



Correction to: Impacts and Policy Implications of Metals Effluent Discharge into Rivers within Industrial Zones: A Sub-Saharan Perspective from Ethiopia

E. Zinabu^{1,2,3} · P. Kelderman² · J. van der Kwast² · K. Irvine^{2,3}

Published online: 22 January 2018
© Springer Science+Business Media, LLC, part of Springer Nature 2018

Correction to: Environmental Management

<https://doi.org/10.1007/s00267-017-0970-9>

The original version of this article unfortunately contained mistakes in Tables 1 and 2.

The correct version of Tables 1&2 and are given below:
Also, the article title has been revised.
The original article has been corrected.

The original article can be found online at <https://doi.org/10.1007/s00267-017-0970-9>.

✉ E. Zinabu
eyuelesk@gmail.com

¹ Wollo University, P.O. Box 1145, Dessie, Ethiopia

² IHE Delft Institute for Water Education, P.O. Box 3015, 2601 DA Delft, Netherlands

³ Aquatic Ecology and Water Quality Management, Wageningen University, P.O. Box 47, 6700 AA Wageningen, Netherlands

Table 1 Estimates of EC, pH, and of effluent concentrations and guidelines (µg/L), as well as standard errors (µg/L), effluent discharges (L/s) and daily loadings (g/day) of metals in the five factories’ effluents, during the first (C1) and second campaign (C2), from June–September 2013 and 2014, respectively. For the effluent loadings, the “direct median loading method” was used, $n = 8$

Factory	Campaign ($n = 8$)	Steel		Textile		Tannery		Meat processing		Brewery	
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
EC (µS/cm)	Median	5730	3800	932	760	710	4470	1480	1590	920	1130
	Mean	14,400	4000	920	800	2200	5200	920	1200	2100	1800
	Maximum	78,000	7460	1190	1010	10,570	12,280	1170	1740	7100	3070
	Minimum	1430	620	730	480	450	800	560	740	720	1,070
	Standard error	920	790	54	63	1240	1500	77	116	731	247
pH	Median	6.1	5.5	10.3	8.2	7.8	7.4	8.2	7.2	11.1	11.2
	Maximum	6.1	10.9	10.2	8.8	7.8	8.1	8.2	8.2	11.8	11.4
	Minimum	0.4	2.2	7.5	7.7	7.4	5.6	6.7	7.1	5.2	6.9
	Standard error	0.7	1.1	0.4	0.1	0.0	0.4	0.4	0.1	0.7	1.1
Cr	Median (µg/L)	89	17	4.1	3.1	6.1	26,800	2.2	9	10	40
	Mean (µg/L)	150	32	4.1	45	22	33,270	2.1	60	8	36
	Maximum (µg/L)	485	85	4.9	297	131	64,600	2.1	215	16	77
	Minimum (µg/L)	2.1	1.1	2.2	2.1	2.3	813	2.3	1.1	2.1	2.9
	Standard error (µg/L)	60	11	0.7	36	17	7,850	0	34	2	8
	USEPA guideline ^a (µg/L)	1300	1300	N.A. ^b	N.A.	12,000	12,000	N.A.	N.A.	N.A.	N.A.
	EMoI guideline ^c (µg/L)	1000	1000	1000	1000	2000	2000	N.A.	N.A.	N.A.	N.A.
	Mean effluent (L/s)	1.7	2.2	15.4	16.5	6.8	8.4	11	8.8	8.2	21
	Loadings (g/day)	11	4	3	4	2.5	18,500	1.1	6	4	40
	Cu	Median (µg/L)	65.2	99	14	6.9	11	15	9.1	3.1	25
Mean (µg/L)		125	137	58	13	125	22	31	6.8	111	43
Maximum (µg/L)		440	340	290	50	290	85	160	20	290	200
Minimum (µg/L)		8.5	0.1	3.5	0.1	8.1	0.1	2.5	0.1	4.9	1.4
Standard error (µg/L)		45	54	34	6	51	0	10	20	3	47
USEPA guideline (µg/L)		1300	1300	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
EMoI guideline (µg/L)		2000	2000	2000	2000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Mean effluent (L/s)		1.7	2.2	15.4	16.5	6.8	8.4	11	8.8	8.2	21
Loadings (g/day)		6	20	22	9	6.3	10	5	3	17	29
Zn		Median (µg/L)	60,040	155,750	120	110	90	280	110	140	150
	Mean (µg/L)	170,000	172,600	200	230	980	390	160	150	210	220
	Maximum (µg/L)	662,700	450,700	7190	640	7190	1250	180	330	720	440
	Minimum (µg/L)	14,100	14,150	26	29	26	130	25	44	20	68
	Standard error (µg/L)	87,800	50,110	76	85	887	0	125	43	33	76
	USEPA guideline (µg/L)	3500	3500	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	EMoI guideline (µg/L)	5,000	5,000	5,000	5,000	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Mean effluent (L/s)	1.7	2.2	15.4	16.5	6.8	8.4	11	8.8	8.2	21
	Loadings (g/day)	4950	17,300	207	160	54	210	47	100	114	280
	Pb	Median (µg/L)	5.1	8.2	2.9	1.1	2.1	2.1	2.9	1.1	5.9
Mean (µg/L)		16	22	4.1	1.7	3.1	130	3.2	2.1	4.9	2.1
Maximum (µg/L)		43	66	7.1	4.1	3.9	1670	4.1	2.9	8.1	2.9
Minimum (µg/L)		2.1	0.6	2.1	0.6	2.1	0.6	2.1	0.6	2.1	0.6
Standard error (µg/L)		5.7	9.5	0.7	0.7	0.3	0.0	233	0.2	0.2	0.7
USEPA guideline (µg/L)		120	120	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
EMoI guideline (µg/L)		500	500	500	500	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Mean effluent (L/s)		1.7	2.2	15.4	16.5	6.8	8.4	11	8.8	8.2	21
Loadings (g/day)		1	1.3	3	1	1	4	1	0.6	3	2

