ALTERNATIVE SOURCE APPORTIONMENT IN THE SURROUNDING REGION OF A LARGE STEEL INDUSTRY APPLYING *Tillandsia usneoides* AS BIOMONITOR

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SUPPLEMENTARY MATERIAL

Table S1: Coordinates of the steelwork stations for its air quality monitoring program

Station	Station Location	Coordinates
EMQAM 1	Adalgisa Nery Municipal School Eduardo de Aguiar Filho Street, s/n° Lote 230 - Conjunto São Fernando - Santa Cruz - RJ - CEP: 23565-250	22° 53' 19.5" S 43° 42' 57.5" W
EMQAM 2	Maestro Francisco Mignone School Kaisser Abraão Street s/n° - Monte Serrat - Itaguaí - RJ - CEP: 23810-560	22° 52' 30,7" S 43° 46' 13.6" W
EMQAM 3	Barão de Itararé School Vitor Dumas Street, s/n° - Largo do Bodegão - Santa Cruz - RJ - CEP: 23550-140	22° 55' 37.3" S 43° 41' 40.8 " W
EMTKCSA 4	Steelwork Meteorological Station Internal Street	22° 54' 19.4" S 43° 43' 33.0" W

Table S2: Operational conditions, data acquisition modes and other information for the determination of elemental concentration by ICP-MS

Operational Conditions	
Forward power	1400 W
Radiofrequency	27.12 MHZ *free running*
Sample introduction	Cross Flow
Sample flow rate (mL min^{-1})	0.98
Argon flow rates (L min^{-1})	16.0 (plasma) 0.95 (auxiliary)
Makeup gas (L min^{-1})	0.23
Temperature Spray Chamber	2 °C
Nebulizer pump	0.1 rps
Measured Isotopes	^{27}Al, ^{47}Ti, ^{51}V, ^{53}Cr, ^{55}Mn, ^{57}Fe, ^{60}Ni, ^{63}Cu, ^{66}Zn, ^{86}Sr, ^{137}Ba, ^{208}Pb
Spectral peak processing	Peak hopping
Reading/replicates	3
Number of replicates	3
Integration Time	15 ms

Table S3: Analysis of Certified Reference Materials, values expressed as µg g^{-1} (N=6, ± means expanded uncertainty and k = 2)

Element	Peach Leaves, NIST-1547				Tomato Leaves, NIST-1573a			
	Obtained Value	Reference Value	Z-score	Recovery (%)	Obtained Value	Reference Value	Z-score	Recovery (%)
V	(0.381±0.043)	(0.37±0.03)	0.41	103	(0.845±0.011)	(0.835±0.010)	1.3	101
Cr	(1.19±0.31)	1.00		119	(1.59±0.47)	(1.99±0.06)	-1.7	80
Mn	(89.3±1.3)	(98±3)	5.36	91	(241.2±6.1)	(246±8)	-1.0	98
Fe	(164±20)	(218±14)	-4.46	75	(278±24)	(368±7)	-7.1	76
Ni	(0.55±0.18)	(0.69±0.09)	-1.12	79	(3.53±0.0.81)	(1.59±0.07)	4.8	
Cu	(3.80±0.12)	(3.7±0.4)	0.50	103	(4.68±0.17)	(4.70±0.14)	-0.2	100
Zn	(17.2±1.4)	(17.9±0.4)	-1.03	96	(29.7±3.3)	(30.9±0.7)	-0.7	96
Sr	(52.9±1.5)	(53±4)	-0.04	100	(85.3±6.3)	85		100
Mo	(0.071±0.007)	(0.06±0.08)	2.06	118	(0.518±0.074)	0.46		113
Cd	(0.024±0.000)	(0.026±0.003)	-1.26	93	(1.383±0.032)	(1.52±0.04)	-3.2	91
Ba	(115.0±5.3)	(124±4)	-2.70	93	(61.1±4.1)	63		97
Pb	(0.860±0.029)	(0.87±0.03)	-0.49	99	(0.491±0.091)			

Table S4: Median referring to composite samples of biomonitoring stations, 1st sample collection, values in μg g^{-1}

