr 2022	-	-	-	-	0.1	0.3	-	-	-	-
20 May 2022	-	-	-	-	3.7	12.2	-	-	-	-
07 Jul 2022	5.2	12.5	6.7	17.5	5.3	14.3	78.3	71.5	78.5	81.7
12 Aug 2022	3.4	8.4	4.1	10.9	3.5	9.5	82.5	77.2	84.8	87.1
10 Oct 2022	1.9	4.5	2.4	6.5	2.0	5.5	76.8	69.6	80.2	84.1

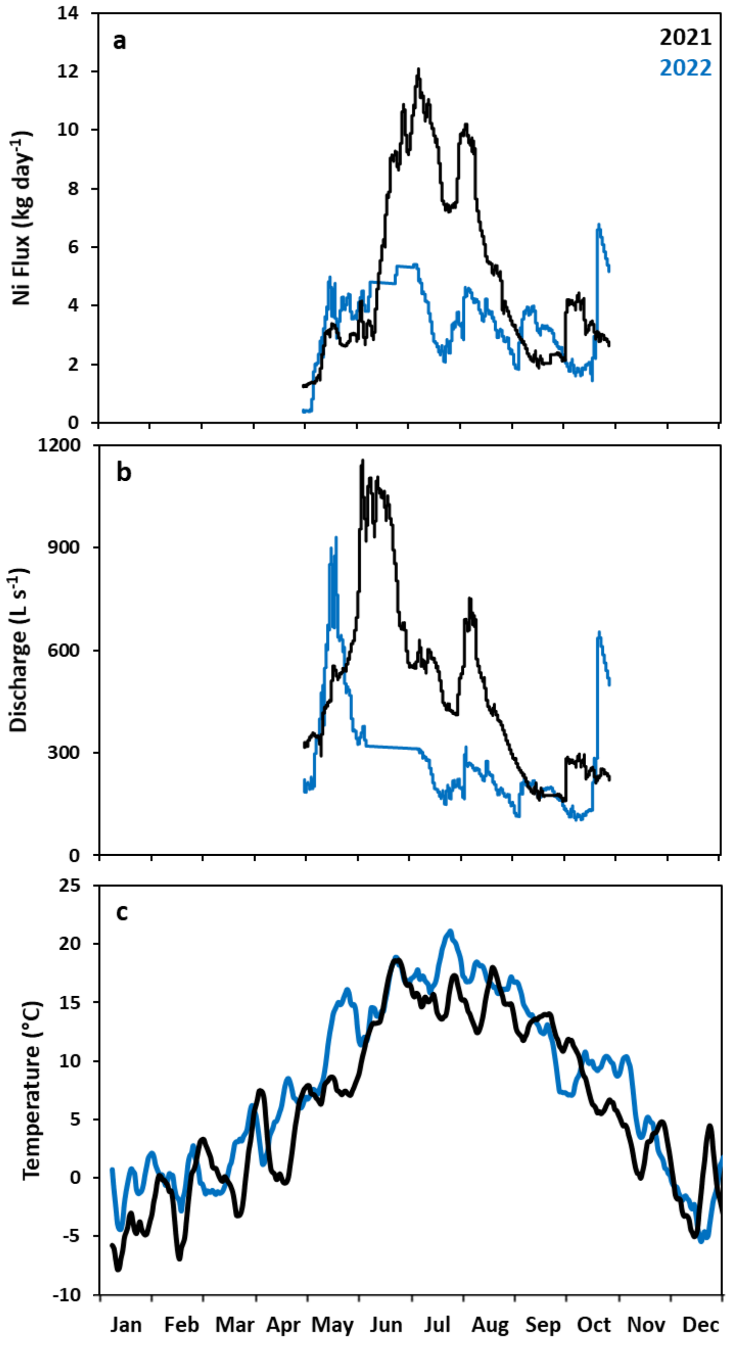

Figure S5: Comparison of selected parameters between the two monitoring years. (a) Ni fluxes estimated at AP10. (b) Discharge at AP10. (c) Daily average temperature at the MeteoSwiss weather station at Santa Maria (MeteoSwiss, 2023).