^a USEPA (2014)

^b N.A. not available; no guideline concentration is given

^c EMoI (2014)

Table 2 Estimates of EC, pH, and the metal concentrations ($\mu\text{g/L}$), flow rates (L/s) and loadings (g/day) for the industrial effluents mixing zones (M.z.) of the Leyole and Worka rivers. The flow rates (in italic) at LD 2–4 were estimated by interpolation, taking the average of flow rates at LD1 and LD5. The loadings were calculated as the product of median concentrations and flow rates of the rivers

Station		LD1		LD2 (M.z. steel)		LD3 (M.z. textile)		LD4 (M.z. tannery)		LD5 (M.z. meat proc.)		WD1		WD2 (M.z. Brewery)	
		C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2	C1	C2
Campaigns ($n = 8$)															
EC ($\mu\text{S/cm}$)	Median	620	530	570	460	750	550	750	980	760	850	430	340	680	1240
	Mean	540	490	540	420	700	550	740	1050	770	850	400	350	700	1280
	Maximum	718	685	617	574	1080	650	1010	1480	1110	1260	480	470	990	2850
	Minimum	200	150	280	180	520	400	420	710	440	290	290	240	430	570
	Standard error	66	65	38	43	62	32	66	105	69	113	24	27	71	241
pH	Median	7.5	8.0	8.1	8.3	8.3	8.1	7.8	7.9	7.6	7.6	8.1	8.4	6.3	9.5
	Maximum	8.3	8.2	8.5	8.7	8.8	8.5	8.2	7.9	8.5	7.9	8.5	8.7	9.5	11.2
	Minimum	7.3	7.2	7.2	7.6	7.9	7.6	7.1	7.4	7.4	7.3	6.4	8.0	4.4	6.9
	Standard error	0.8	0.13	0.8	0.13	0.89	0.13	0.83	0.07	0.84	0.09	0.83	0.1	0.74	0.58
Cr	Median ($\mu\text{g/L}$)	3.9	2.1	12	6.1	7.9	51	9.1	2660	8.9	280	2.1	2.1	7.1	38
	Mean ($\mu\text{g/L}$)	3	440	11	380	6.9	230	9	6880	11	4280	3.1	37	7.9	30
	Maximum ($\mu\text{g/L}$)	21	2690	44	2160	25	1130	15	25,900	16	18,250	4.9	154	13	73
	Minimum ($\mu\text{g/L}$)	1.9	1.1	2.1	0.7	2.1	0.7	1.9	206	2.1	26	2.1	1.2	2.1	2.1
	Standard error ($\mu\text{g/L}$)	4.1	330	5.1	260	3.1	140	8.9	3360	6.1	2580	0.1	22	1.1	9.1
	Mean river flows (L/s)	98	184	<i>120</i>	<i>240</i>	<i>135</i>	<i>277</i>	<i>138</i>	<i>287</i>	142	296	360	1320	360	1,320
Loadings (g/day)	34	32	<i>124</i>	<i>124</i>	<i>93</i>	<i>1220</i>	<i>110</i>	<i>66,000</i>	<i>110</i>	<i>7260</i>	62	228	<i>218</i>	<i>4330</i>	
