

Supplementary Materials

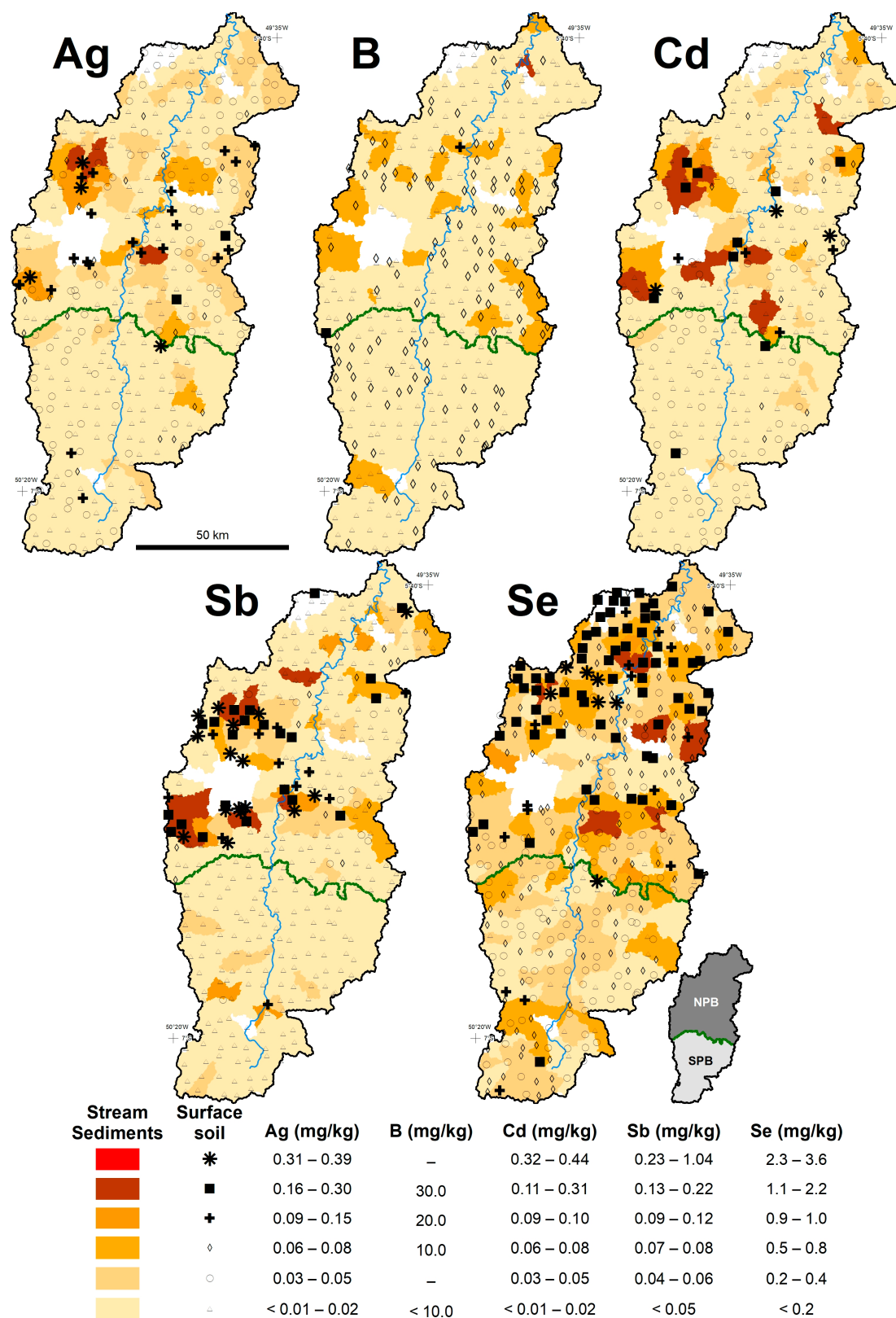


Figure S1. Geochemical maps for Ag, B, Cd, Sb, and Se in stream sediments (catchment area - polygon) and surface soil (in-situ sampling site - point) in the Parauapebas basin. Note that the same concentration range for each element is used for the map representation on both sampling media. Inset shows the Northern (NPB) and Southern (SPB) PB.

