

Supplementary Information

Assessment of Metal Concentration in the Billings Reservoir Sediments, São Paulo State, Southeastern Brazil

Marcos A. Hortellani,^{*,a} Jorge E. S. Sarkis,^a Luciana C. B. Menezes,^b
Renata Bazante-Yamaguishi,^a Alder S. A. Pereira,^a Priscila F. G. Garcia,^a
Lídia S. Maruyama^b and Paula M. Gênova de Castro^b

^aCentro de Química e Meio Ambiente, Instituto de Pesquisas Energéticas e Nucleares (IPEN),
Travessa R No. 400, Cidade Universitária, 05508-000 São Paulo-SP, Brazil

^bInstituto de Pesca (IP-SP), Avenida Francisco Matarazzo 455,
Parque da Água Branca, Perdizes, 05001-900 São Paulo-SP, Brazil

Table S1. Localization and water depth (m) of the sampling sites

Sampling site	Description	Water depth / m	UTM coordinate zone/setor: 23 K	
			Northing	Easting
P1	Porcos River	5	7359712	341733
P2	Summint Control - Pequeno River	7.4	7365624	343982
P3	Biguás Island	13.5	7366357	341874
P4	House broken	10.0	7369115	338844
P5	Taquaquetuba exit	10.3	7363318	332385
P6	Taquaquetuba entry	13.8	7366328	334227
P7	Bororé exit	5.2	7376892	331680
P8	in front of Bororé (entry)	11.0	7370573	331321
P9	Alvarenga	10.10	7371238	335045
P10	Pedreira Barrage	7.0	7377578	329722
P11	Capivari I, ferry boat, the right side	0.5	7366947	342717
P12	Capivari II, ferry boat, the left side	0.5	7366947	342795
P13	Bororé, ferry boat	0.5	7371131	331391

*e-mail: mahortel@ipen.br

Table S2. Metal values, certified values, recovery, Z score and limits of Buffalo River⁽¹⁾ sediment and San Joaquin soil⁽²⁾ samples

Metal	Measured ^a / ($\mu\text{g g}^{-1}$)	Certified ^b / ($\mu\text{g g}^{-1}$)	Recuperation / %	Z score	LOD / ($\mu\text{g mL}^{-1}$)	LOQ / ($\mu\text{g mL}^{-1}$)	LOQ _f / ($\mu\text{g g}^{-1}$)
Al ⁽¹⁾	2.37 ± 0.07 ^c	6.17 ± 0.16 ^c	38.4	23.4	1.0	1.34	700
Al ⁽²⁾	3.83 ± 0.04 ^c	7.50 ± 0.06 ^c	51.1	61.2			
Fe ⁽¹⁾	3.55 ± 0.014	4.31 ± 0.14	82.5	5.4	0.01	0.02	10
Fe ⁽²⁾	3.22 ± 0.017	3.50 ± 0.14	92.1	2.0			
Mn ⁽¹⁾	553 ± 11.2	555 ± 19	99.6	0.1	0.03	0.04	3.20
Mn ⁽²⁾	539 ± 2.0	538 ± 17	100.3	0.1			
Hg ⁽¹⁾	1.48 ± 0.04	1.47 ± 0.07	101	0.3	0.57 ^d	0.95 ^d	0.03
Hg ⁽²⁾	1.45 ± 0.06	1.40 ± 0.08	103	0.8			
Cd ⁽¹⁾	3.13 ± 0.10	3.45 ± 0.22	90.6	1.5	0.005	0.01	0.60
Cd ⁽²⁾	< 0.60	0.38 ± 0.011	X	X			
Co ⁽¹⁾	12.6 ± 0.25	14.0 ± 0.6	90.0	2.3	0.01	0.013	1.0
Co ⁽²⁾	13.0 ± 0.23	13.4 ± 0.7	97.1	0.6			
Cr ⁽¹⁾	76.6 ± 1.6	135 ± 5	56.7	11.7	0.039	0.063	5.0
Cr ⁽²⁾	63.5 ± 0.7	130 ± 4	48.9	16.6			
Cu ⁽¹⁾	95.2 ± 5.1	98.5 ± 5	98.9	0.7	0.017	0.026	2.0
Cu ⁽²⁾	33.9 ± 0.5	34.6 ± 0.7	98.1	1.0			
Ni ⁽¹⁾	46.0 ± 0.39	44.1 ± 3	104.4	0.6	0.020	0.026	2.0
Ni ⁽²⁾	84.7 ± 1.0	88 ± 5	96.2	0.7			
Pb ⁽¹⁾	153.1 ± 0.1	164 ± 17	95.1	0.5	0.021	0.025	2.0
Pb ⁽²⁾	not measured	18.9 ± 0.5	X	X			
Zn ⁽¹⁾	432 ± 12.4	438 ± 12	98.7	0.5	0.042	0.062	5.0
Zn ⁽²⁾	99.0 ± 0.34	103 ± 3	93.4	1.3			