Cu	Median ($\mu\text{g/L}$)	23	0.4	17	14	63	41	10	21	14	27	8	0.2	13	33
	Mean ($\mu\text{g/L}$)	80	300	83	270	100	160	41	85	65	190	51	34	73	350
	Maximum ($\mu\text{g/L}$)	303	1900	248	1540	250	830	250	360	270	1180	270	150	270	2450
	Minimum ($\mu\text{g/L}$)	3.1	0.1	6.9	0.1	4.1	0.1	2.9	0.1	3.1	0.1	2.1	0.1	3.1	0.1
	Standard error ($\mu\text{g/L}$)	37	240	36	190	37	100	30	45	33	140	33	22	35	300
	Mean river flows (L/s)	98	180	<i>120</i>	<i>240</i>	<i>130</i>	<i>280</i>	<i>140</i>	<i>290</i>	140	300	360	1,320	360	1,320
Loadings (g/day)	195	6	<i>176</i>	<i>290</i>	<i>735</i>	<i>980</i>	<i>119</i>	<i>521</i>	<i>172</i>	<i>691</i>	249	23	<i>404</i>	<i>3,760</i>	
Zn	Median ($\mu\text{g/L}$)	72	110	95	520	71	187	30	205	81	214	41	137	106	194
	Mean ($\mu\text{g/L}$)	77	110	109	886	91	525	52	384	127	528	67	151	194	175
	Maximum ($\mu\text{g/L}$)	126	3310	367	2780	218	1600	131	1050	611	2120	143	338	855	278
	Minimum ($\mu\text{g/L}$)	26	16	29	9.1	54	34	15	67	15	25	8.9	12	14	46
	Standard error ($\mu\text{g/L}$)	15	402	37	365	21	209	17	127	65	250	19	45	92	29
	Mean river flows (L/s)	98	184	<i>120</i>	<i>240</i>	<i>135</i>	<i>277</i>	<i>138</i>	<i>287</i>	142	296	360	1320	360	1320
Loadings (g/day)	610	1750	<i>985</i>	<i>10,800</i>	<i>828</i>	<i>4480</i>	<i>358</i>	<i>5080</i>	<i>994</i>	<i>5470</i>	1280	15,630	<i>3300</i>	<i>22,130</i>	
Pb	Median ($\mu\text{g/L}$)	2.1	1.1	2.9	1.1	2.9	3.1	3.9	5.1	3.1	0.8	2.1	1.1	3.9	1.1
	Mean ($\mu\text{g/L}$)	1.1	11	1.1	9.9	1.1	8.1	0.4	128	1.1	7.9	3.1	2.1	2.1	1.1
	Maximum ($\mu\text{g/L}$)	4.9	70	6.1	60	4.9	34	4.1	980	4.1	44	3.9	7.1	4.9	5.1
	Minimum ($\mu\text{g/L}$)	2.1	1.1	2.1	1.1	1.9	1.1	2.1	0.6	2.1	0.6	2.1	1.1	2.1	1.1
	Standard error ($\mu\text{g/L}$)	0.4	8	0.7	7	0.4	3.9	4.1	121	0.4	5.1	0.3	0.7	0.2	0.4
	Mean river flows (L/s)	98	184	<i>120</i>	<i>240</i>	<i>135</i>	<i>277</i>	<i>138</i>	<i>287</i>	142	296	360	1320	360	1320
Loadings (g/day)	17	16	<i>31</i>	<i>21</i>	<i>35</i>	<i>72</i>	<i>48</i>	<i>124</i>	<i>37</i>	<i>20</i>	62	114	<i>124</i>	<i>114</i>	