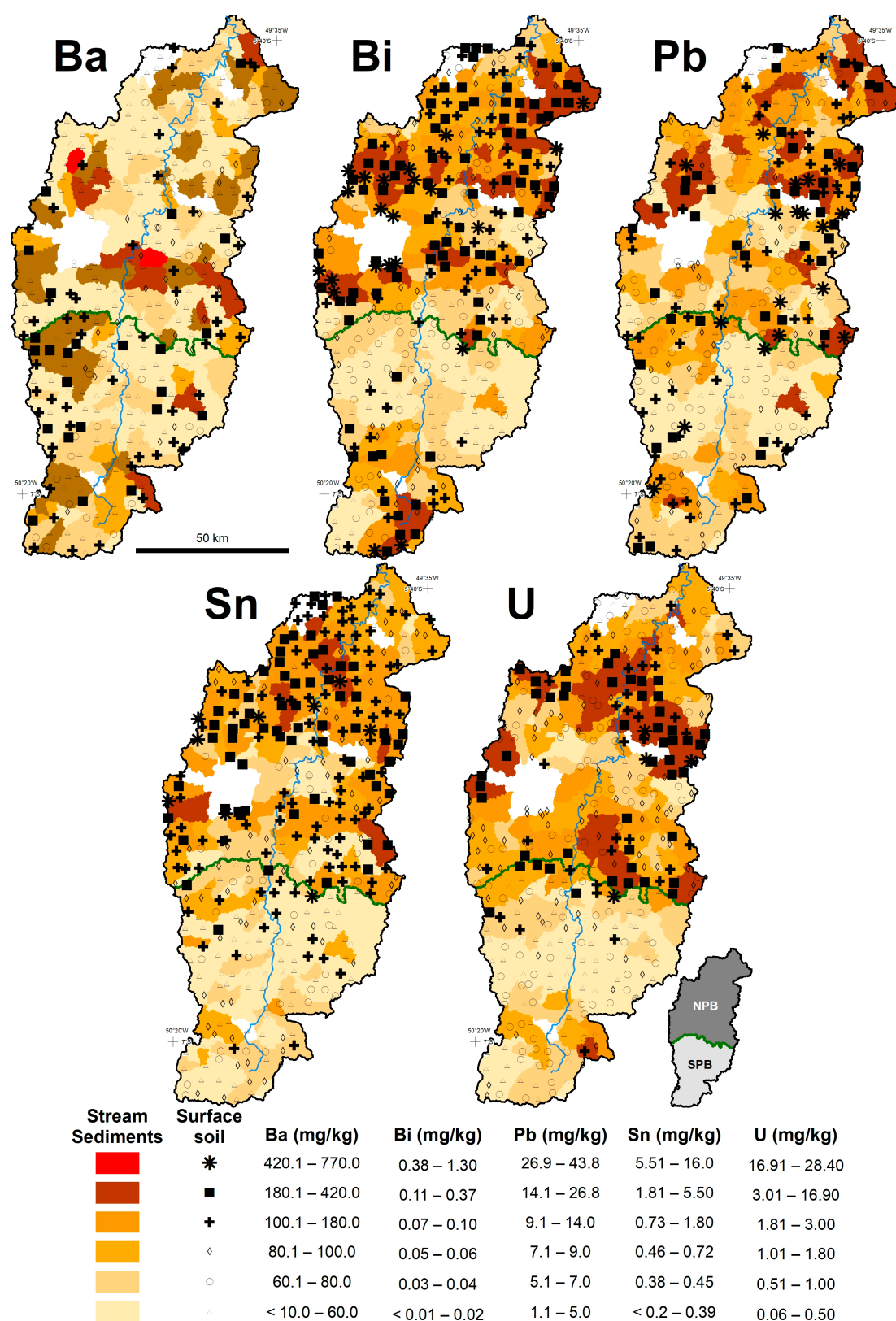


Figure S2. Geochemical maps for Ba, Bi, Pb, Sn, and U in stream sediments (catchment area - polygon) and surface soil (in-situ sampling site - point) in the Parauapebas basin. Note that the same concentration range for each element is used for the map representation on both sampling media. Inset shows the Northern (NPB) and Southern (SPB) PB.