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Sb	Ba	Pb
PUC-Rio	444	25	1.2	1.7	38	717	1.1	17	76	19	1.5	1.1	19	3.4
EMQAM 1	1924	102	7.3	7.6	163	3230	2.6	21	117	30	2.6	1.2	35	9.4
EMQAM 2	1545	86	4.2	4.3	79	2562	2.0	25	104	25	2.4	1.1	28	7.4
EMQAM 3	2898	168	6.5	5.5	100	4210	2.7	25	136	30	3.0	1.7	43	8.8
EMTKCSA 4	3666	237	41	45	1268	16222	3.8	18	231	100	2.8	1.2	46	25

Table S5: Median referring to composite samples of biomonitoring stations, 2nd sample collection, values in μg g^{-1}

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Ba	Pb
PUC-Rio	780	49	1.7	1.9	50	1160	1.4	13	82	20	22	4.4
EMQAM 1	747	40	2.6	2.8	74	1507	1.0	5.6	44	11	11	3.0
EMQAM 2	914	54	2.1	2.9	53	1300	1.3	7.6	43	10	13	3.1
EMQAM 3	1316	72	2.8	2.6	40	1478	1.3	7.6	50	12	17	2.9
EMTKCSA 4	2021	125	26.2	20.1	750	9426	2.4	6.0	119	61	22	8.7

Table S6: Median referring to composite samples of biomonitoring stations, 3rd sample collection, values in μg g^{-1}

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
PUC-Rio	510	31	1.5	1.4	32	632	1.1	9.0	72	15	1.6	16	3.0
EMQAM 1	657	38	3.0	3.3	66	1362	1.1	5.2	40	9.8	2.1	10	3.0
EMQAM 2	616	35	2.0	2.5	46	1106	1.7	7.9	39	9.7	2.5	11	3.5
EMQAM 3	990	60	2.9	2.5	28	1183	1.4	6.0	42	8.3	2.7	15	2.5
EMTKCSA 4	2625	199	52	39	1278	15342	3.2	7.8	162	110	1.5	34	13

Table S7: Median referring to composite samples of biomonitoring stations, 4th sample collection, values in μg g^{-1}

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
PUC-Rio	488	31	1.3	1.4	38	641	1.1	10	62	17	1.6	20	3.2
EMQAM 1	1156	63	4.1	4.6	114	2135	1.4	10	84	20	2.1	23	5.4
EMQAM 2	908	54	2.4	2.6	76	1425	1.4	15	85	22	2.1	27	4.7
EMQAM 3	2005	109	4.6	4.2	68	2313	2.1	15	87	22	2.3	33	5.4
EMTKCSA 4	2357	175	40	30	954	12423	2.8	11	222	96	1.7	33	14

Table S8: Median referring to composite samples of biomonitoring stations, 5th sample collection, values in μg g^{-1}

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
PUC-Rio	706	47	2.4	2.3	63	1022	<LQ	19	105	29	2.0	27	4.7
EMQAM 1	1064	66	3.4	4.2	104	1772	<LQ	14	101	23	1.7	23	5.3
EMQAM 2	1214	78	3.0	3.8	82	1653	<LQ	17	116	28	2.0	30	5.9
EMQAM 3	2909	210	7.1	6.4	103	3427	2.1	19	144	30	2.2	48	7.4
EMTKCSA 4	3338	299	47	56	1407	18109	2.7	14	243	99	1.5	40	15

LQ = Limit of Quantification

Table S9: Median referring to composite samples of biomonitoring stations, 6th sample collection, values in μg g^{-1}

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
PUC-Rio	687	48	1.6	2.2	44	1024	1.1	13	77	22	2.2	24	4.6
EMQAM 1	568	37	2.1	2.8	69	1156	<LQ	5.8	57	14	1.3	14	2.8
EMQAM 2	757	43	1.5	2.2	41	1053	1.3	6.3	43	11	1.3	13	3.1
EMQAM 3	1299	93	3.2	3.4	46	1865	1.7	7.0	47	12	1.4	22	3.5
EMTKCSA 4	1133	102	17	16	433	6283	1.4	4.8	85	40	1.0	19	6.1

LQ = Limit of Quantification

Table S10: Obtained enrichment factor, 1st sample collection (bold = values higher than 100)