Table S2: Chemical analysis of streamwater samples collected between March 2021 and November 2022 at the AP10 location of the Aua Prasüra stream (Fig. 1).

AP10	Method	Unit	22 Mar 2021	09 Apr 2021	23 Apr 2021	07 May 2021	20 May 2021	03 Jun 2021	10 Jun 2021	18 Jun 2021
T	Electrode	°C	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	5.9	n.a.
pH	Electrode	-	7.08	6.59	6.51	6.44	6.44	6.45	7.14	6.17
EC[1]	Electrode of installed probe	µS cm^{-1}	n.a.	n.a.	n.a.	n.a.	288	229	220	287
Na^+	IC	mg L^{-1}	1.95	1.79	1.79	1.78	1.81	1.53	1.41	1.67
K^+	IC	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1	<1
Ca^{2+}	IC	mg L^{-1}	31.4	27.1	27.3	27.0	26.8	21.2	19.2	23.1
Mg^{2+}	IC	mg L^{-1}	15.4	13.2	13.0	14.1	15.3	12.6	11.7	16.3
Al	ICP-OES	mg L^{-1}	<0.05	<0.05	<0.05	<0.05	<0.05	0.050	0.057	0.098
Co	ICP-OES	mg L^{-1}	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu	ICP-OES	mg L^{-1}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	ICP-OES	mg L^{-1}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	mg L^{-1}	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.084
Ni	ICP-OES	mg L^{-1}	0.036	0.021	0.018	0.045	0.042	0.039	0.039	0.077
Sr	ICP-OES	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	mg L^{-1}	0.052	0.050	0.046	0.068	0.108	0.123	0.130	0.251
As	AAS	µg L^{-1}	<4	<4	<4	<4	<4	<4	<4	<4
F^-	IC	mg L^{-1}	0.610	0.596	0.608	0.623	0.710	0.773	0.772	0.960
Cl^-	IC	mg L^{-1}	0.176	0.264	0.170	0.179	0.175	0.147	0.126	0.220
Br^-	IC	mg L^{-1}	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
NO_3^-	IC	mg L^{-1}	0.540	0.750	0.554	0.553	0.628	0.598	0.619	0.910
SO_4^{2-}	IC	mg L^{-1}	114	95.5	94.6	101	107	86.3	79.6	121
Si	ICP-OES	mg L^{-1}	3.18	3.01	3.05	3.08	2.97	2.70	2.57	2.67
TOC	C-analyzer	mg L^{-1}	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TIC	C-analyzer	mg L^{-1}	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.88
TDS		mg L^{-1}	168.36	142.98	141.86	149.19	156.26	126.58	116.69	169.40

[1] These data were used to derive correlations between the EC and the solute concentrations.