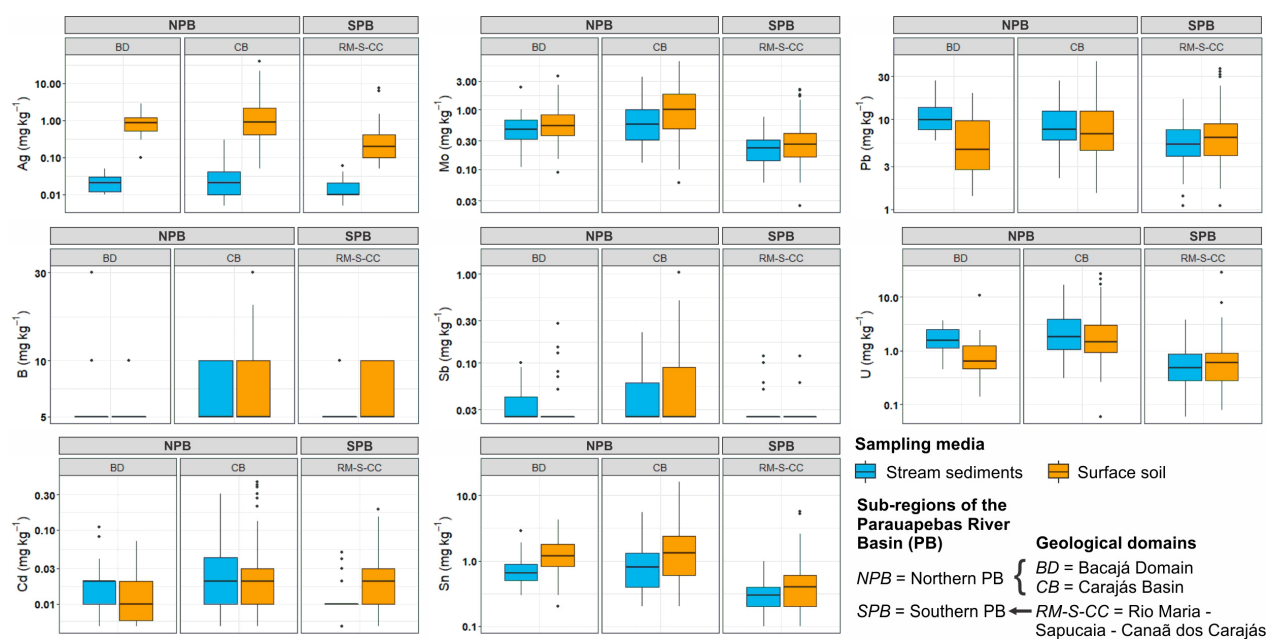


Figure S3. Boxplots for 8 potentially toxic elements (PTE; Ag, B, Cd, Mo, Sb, Sn, Pb, and U) in surface soils and stream sediments samples of the Parauapebas River Basin (PB), according to the major geological domains of the study area: BD = Bacajá Domain and CB = Carajás Basin, both domains comprised at the Northern PB (NPB); and RM-S-CC = Rio Maria – Sapucaia – Canaã dos Carajás domains, comprised at the Southern PB. Refer to Figure 1 for the geological setting of the study area.