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Sb	Ba	Pb
EMQAM 1	**333**	**312**	**494**	**343**	**324**	**351**	**133**	24	54	59	67	3	85	**178**
EMQAM 2	**248**	**247**	**245**	**147**	**106**	**257**	77	48	37	33	54	0	49	**119**
EMQAM 3	**553**	**575**	**433**	**222**	**160**	**487**	**140**	47	78	57	96	54	**130**	**160**
EMTKCSA 4	**726**	**857**	**3245**	**2496**	**3211**	**2163**	**233**	6	**203**	**431**	80	7	**142**	**635**

Table S11: Obtained enrichment factor, 2nd sample collection (bold = values higher than 100)

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Ba	Pb
EMQAM 1	<0	<0	52	49	48	30	<0	<0	<0	<0	<0	<0
EMQAM 2	17	12	26	51	7	12	<0	<0	<0	<0	<0	<0
EMQAM 3	69	48	65	37	<0	27	<0	<0	<0	<0	<0	<0
EMTKCSA 4	**159**	**156**	**1447**	**955**	**1411**	**713**	73	<0	45	<0	**208**	98

Table S12: Obtained enrichment factor, 3rd sample collection (bold = values higher than 100)

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
EMQAM 1	29	23	**103**	**142**	**108**	**115**	2	<0	<0	<0	36	<0	<0
EMQAM 2	21	14	37	82	47	75	55	<0	<0	<0	59	<0	<0
EMQAM 3	94	93	94	85	<0	87	29	<0	<0	<0	73	<0	<0
EMTKCSA 4	**415**	**540**	**3408**	**2786**	**3938**	**2326**	**193**	<0	**126**	**626**	<0	**115**	**332**

Table S13: Obtained enrichment factor, 4th sample collection (bold = values higher than 100)

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
EMQAM 1	**137**	**103**	**214**	**222**	**198**	**233**	35	3	35	17	28	14	66
EMQAM 2	86	72	84	83	99	**122**	31	53	37	28	33	35	45
EMQAM 3	**311**	**251**	**247**	**194**	78	**261**	92	50	41	28	43	67	68
EMTKCSA 4	**384**	**462**	**2899**	**1991**	**2391**	**1837**	**165**	9	**257**	**452**	4	66	**341**

Table S14: Obtained enrichment factor, 5th sample collection (bold = values higher than 100)

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
EMQAM 1	51	39	41	88	64	73	NC	<0	<0	<0	<0	<0	13
EMQAM 2	72	66	26	68	30	62	NC	<0	10	<0	0	12	26
EMQAM 3	**312**	**345**	**192**	**184**	62	**235**	NC	<0	38	2	11	76	59
EMTKCSA 4	**373**	**536**	**1844**	**2380**	**2118**	**1672**	NC	<0	**132**	**237**	<0	49	**212**

NC = Not Calculed

Table S15: Obtained enrichment factor, 6th sample collection (bold = values higher than 100)

Site	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
EMQAM 1	<0	<0	30	28	57	13	NC	<0	<0	<0	<0	<0	<0
EMQAM 2	10	<0	<0	3.8	<0	2.8	12	<0	<0	<0	<0	<0	<0
EMQAM 3	89	97	98	58	3.3	8.2	49	<0	<0	<0	<0	<0	<0
EMTKCSA 4	65	**115**	**925**	**658**	**876**	**514**	20	<0	9.5	79	<0	<0	<0

NC = Not Calculed

Table S16: Pearson correlation coefficients for the elemental concentrations in samples of biomonitors installed in the steelwork monitoring stations and the Steelwork`s Meteorological Station (values significant at 95% level)

	Al	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Sr	Sn	Ba	Pb
Al	1				0.521	0.793							
Ti		1	0.612	0.714				0.742	0.950				
V		0.612	1	0.963			0.933	0.897	0.613		0.587	0.962	0.586
Cr		0.714	0.963	1			0.865		0.751		0.607	0.867	0.615
Mn	0.521				1	0.859							
Fe	0.793				0.859	1							
Ni			0.933	0.865			1	0.876		0.601		0.975	0.685
Cu		0.742	0.897	0.945			0.876	1	0.755		0.569	0.850	0.712
Zn		0.950	0.613	0.751				0.755	1				
Sr							0.601			1		0.587	0.885
Sn			0.587	0.607				0.569			1		
Ba			0.962	0.867			0.975	0.850		0.587		1	0.628
Pb			0.586	0.615			0.685	0.712		0.885		0.628	1