Table S2 continued

AP10	Method	Unit	02 Jul 2021	08 Jul 2021	16 Jul 2021	06 Aug 2021	18 Aug 2021	03 Sep 2021	22 Sep 2021	30 Sep 2021
T	Electrode	°C	n.a.	9.5	n.a.	n.a.	8.7	n.a.	4.7	n.a.
pH	Electrode	-	6.08	6.43	6.00	6.02	7.47	6.53	7.66	6.25
EC	Electrode of installed probe	µS cm^{-1}	532	641	574	502	443	n.a.	n.a.	n.a.
Na^{+}	IC	mg L^{-1}	2.60	2.84	2.69	2.42	2.31	2.30	2.42	2.58
K^{+}	IC	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1	<1
Ca^{2+}	IC	mg L^{-1}	42.1	50.7	45.5	40.0	35.9	39.6	42.6	47.9
Mg^{2+}	IC	mg L^{-1}	36.2	45.7	39.0	33.0	28.2	29.3	31.5	36.1
Al	ICP-OES	mg L^{-1}	0.186	0.402	0.278	0.116	0.081	0.146	0.064	<0.05
Co	ICP-OES	mg L^{-1}	<0.005	0.018	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu	ICP-OES	mg L^{-1}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	ICP-OES	mg L^{-1}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	mg L^{-1}	0.286	0.365	0.315	0.247	0.160	0.103	0.079	0.10
Ni	ICP-OES	mg L^{-1}	0.190	0.245	0.206	0.171	0.138	0.136	0.134	0.154
Sr	ICP-OES	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	mg L^{-1}	0.526	0.624	0.560	0.459	0.388	0.349	0.333	0.408
As	AAS	µg L^{-1}	<4	<4	<4	<4	<4	<4	<4	<4
F^{-}	IC	mg L^{-1}	1.500	1.85	1.560	1.420	1.260	1.21	1.17	1.15
Cl^{-}	IC	mg L^{-1}	0.280	0.260	0.260	0.300	0.250	0.203	0.239	0.300
Br^{-}	IC	mg L^{-1}	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
NO_3^{-}	IC	mg L^{-1}	0.640	0.590	0.630	0.600	0.660	0.574	0.563	0.690
SO_4^{2-}	IC	mg L^{-1}	244	308	262	227	195	211	229	253
Si	ICP-OES	mg L^{-1}	3.55	2.88	3.60	3.47	3.53	3.23	3.30	3.80
TOC	C-analyzer	mg L^{-1}	0.50	<0.5	<0.5	<0.5	<0.5	<0.5	0.45	<0.5
TIC	C-analyzer	mg L^{-1}	1.41	0.96	1.54	2.05	2.54	<0.5	3.05	<0.5
TDS		mg L^{-1}	334.27	416.66	357.81	311.40	271.01	288.37	315.37	346.40

Table S2 continued

AP10	Method	Unit	11 Oct 2021	21 Oct 2021	29 Oct 2021	02 Apr 2022	20 Apr 2022	29 Apr 2022	14 May 2022	19 May 2022
T	Electrode	°C	n.a.	4	n.a.	0.6	n.a.	n.a.	n.a.	9.5
pH	Electrode	-	6.38	6.67	7.07	6.81	6.85	6.19	6.41	7.73
EC	Electrode of installed probe	$\mu S\ cm^{-1}$	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	300
Na^{+}	IC	$mg\ L^{-1}$	2.73	2.67	2.54	1.968	1.90	1.94	1.80	1.54
K^{+}	IC	$mg\ L^{-1}$	<1	<1	<1	<1	<1	<1	<1	<1
Ca^{2+}	IC	$mg\ L^{-1}$	52.2	51.4	51.1	36.260	33.3	33.7	33.4	27.0
Mg^{2+}	IC	$mg\ L^{-1}$	40.2	38.3	37.0	17.589	16.3	17.2	21.8	18.0
Al	ICP-OES	$mg\ L^{-1}$	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08
Co	ICP-OES	$mg\ L^{-1}$	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu	ICP-OES	$mg\ L^{-1}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	ICP-OES	$mg\ L^{-1}$	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	$mg\ L^{-1}$	0.109	0.060	0.037	<0.005	<0.005	<0.005	0.007	0.014
Ni	ICP-OES	$mg\ L^{-1}$	0.173	0.156	0.138	0.021	0.019	0.023	0.068	0.063
Sr	ICP-OES	$mg\ L^{-1}$	<1	<1	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	$mg\ L^{-1}$	0.434	0.422	0.347	0.057	0.050	0.058	0.212	0.201
As	AAS	$\mu g\ L^{-1}$	<4	<4	<4	<4	<4	<4	<4	<4
F^{-}	IC	$mg\ L^{-1}$	1.10	1.04	0.964	0.531	0.555	0.576	0.818	0.834
Cl^{-}	IC	$mg\ L^{-1}$	0.340	2.670	0.229	0.197	0.255	0.240	0.199	0.176
Br^{-}	IC	$mg\ L^{-1}$	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
NO_3^{-}	IC	$mg\ L^{-1}$	1.16	0.890	0.702	0.581	0.686	0.624	0.962	0.630
SO_4^{2-}	IC	$mg\ L^{-1}$	273	268	265	144	123	137	157	130
Si	ICP-OES	$mg\ L^{-1}$	3.92	3.87	3.326	2.922	n.a.	n.a.	n.a.	n.a.
TOC	C-analyzer	$mg\ L^{-1}$	<0.5	0.54	<0.5	<0.5	<0.5	<0.5	<0.5	1.23
TIC	C-analyzer	$mg\ L^{-1}$	<0.5	1.76	<0.5	<0.5	<0.5	<0.5	<0.5	2.12
TDS		$mg\ L^{-1}$	376.54	372.63	361.63	205.40	176.51	192.01	216.41	181.95