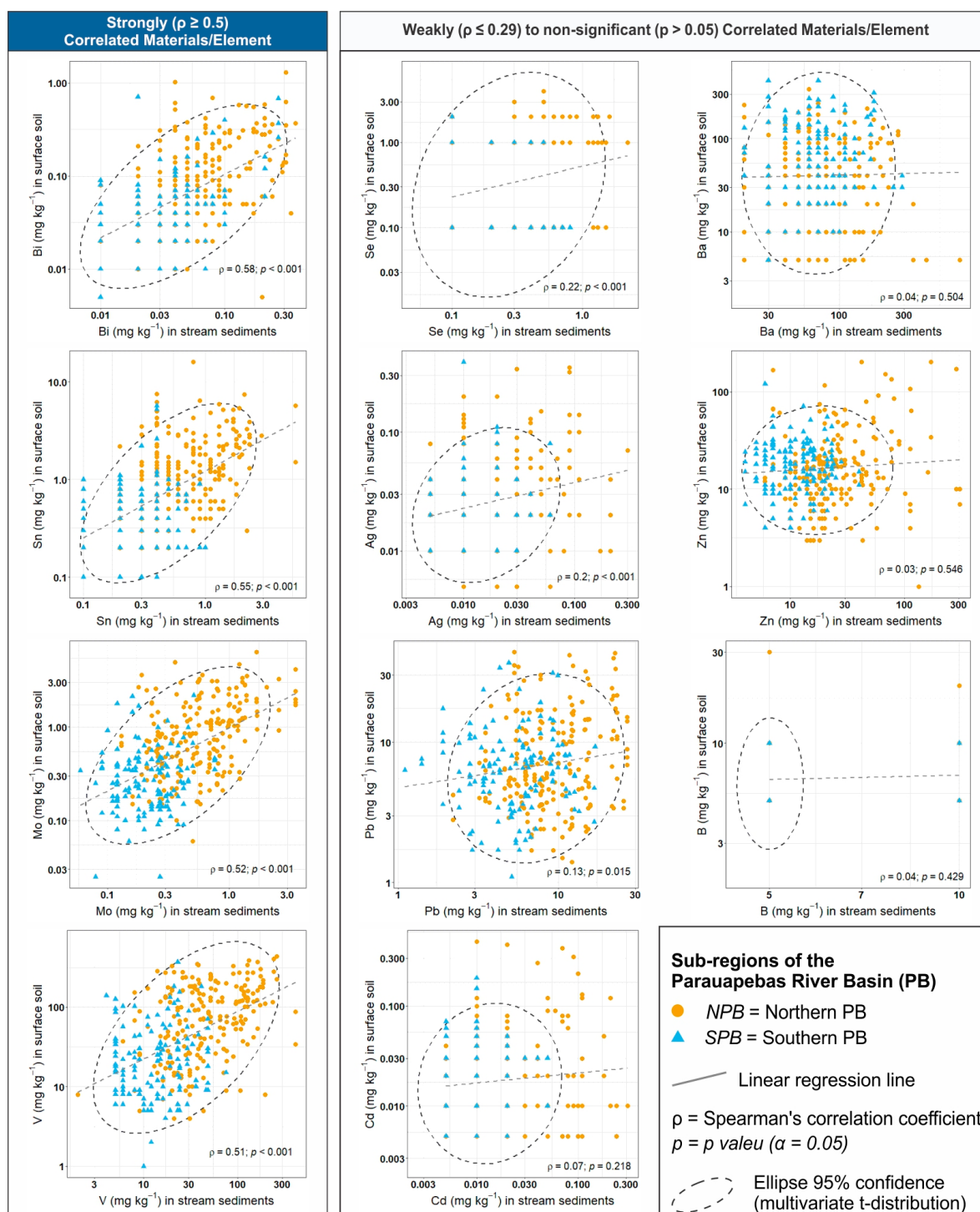


Figure S4. Scatter plot comparing the concentrations of the studied elements in surface soil and stream sediment samples. Three groups of elements were observed: i) Strongly correlated materials (e.g., Bi, Sn, Mo, and V); ii) Moderately correlated materials; iii) Weakly to non-significant correlated materials (e.g., Se, Ag, Pb, Cd, Ba, Z, and B); Refer to Figure 5 for the remaining elements.

Table S1. Descriptive statistics for 10 potentially toxic elements (PTE; Ag, B, Ba, Bi, Cd, Pb, Sb, Se, Sn, and U) in surface soils and stream sediments. Values were calculated for the entire Parauapebas River Basin (PB; soils = 364 samples; stream sediments = 189 samples) and for the northern (NPB; soils = 223 samples; stream sediments = 122 samples) and southern (SPB; soils = 141 samples; stream sediments = 67 samples) regions separately.