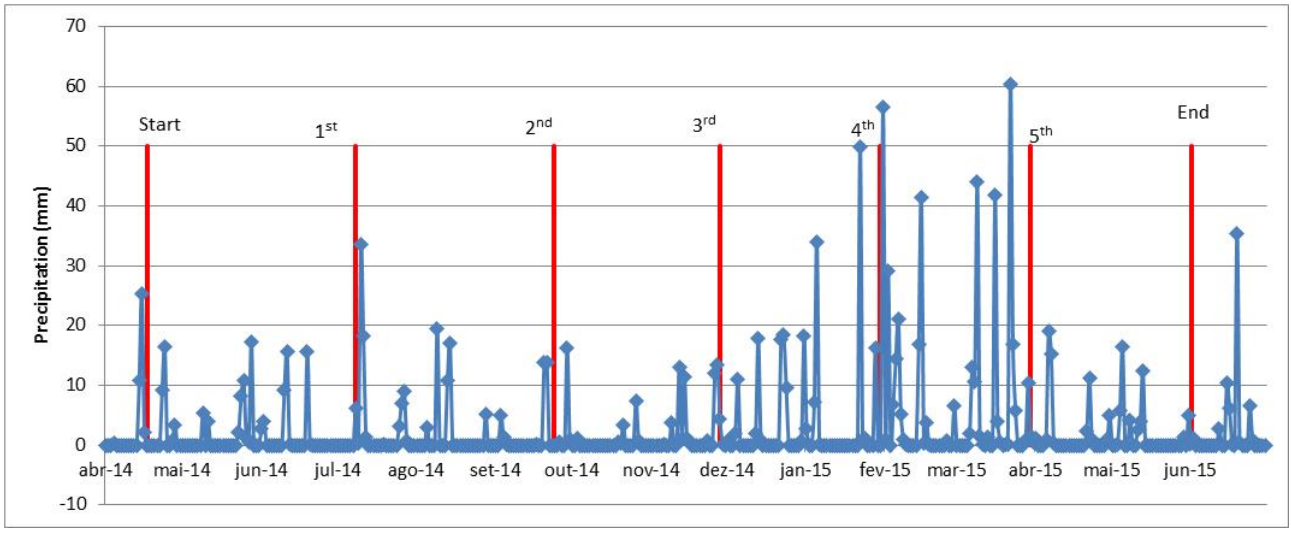

Figure S1: Daily precipitation and sampling periods (red bars)

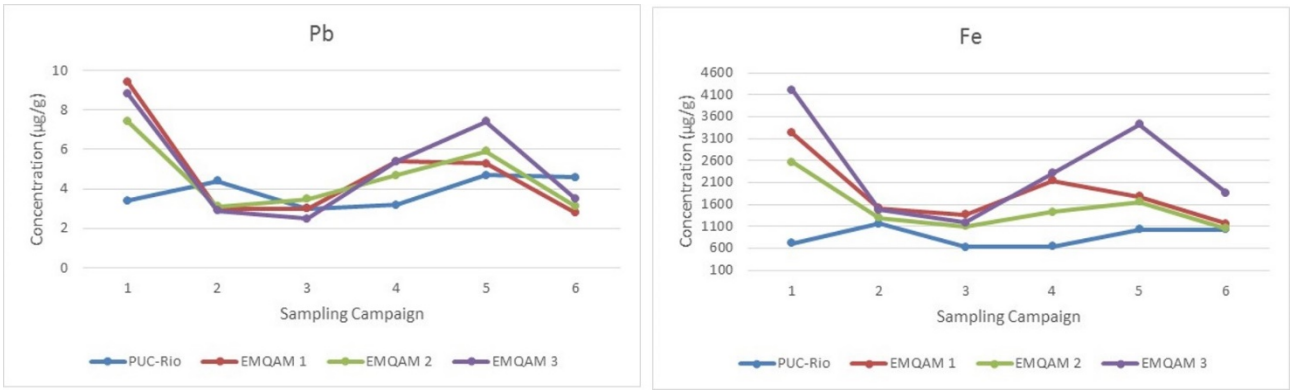

Figure S2: Lead and iron concentration according the sampling campaign