Table S2 continued

AP10	Method	Unit	19 May 2022	20 May 2022	03 Jun 2022	16 Jun 2022	05 Jul 2022	07 Jul 2022	13 Jul 2022	29 Jul 2022
T	Electrode	°C	6.1	5.1	n.a.	n.a.	11.4	9	n.a.	n.a.
pH	Electrode	-	8.10	7.90	6.44	6.18	6.91	6.91	6.49	6.34
EC	Electrode of installed probe	µS cm^{-1}	295	299	491	n.a.	n.a.	n.a.	582	592
Na^+	IC	mg L^{-1}	1.52	1.63	2.29	2.58	2.88	2.91	2.70	2.74
K^+	IC	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1	<1
Ca^{2+}	IC	mg L^{-1}	25.4	26.2	41.3	48.4	53.3	54.9	49.9	49.8
Mg^{2+}	IC	mg L^{-1}	17.0	17.2	32.9	39.7	43.5	44.9	39.6	39.4
Al	ICP-OES	mg L^{-1}	0.07	0.057	0.112	0.121	0.131	0.154	0.076	0.07
Co	ICP-OES	mg L^{-1}	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu	ICP-OES	mg L^{-1}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	ICP-OES	mg L^{-1}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	mg L^{-1}	0.020	0.013	0.142	0.176	0.199	0.208	0.152	0.128
Ni	ICP-OES	mg L^{-1}	0.062	0.058	0.138	0.174	0.197	0.200	0.179	0.173
Sr	ICP-OES	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	mg L^{-1}	0.203	0.192	0.400	0.487	0.529	0.547	0.477	0.460
As	AAS	µg L^{-1}	<4	<4	<4	<4	<4	<4	<4	<4
F^-	IC	mg L^{-1}	0.811	0.815	1.34	1.51	1.59	1.61	1.47	1.40
Cl^-	IC	mg L^{-1}	0.163	0.164	0.330	1.17	0.530	0.350	0.270	0.281
Br^-	IC	mg L^{-1}	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
NO_3^-	IC	mg L^{-1}	0.594	0.664	0.840	1.24	0.720	0.590	0.678	0.640
SO_4^{2-}	IC	mg L^{-1}	117	121	218	254	285	293	273	276
Si	ICP-OES	mg L^{-1}	n.a.	n.a.	2.879	2.99	3.30	3.21	3.15	3.23
TOC	C-analyzer	mg L^{-1}	1.10	0.91	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TIC	C-analyzer	mg L^{-1}	1.89	2.38	<0.5	<0.5	1.59	1.66	<0.5	<0.5
TDS		mg L^{-1}	166.26	171.33	300.45	353.18	393.16	404.11	372.32	375.56