Element	Region	Surface soil						Stream sediments					
		LLD (%<LLD)	Mean	SD	Min	Med	Max	LLD (%<LLD)	Mean	SD	Min	Med	Max
Ag	PB*	0.01 (1.1)	0.04	0.04	<0.01	0.02	0.39	0.01 (6.3)	0.03	0.03	<0.01	0.02	0.3
	NPB	0.01 (1.8)	0.04	0.05	<0.01	0.03	0.35	0.01 (5.7)	0.03	0.04	<0.01	0.02	0.3
	SPB	0.01 (0)	0.03	0.04	0.01	0.02	0.39	0.01 (7.5)	0.02	0.01	<0.01	0.01	0.06
B	PB*	10 (64.0)	6.88	2.77	<10	<10	30	10 (84.7)	5.87	2.51	<10	<10	30
	NPB	10 (61.9)	7.04	3.00	<10	<10	30	10 (77.0)	6.31	3.00	<10	<10	30
	SPB	10 (67.4)	6.63	2.35	<10	<10	10	10 (98.5)	5.08	0.61	<10	<10	10
Ba	PB*	10 (10.2)	65.87	67.2	<10	50	420	10 (0)	90.53	80.03	20	70	770
	NPB	10 (16.1)	50.49	53.57	<10	30	340	10 (0)	95.57	91.78	20	70	770
	SPB	10 (0.7)	90.11	78.79	<10	60	420	10 (0)	81.34	51.64	20	70	290
Bi	PB*	0.01 (0.5)	0.12	0.2	<0.01	0.06	1.3	0.01 (0)	0.07	0.07	0.01	0.05	0.37
	NPB	0.01 (0.4)	0.16	0.17	<0.01	0.09	1.3	0.01 (0)	0.09	0.07	0.01	0.07	0.37
	SPB	0.01 (0.7)	0.06	0.10	<0.01	0.03	0.71	0.01 (0)	0.04	0.04	0.01	0.02	0.27
Cd	PB*	0.01 (15.1)	0.03	0.1	<0.01	0.02	0.44	0.01 (11.6)	0.03	0.04	<0.01	0.01	0.31
	NPB	0.01 (19.3)	0.03	0.06	<0.01	0.01	0.44	0.01 (9.0)	0.04	0.05	<0.01	0.02	0.31
	SPB	0.01 (8.5)	0.02	0.02	<0.01	0.02	0.19	0.01 (16.4)	0.01	0.01	<0.01	0.01	0.05
Pb	PB*	0.2 (0)	8.78	7.6	1.1	6.35	43.8	0.2 (0)	8.86	5.46	1.1	7	26.8
	NPB	0.2 (0)	9.55	8.37	1.4	6.4	43.8	0.2 (0)	10.31	5.84	2.2	8.05	26.8
	SPB	0.2 (0)	7.55	5.96	1.1	6.3	36.7	0.2 (0)	6.23	3.41	1.1	5.3	16.9
Sb	PB*	0.05 (79.4)	0.05	0.09	<0.05	<0.05	1.04	0.05 (75.1)	0.04	0.03	<0.05	<0.05	0.22
	NPB	0.05 (67.3)	0.07	0.11	<0.05	<0.05	1.04	0.05 (67.2)	0.05	0.04	<0.05	<0.05	0.22
	SPB	0.05 (98.6)	0.03	0.01	<0.05	<0.05	0.12	0.05 (89.6)	0.03	0.02	<0.05	<0.05	0.12
Se	PB*	0.2 (10.2)	0.66	0.7	<0.2	0.1	4	0.2 (29.6)	0.37	0.32	<0.2	0.3	2.2
	NPB	0.2 (5.8)	0.87	0.60	<0.2	0.7	3.6	0.2 (18.9)	0.43	0.36	<0.2	0.3	2.2
	SPB	0.2 (17.0)	0.39	0.28	<0.2	0.3	2.3	0.2 (49.3)	0.24	0.18	<0.2	0.2	0.8
Sn	PB*	0.2 (2.7)	1.31	1.6	<0.2	0.7	16	0.2 (4.2)	0.72	0.65	<0.2	0.5	5.5
	NPB	0.2 (0)	1.81	1.85	0.2	1.3	16	0.2 (0)	0.94	0.72	0.2	0.75	5.5
	SPB	0.2 (7.1)	0.52	0.69	<0.2	0.4	5.7	0.2 (11.9)	0.32	0.17	<0.2	0.3	1
U	PB*	0.05 (0)	1.93	3.3	0.06	0.95	28.4	0.05 (0)	2.06	2.56	0.06	1.21	16.9
	NPB	0.05 (0)	2.51	3.58	0.06	1.34	26.8	0.05 (0)	2.80	2.88	0.31	1.76	16.9
	SPB	0.05 (0)	1.02	2.52	0.08	0.6	28.4	0.05 (0)	0.69	0.68	0.06	0.48	3.79

Note: The concentration unit is expressed in mg kg⁻¹, except for Fe and Al in wt.%; DL = Lower limit of detection; %<DL = percentage of data below LLD; Mean = Arithmetic mean; SD = Standard deviation; Min = Minimum; Med = Median; Max = Maximum.