^aMean ± standard deviation; ^bmean ± 95% confidence limit; ^cvalues in %; ^dvalues in $\mu\text{g L}^{-1}$. LOD: limit of detection; LOQ: limit of determination; LOQ_f: final limit of determination.

Table S3. I_{Geo} index calculated from Billings Reservoir

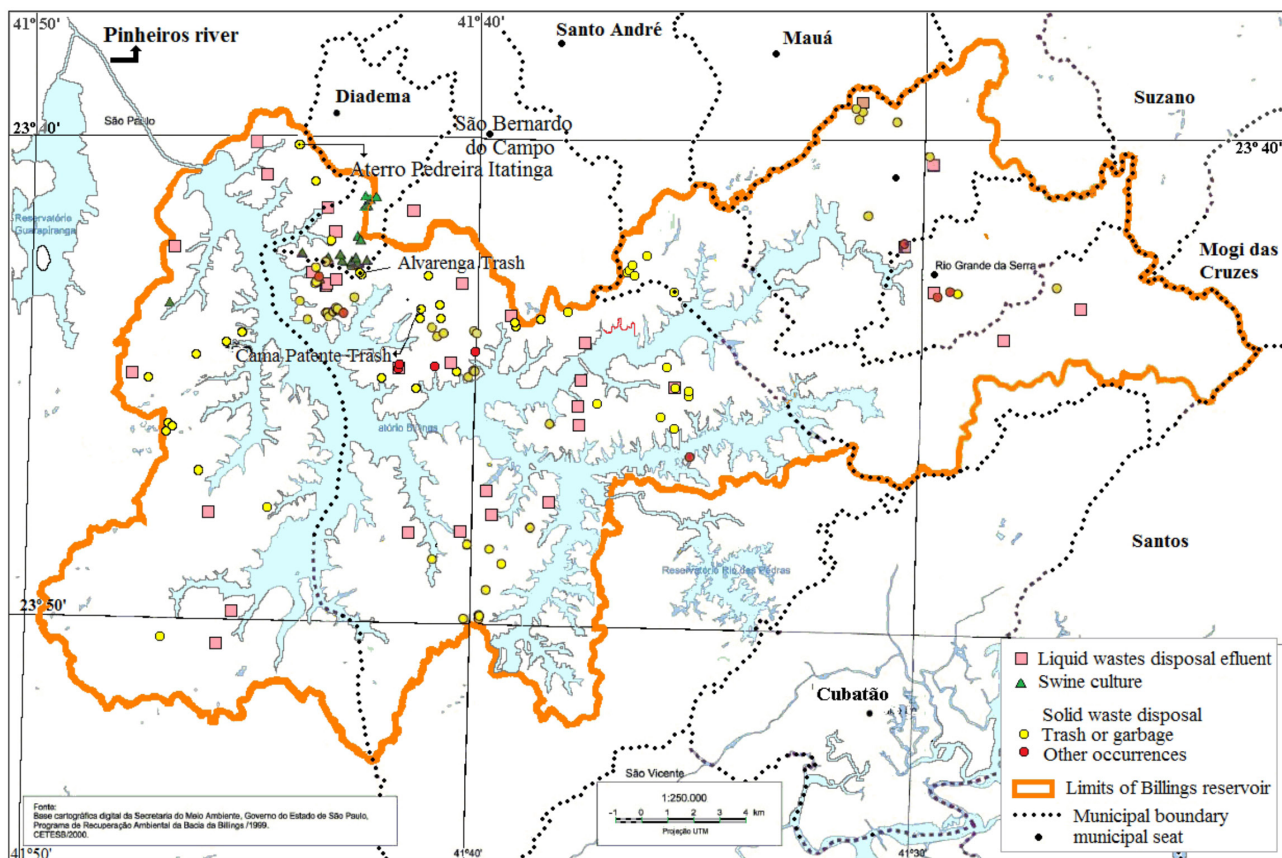
Sites	Al	Fe	Mn	Co	Cd	Hg	Cu	Cr	Ni	Pb	Zn
P-1 - A	1.4	-0.1	-1.0	-1.4	nd	1.3	1.8	-0.6	1.2	0.0	0.1
P-1 - B	1.7	-0.1	-0.8	-1.0	nd	1.6	0.5	-0.6	1.5	0.1	0
P-1 - C	1.4	0.0	-1.2	-1.1	nd	1.6	0.3	-0.6	1.4	-0.1	0
P-1 - D	1.0	-0.1	-1.0	-1.9	nd	1.2	0	-0.4	1.2	-0.1	0
P-2 - A	1.8	0.7	0.9	0.7	3.1	2.7	2.5	1.3	2.7	1.1	1.6
P-2 - B	1.9	0.5	0.9	0.9	3.4	3.3	2.6	1.7	3.0	1.4	1.8
P-2 - C	2.2	0.4	0.9	0.6	3.1	3.7	2.2	1.8	2.7	1.5	1.7
P-2 - D	1.9	0.8	2.1	1.0	3.7	2.8	2.7	2.4	3.1	1.0	1.7
P-3 - A	2.5	0.7	0.6	0.2	2.6	2.4	2.5	1.1	2.4	0.7	1.2
P-3 - B	2.5	0.8	1.6	-1.2	nd	2.4	1.0	-0.6	1.0	0.4	0.7
P-3 - C	2.1	0.9	1.1	0.6	3.0	3.0	2.3	1.5	2.8	1.4	1.8
P-3 - D	-0.3	-0.3	0.0	-2.8	nd	0.0	0	-1.7	0.0	-3.9	0
P-4 - A	2.1	0.5	0.0	0.6	nd	1.5	1.4	1.1	2.3	0.4	0.6
P-4 - B	2.9	0.5	2.3	-1.1	nd	1.7	0.8	-0.2	1.1	-0.7	0
P-4 - C	1.1	0.5	1.6	-1.2	nd	1.2	1.7	-0.3	0.9	-0.3	0
P-4 - D	1.8	0.4	1.6	-0.1	2.8	2.3	1.9	0.2	1.9	0.8	1.4
P-5 - A	2.6	0.9	1.8	0.0	nd	3.9	3.2	0.6	2.0	0.7	1.7
P-5 - B	2.5	1.0	2.1	2.2	nd	1.2	2.0	1.8	2.8	0.6	0
P-5 - C	2.4	1.0	1.2	0.9	nd	1.1	1.2	1.5	2.2	0.0	0
P-5 - D	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
P-6 - A	2.0	0.5	0.6	0.0	2.7	2.0	2.1	0.4	2.2	1.0	1.5
P-6 - B	-0.5	0.1	-0.5	-2.0	nd	0.9	2.4	-0.7	0.6	-0.6	0
P-6 - C	1.5	0.1	0.4	-0.4	1.9	2.6	2.0	0.2	1.7	0.3	0.8