Table S2 continued

AP10	Method	Unit	12 Aug 2022	26 Aug 2022	13 Sep 2022	30 Sep 2022	10 Oct 2022	28 Oct 2022	15 Nov 2022
T	Electrode	°C	10	n.a.	n.a.	n.a.	6.8	n.a.	n.a.
pH	Electrode	-	7.10	6.70	6.12	6.30	7.27	6.43	6.29
EC	Electrode of installed probe	µS cm^{-1}	629	629	677	599	590	n.a.	n.a.
Na^{+}	IC	mg L^{-1}	2.83	2.25	2.23	2.02	2.72	2.327	2.182
K^{+}	IC	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1
Ca^{2+}	IC	mg L^{-1}	53.8	54.5	61.6	51.9	53.1	41.6	37.9
Mg^{2+}	IC	mg L^{-1}	42.8	42.8	47.9	39.6	39.9	30.3	24.9
Al	ICP-OES	mg L^{-1}	0.08	0.10	0.18	0.094	0.067	0.10	<0.05
Co	ICP-OES	mg L^{-1}	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu	ICP-OES	mg L^{-1}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	ICP-OES	mg L^{-1}	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	mg L^{-1}	0.155	0.157	0.193	0.122	0.109	0.101	0.023
Ni	ICP-OES	mg L^{-1}	0.189	0.19	0.21	0.17	0.16	0.12	0.08
Sr	ICP-OES	mg L^{-1}	<1	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	mg L^{-1}	0.516	0.525	0.601	0.489	0.446	0.364	0.252
As	AAS	µg L^{-1}	<4	<4	<4	<4	<4	<4	<4
F^{-}	IC	mg L^{-1}	1.47	1.51	1.62	1.38	1.37	1.270	1.050
Cl^{-}	IC	mg L^{-1}	0.273	0.287	0.340	0.302	0.305	0.326	0.252
Br^{-}	IC	mg L^{-1}	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
NO_3^{-}	IC	mg L^{-1}	0.687	0.677	0.832	0.756	0.758	0.853	0.831
SO_4^{2-}	IC	mg L^{-1}	292	290	327	274	270	211.170	178.450
Si	ICP-OES	mg L^{-1}	3.39	3.33	3.42	3.55	3.23	3.67	3.65
TOC	C-analyzer	mg L^{-1}	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TIC	C-analyzer	mg L^{-1}	1.92	<0.5	<0.5	<0.5	2.32	<0.5	<0.5
TDS		mg L^{-1}	400.80	397.44	447.31	375.29	375.63	292.99	250.37

Table S3: Chemical analysis of streamwater samples collected between June 2021 and October 2022 at the AP5 location of the Aua Prasüra stream (Fig. 1).

AP5	Method	Unit	11 Jun 2021	09 Jul 2021	20 Aug 2021	23 Sep 2021	20 Oct 2021	06 Jul 2022	13 Aug 2022	11 Oct 2022
T	Electrode	°C	1.4	4.9	5.7	4.9	2.5	8.9	6	5.4
pH	Electrode	-	5.71	5.60	5.54	5.32	5.56	5.57	5.63	5.68
EC	Electrode	$\mu S\ cm^{-1}$	567	1200	1557	1935	1859	1418	1612	1759
Na^{+}	IC	$mg\ L^{-1}$	2.55	4.97	6.14	7.64	8.07	4.56	6.72	6.97
K^{+}	IC	$mg\ L^{-1}$	<1	<1	1.03	1.07	1.05	1.12	1.07	1.06
Ca^{2+}	IC	$mg\ L^{-1}$	49.6	94.8	123	168	162	126	138.9	157
Mg^{2+}	IC	$mg\ L^{-1}$	42.4	109	154	206	194	139	161.1	179
Al	ICP-OES	$mg\ L^{-1}$	1.42	5.35	7.761	8.30	7.32	6.62	7.84	7.60
Co	ICP-OES	$mg\ L^{-1}$	0.013	0.058	<0.005	0.029	<0.005	0.031	0.028	0.024
Cu	ICP-OES	$mg\ L^{-1}$	<0.01	<0.01	<0.01	0.067	0.072	0.0625	0.0682	0.06
Fe	ICP-OES	$mg\ L^{-1}$	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	$mg\ L^{-1}$	0.079	1.415	1.73	1.60	1.47	1.381	1.56	1.41
Ni	ICP-OES	$mg\ L^{-1}$	0.185	0.733	1.001	1.225	1.155	0.847	1.01	1.06
Sr	ICP-OES	$mg\ L^{-1}$	<1	<1	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	$mg\ L^{-1}$	0.560	1.764	2.61	3.007	2.871	2.22	2.69	2.851
As	AAS	$\mu g\ L^{-1}$	<4	<4	<4	<4	<4	<4	<4	<4
F^{-}	IC	$mg\ L^{-1}$	1.877	5.65	3.200	2.89	2.46	6.47	0.468	1.55
Cl^{-}	IC	$mg\ L^{-1}$	0.250	0.500	0.680	0.944	2.71	0.780	0.829	0.831
Br^{-}	IC	$mg\ L^{-1}$	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
NO_3^{-}	IC	$mg\ L^{-1}$	0.656	0.860	0.930	0.840	1.21	0.920	0.925	1.042
SO_4^{2-}	IC	$mg\ L^{-1}$	285	679	965	1287	1212	822	1033	1141
Si	ICP-OES	$mg\ L^{-1}$	2.74	3.68	6.47	5.20	7.03	4.81	5.54	5.58
TOC	C-analyzer	$mg\ L^{-1}$	0.51	<0.5	0.63	0.57	0.63	<0.5	0.55	0.87
TIC	C-analyzer	$mg\ L^{-1}$	<0.5	<0.5	<0.5	0.50	0.59	<0.5	0.53	0.52
TDS		$mg\ L^{-1}$	387.98	909.05	1274.47	1695.86	1604.66	1117.13	1363.17	1509.12