Table S2. Geochemical threshold values for 10 potentially toxic elements (PTE; Ag, B, Ba, Bi, Cd, Pb, Sb, Se, Sn, and U) in surface soils and stream sediments, estimated by a variety of methods [Median + 2 Median Absolute Deviation (M_{MAD}), Tukey's inner fences (TIF), the 98th (P98) and 95th (P95) percentiles]. Values are provided for the entire Parauapebas River Basin (PB, retrieved from previous studies), for the northern (NPB) and the southern (SPB) regions separately, determined in the present study. Guideline values reposted by Brazilian environmental agencies are presented as references.

Element.	Regions	Geochemical threshold in Surface soil				Soil guidelines		Geochemical threshold in Stream sediments				Stream sediment guidelines	
		M_{MAD}	TIF	P98	P95	VRQ ^b	PGV ^c	M_{MAD}	TIF	P98	P95	L1 ^d	L2 ^d
Ag	PB	0.16	0.11	0.14	0.10			0.16	0.16	0.11	0.08		
	NPB	0.10	0.11	0.18	0.12	0.25	2	0.16	0.32	0.14	0.09		
	SPB	0.07	0.06	0.08	0.06			0.01	0.06	0.04	0.03		
B	PB ^a		28	10	10			<10	<10	10	10		
	NPB	<10	28	10	10			<10	<10	10	10		
	SPB	<10	28	10	10			<10	<10	<10	<10		
Ba	PB ^a	661	841	257	200			234	355	274	210		
	NPB	780	1296	201	159	75	150	304	461	314	219		
	SPB	469	1173	286	250			190	248	225	180		
Bi	PB	0.47	1.41	0.59	0.42			0.23	0.35	0.29	0.23		
	NPB	0.83	1.81	0.60	0.45			0.20	0.28	0.31	0.24		
	SPB	0.10	0.31	0.38	0.16			0.16	0.32	0.17	0.09		
Cd	PB ^a	0.16	0.16	0.14	0.08			0.08	0.06	0.2	0.11		
	NPB	0.08	0.16	0.24	0.10	< 0.5	1.3	0.16	0.32	0.21	0.11	0.6	3.5
	SPB	0.16	0.16	0.07	0.05			0.01	0.01	0.04	0.03		
Pb	PB ^a	27.5	43.7	33.9	25.1			23.4	▲	24.8	22.0		
	NPB	32.5	62.6	35.2	28.4	17	72	24.4	35.0	25.1	22.7	35	91.3
	SPB	20.6	29.5	30.0	17.3			14.2	21.0	15.6	12.3		
Sb	PB	<0.05	<0.05	0.32	0.22			<0.05	<0.05	0.16	0.10		
	NPB	<0.05	0.33	0.37	0.27	< 0.5	2	<0.05	0.22	0.18	0.13		
	SPB	<0.05	<0.05	<0.05	<0.05			<0.05	<0.05	0.09	0.06		
Se	PB ^a		31.6	2.0	2.0			1.4	5.6	1.3	0.9		
	NPB	3.7	6.9	2.4	1.9	0.25	5	1.4	2.0	1.5	1.2		
	SPB	1.4	2.0	1.0	0.8			1.6	2.2	0.7	0.6		
Sn	PB ^a	5.6	11.2	5.8	4.2			2.3	4.7	2.4	1.9		
	NPB	8.0	13.0	6.3	5.0			3.8	7.0	2.5	2.1		
	SPB	1.3	3.1	2.3	1.0			0.7	1.1	0.8	0.6		
U	PB ^a	5.75	10.23	12.59	6.92			11.88	23.20	9.90	6.90		
	NPB	6.19	10.51	13.99	10.69			9.54	21.49	13.29	7.95		
	SPB	3.87	5.19	4.03	2.36			2.64	4.77	2.58	2.24		

Note: The concentration unit is expressed in mg kg⁻¹, except for Fe and Al in wt.%; *Italic* or '▲' (value not available): threshold values greater than the maximum value; ^a Results reported in previous studies of soil [24] and stream sediments [58] of the PB; ^b Quality reference value (VRQ) reported by the Sao Paulo Sanitation Technology Company (CETESB) [59]; ^c Prevention guideline value (PGV) reported by the National Council of the Environment (CONAMA) of Brazil [50]; ^d Threshold levels 1 (L1) and 2 (L2) reposted by CONAMA [60]. Blank entries indicate data not available.