P-6 - D	nd	nd	nd	nd	nd	nc	nd	nc	nc	nc	nc
P-7 - A	2.4	0.6	-0.6	0.1	1.9	2.3	1.7	0.5	2.0	0.7	1.0
P-7 - B	2.0	0.5	-0.2	0.0	3.0	2.3	2.0	0.8	2.3	0.8	1.4
P-7 - C	2.3	0.5	-0.3	-0.2	2.5	2.3	1.8	0.7	2.3	0.8	1.2
P-7 - D	0.4	-1.7	0.0	-1.4	nd	0.0	0	-1.5	0.0	-1.1	0
P-8 - A	2.1	0.7	0.3	-0.3	2.1	2.5	2.0	0.2	1.8	0.8	1.5
P-8 - B	1.3	0.0	-0.4	0.0	2.9	3.0	2.3	0.3	1.8	0.7	1.5
P-8 - C	1.6	0.2	-1.3	0.1	3.3	4.4	2.5	0.8	1.6	1.5	1.8
P-8 - D	1.3	0.7	1.4	0.9	3.8	3.0	2.8	2.1	3.0	1.0	1.8
P-9 - A	2.3	0.5	0.8	0.2	2.9	2.6	2.2	0.2	2.0	1.3	1.7
P-9 - B	2.1	0.5	0.7	0.6	3.7	2.5	2.7	0.9	2.5	1.4	2.0
P-9 - C	2.2	0.6	0.6	0.3	3.4	2.6	2.4	0.0	2.3	1.3	1.7
P-9 - D	2.6	0.6	2.0	-0.9	nd	2.8	0.7	0.2	1.5	-0.5	0.8
P-10 - A	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
P-10 - B	2.1	0.5	0.3	0.5	4.2	3.2	4.1	1.5	2.3	2.1	3.0
P-10 - C	2.1	0.5	0.2	0.4	4.01	3.6	3.9	1.7	2.2	2.3	2.9
P-10 - D	2.3	0.5	0.2	0.6	3.8	2.9	3.8	1.2	2.2	1.9	2.4
P-11 - A	2.8	-0.8	0.7	-3.2	-0.8	0.7	1.5	-1.8	-0.5	0.1	0
P-11 - B	2.2	1.1	-1.2	-1.6	1.1	2.0	1.9	0.0	0.0	0.5	0.3
P-11 - C	2.4	0.8	-1.2	-2.1	0.8	1.6	0.9	-0.4	0.1	1.2	0.0
P-11 - D	0.5	1.2	-2.0	-2.6	1.2	0.9	0	0.2	-1.9	-2.2	0
P-12 - A	2.3	1.3	0.7	-1.0	1.3	2.9	4.7	-0.2	0.7	2.6	2.3
P-12 - B	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
P-12 - C	1.2	0.6	0.8	-0.3	0.6	3.4	2.3	-0.3	0.7	1.5	1.5
P-12 - D	2.0	1.1	0.1	-0.7	1.1	1.5	1.4	0.0	1.0	0.0	0
P-13 - A	1.5	1.5	0.1	-2.0	1.5	1.3	2.7	-0.7	0.1	-2.0	0
P-13 - B	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
P-13 - C	3.4	0.0	-2.6	-2.1	0.0	1.0	0	-1.1	-0.8	-1.2	0
P-13 - D	0.4	-2.0	0.0	-2.8	-2.0	0	0	-3.9	0.0	-3.4	0