Table S4: Chemical analysis of streamwater samples collected between August 2021 and October 2022 at the AP1_2 location of the Aua Prasüra stream (Fig. 1).

AP1_2	**Method**	**Unit**	**20 Aug 2021**	**23 Sep 2021**	**20 Oct 2021**	**06 Jul 2022**	**13 Aug 2022**	**11 Oct 2022**
T	Electrode	°C	4.7	3.2	2.1	7.6	5	4
pH	Electrode	-	4.84	5.04	5.15	5.19	5.35	5.27
EC	Electrode	µS/cm	2173	2578	2331	1777	2045	2019
Na^+	IC	mg/L	9.33	10.08	9.90	6.19	9.16	9.93
K^+	IC	mg/L	1.38	1.38	1.30	1.13	1.34	1.63
Ca^{2+}	IC	mg/L	171	224	209	158	177.1	222
Mg^{2+}	IC	mg/L	237	301	255	187	224.1	281
Al	ICP-OES	mg/L	13.011	12.57	9.456	9.87	12.113	13.73
Co	ICP-OES	mg/L	0.095	0.051	<0.005	0.052	0.043	0.050
Cu	ICP-OES	mg/L	<0.01	0.111	0.095	0.1020	0.1142	0.12
Fe	ICP-OES	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	mg/L	3.06	2.67	1.935	2.177	2.53	3.21
Ni	ICP-OES	mg/L	1.522	1.679	1.369	1.173	1.40	1.73
Sr	ICP-OES	mg/L	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	mg/L	3.50	3.849	3.008	2.81	3.50	4.209
As	AAS	µg/L	<4	<4	<4	<4	<4	<4
F^-	IC	mg/L	11.890	4.46	3.42	9.02	0.529	1.22
Cl^-	IC	mg/L	1.060	1.29	1.30	1.11	1.03	1.33
Br^-	IC	mg/L	<0.016	0.018	<0.016	<0.016	<0.016	0.019
NO_3^-	IC	mg/L	1.150	0.054	1.20	0.800	1.012	0.067
SO_4^{2-}	IC	mg/L	1470	1821	1660	1083	1369	1687
Si	ICP-OES	mg/L	7.06	5.43	7.32	4.925	5.79	6.25
TOC	C-analyzer	mg/L	<0.5	0.51	0.78	<0.5	0.74	<0.5
TIC	C-analyzer	mg/L	<0.5	0.64	0.76	<0.5	0.61	0.67
TDS		mg/L	1931.87	2394.77	2180.57	1470.48	1814.70	2458.31

Table S5: Chemical analysis of streamwater samples collected between July 2021 and October 2022 at the AP3 location of the Aua Prasüra stream (Fig. 1).

AP3	Method	Unit	09 Jul 2021	20 Aug 2021	23 Sep 2021	06 Jul 2022	13 Aug 2022	11 Oct 2022
T	Electrode	°C	2.9	3.5	4.1	4.7	5	3.5
pH	Electrode	-	6.37	6.04	5.77	6.35	6.21	5.98
EC	Electrode	$\mu S\ cm^{-1}$	687	1147	1402	1035	1329	1333
Na^{+}	IC	$mg\ L^{-1}$	3.16	4.87	8.91	3.50	5.89	5.38
K^{+}	IC	$mg\ L^{-1}$	<1	<1	<1	<1	<1	<1
Ca^{2+}	IC	$mg\ L^{-1}$	88.0	152	190	138	171.9	165
Mg^{2+}	IC	$mg\ L^{-1}$	40.1	67.9	94.3	66.9	86.0	80.7
Al	ICP-OES	$mg\ L^{-1}$	0.466	1.254	1.47	0.55	0.69	0.96
Co	ICP-OES	$mg\ L^{-1}$	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cu	ICP-OES	$mg\ L^{-1}$	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fe	ICP-OES	$mg\ L^{-1}$	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	$mg\ L^{-1}$	0.063	<0.005	0.009	0.014	0.015	0.017
Ni	ICP-OES	$mg\ L^{-1}$	0.096	0.078	0.118	0.051	0.064	0.08
Sr	ICP-OES	$mg\ L^{-1}$	<1	<1	<1	<1	<1	<1
Zn	ICP-OES	$mg\ L^{-1}$	0.180	0.149	0.202	0.122	0.131	0.182
As	AAS	$\mu g\ L^{-1}$	<4	<4	<4	<4	<4	<4
F^{-}	IC	$mg\ L^{-1}$	1.38	4.280	2.26	1.59	1.71	1.52
Cl^{-}	IC	$mg\ L^{-1}$	0.550	0.320	0.514	0.460	0.749	0.350
Br^{-}	IC	$mg\ L^{-1}$	<0.016	<0.016	<0.016	<0.016	<0.016	<0.016
NO_3^{-}	IC	$mg\ L^{-1}$	0.730	0.870	0.689	1.25	1.075	0.960
SO_4^{2-}	IC	$mg\ L^{-1}$	369	666	870	546	735	685
Si	ICP-OES	$mg\ L^{-1}$	3.00	7.11	4.16	3.66	4.17	4.32
TOC	C-analyzer	$mg\ L^{-1}$	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
TIC	C-analyzer	$mg\ L^{-1}$	1.82	2.97	4.31	4.12	4.79	6.39
TDS		$mg\ L^{-1}$	509.35	908.06	1177.59	766.47	1013.72	952.44

Table S6: Chemical analysis of streamwater samples collected between July 2021 and October 2022 at the AP2 location of the Aua Prasüra stream (Fig. 1).

AP2	Method	Unit	09 Jul 2021	20 Aug 2021	06 Jul 2022	13 Aug 2022	11 Oct 2022
T	Electrode	°C	0.3	3.1	0.4	0	1
pH	Electrode	-	5.25	5.23	5.14	5.23	5.1
EC	Electrode	$\mu S\ cm^{-1}$	749	1204	1296	1998	290
Na^+	IC	$mg\ L^{-1}$	2.95	4.44	3.82	7.49	12.05
K^+	IC	$mg\ L^{-1}$	<1	<1	1.13	2.82	1.93
Ca^{2+}	IC	$mg\ L^{-1}$	72.4	119	152	242.0	375
Mg^{2+}	IC	$mg\ L^{-1}$	51.2	76.8	111	165.4	276
Al	ICP-OES	$mg\ L^{-1}$	2.68	2.728	6.06	9.151	10.83
Co	ICP-OES	$mg\ L^{-1}$	0.052	<0.005	0.087	0.152	0.250
Cu	ICP-OES	$mg\ L^{-1}$	<0.01	<0.01	0.0991	0.1354	0.16
Fe	ICP-OES	$mg\ L^{-1}$	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	$mg\ L^{-1}$	0.547	0.268	1.196	2.02	3.39
Ni	ICP-OES	$mg\ L^{-1}$	0.350	0.361	0.707	1.05	1.63
Sr	ICP-OES	$mg\ L^{-1}$	<1	<1	<1	<1	<1
Zn	ICP-OES	$mg\ L^{-1}$	0.737	0.961	1.31	1.80	2.489
As	AAS	$\mu g\ L^{-1}$	<4	<4	<4	<4	<4
F^-	IC	$mg\ L^{-1}$	2.92	4.780	5.63	0.376	0.632
Cl^-	IC	$mg\ L^{-1}$	0.290	0.460	0.580	4.59	1.199
Br^-	IC	$mg\ L^{-1}$	<0.016	<0.016	<0.016	<0.016	0.021
NO_3^-	IC	$mg\ L^{-1}$	1.74	1.120	1.64	1.921	0.097
SO_4^{2-}	IC	$mg\ L^{-1}$	415	654	777	1297	1986
Si	ICP-OES	$mg\ L^{-1}$	2.26	5.16	3.76	4.78	5.71
TOC	C-analyzer	$mg\ L^{-1}$	<0.5	<0.5	<0.5	<0.5	<0.5
TIC	C-analyzer	$mg\ L^{-1}$	0.72	1.13	2.27	5.00	5.47
TDS		$mg\ L^{-1}$	554.83	871.57	1068.66	1745.73	2682.63