A: 1st sampling; B: 2nd sampling; C: 3rd sampling; D: 4th sampling; nd: not determined; I_{Geo} class 5 are formatted in red color; I_{Geo} class 4 are formatted in blue color; I_{Geo} class 3 are formatted in green color; I_{Geo} class 2 are formatted in bolt; nc: not collected samples; nd: not determined.

Table S4. Correlation matrix of metal content from Billings Reservoir

	Hg	Cu	Ni	Cd	Zn	Pb	Mn	Al	Fe	Co	Cr
Hg	1										
n	(46)										
Cu	0.457 ^a	1									
n	(46)	(47)									
Ni	0.389 ^a	0.237	1								
n	(46)	(46)	(46)								
Cd	0.366	0.84 ^a	0.411	1							
n	(22)	(22)	(22)	(22)							
Zn	0.67 ^a	0.81 ^a	0.52 ^a	0.867 ^a	1						
n	(46)	(47)	(46)	(22)	(47)						
Pb	0.59 ^a	0.868 ^a	0.342 ^b	0.790 ^a	0.882 ^a	1					
n	(45)	(46)	(45)	(22)	(46)	(46)					
Mn	0.130	0.093	0.396 ^a	0.237	0.119	0.031	1				
n	(46)	(47)	(46)	(22)	(47)	(46)	(47)				
Al	0.054	0.105	0.070	-0.128	0.104	0.116	0.329 ^b	1			
n	(46)	(47)	(46)	(22)	(47)	(46)	(47)	(47)			
Fe	0.075	0.344	0.123	0.187	0.200	0.212	0.30 ^b	0.213	1		
n	(46)	(47)	(46)	(22)	(47)	(46)	(47)	(47)	(47)		
Co	0.224	0.186	0.794 ^a	0.672 ^a	0.346 ^b	0.281	0.44 ^a	0.090	0.193	1	
n	(45)	(45)	(45)	(22)	(45)	(45)	(45)	(45)	(45)	(45)	
Cr	0.419 ^a	0.337 ^b	0.888 ^a	0.629 ^a	0.552 ^a	0.406 ^a	0.421 ^a	0.087	0.297 ^b	0.777 ^a	1
n	(46)	(47)	(46)	(22)	(47)	(46)	(47)	(47)	(47)	(45)	(47)

^a $p < 0.01$; ^b $p < 0.05$; n: number of analyzed samples.

**Figure S1.** Map of the study area and location of the area the disposal of solid wastes and liquid effluents (adapted from CETESB 2000).