Table S7: Chemical analysis of streamwater samples collected between July 2021 and October 2022 at the AP1 location of the Aua Prasüra stream (Fig. 1).

AP1	Method	Unit	09 Jul 2021	20 Aug 2021	06 Jul 2022	13 Aug 2022	11 Oct 2022
T	Electrode	°C	0.8	1.4	1	1.9	1
pH	Electrode	-	4.90	4.90	5.02	4.9	4.70
EC	Electrode	$\mu S\ cm^{-1}$	2186	3097	2808	3053	3701
Na^{+}	IC	$mg\ L^{-1}$	8.06	11.3	8.95	11.47	14.52
K^{+}	IC	$mg\ L^{-1}$	1.61	2.07	2.16	2.03	1.95
Ca^{2+}	IC	$mg\ L^{-1}$	162	230	205	216.6	272
Mg^{2+}	IC	$mg\ L^{-1}$	234	389	353	387.7	493
Al	ICP-OES	$mg\ L^{-1}$	15.44	23.447	26.7	27.50	28.74
Co	ICP-OES	$mg\ L^{-1}$	0.280	0.325	0.396	0.336	0.433
Cu	ICP-OES	$mg\ L^{-1}$	<0.01	<0.01	0.3190	0.3207	0.32
Fe	ICP-OES	$mg\ L^{-1}$	<0.05	<0.05	<0.05	<0.05	<0.05
Mn	ICP-OES	$mg\ L^{-1}$	4.761	7.67	8.174	8.62	11.27
Ni	ICP-OES	$mg\ L^{-1}$	1.689	2.520	2.536	2.78	3.31
Sr	ICP-OES	$mg\ L^{-1}$	<1	<1	<1	<1	<1
Zn	ICP-OES	$mg\ L^{-1}$	4.214	5.95	6.96	7.23	7.812
As	AAS	$\mu g\ L^{-1}$	<4	<4	4.06	<4	<4
F^{-}	IC	$mg\ L^{-1}$	15.7	8.770	23.0	2.13	6.17
Cl^{-}	IC	$mg\ L^{-1}$	1.07	1.470	1.40	1.50	1.49
Br^{-}	IC	$mg\ L^{-1}$	<0.016	<0.016	<0.016	0.021	0.018
NO_3^{-}	IC	$mg\ L^{-1}$	1.06	1.240	1.31	0.044	0.043
SO_4^{2-}	IC	$mg\ L^{-1}$	1354	2318	2020	2246	2803
Si	ICP-OES	$mg\ L^{-1}$	5.89	8.86	7.38	7.61	8.10
TOC	C-analyzer	$mg\ L^{-1}$	<0.5	<0.5	<0.5	<0.5	<0.5
TIC	C-analyzer	$mg\ L^{-1}$	1.69	2.76	1.80	5.40	3.29
TDS		$mg\ L^{-1}$	1810.24	3014.10	2674.23	2928.22	3656.77

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