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Pollution status, source apportionment, ecological and human health risks of potentially (eco)toxic elements-laden dusts from urban roads, highways and pedestrian bridges in Uganda

Mark Opolot [1], Timothy Omara [2,3,*], Christopher Adaku[1] and Emmanuel Ntambi[1*]

[1] Department of Chemistry, Faculty of Science, Mbarara University of Science and Technology, P.O. Box 1410, Mbarara, Uganda
[2] Institute of Chemistry of Renewable Resources, Department of Chemistry, University of Natural Resources and Life Sciences Vienna (BOKU), Konrad-Lorenz-Straße 24, 3430 Tulln, Austria
[3] Chemistry Division, Testing Department (Standards Directorate), Uganda National Bureau of Standards, Bweyogerere Industrial and Business Park, P.O. Box 6329, Kampala, Uganda
* Correspondence: prof.timo2018@gmail.com, prof.timo2018@mu.ac.ke; Tel.: +254 742 777 349 (T.O.); emmantambi@must.ac.ug; Tel.: +256 772 667 343 (E.N.).

SUPPLEMENTARY FILES

Table S1. Classification values of pollution and risk indices and their description

Pollution and risk indicators	Classification values	Description
Contamination factor (CF)	CF< 1	Low contamination
	1 ≤CF< 3	Moderate contamination
	3 ≤ CF< 6	Considerable contamination
	CF> 6	Very high contamination
Geo-accumulation index (I_{geo})	I_{geo}<0 (class 0)	Practically uncontaminated
	0<I_{geo}<1 (class 1)	Low to median contamination
	1<I_{geo}<2 (class 2)	Median contamination
	2<I_{geo} <3 (class 3)	Median to strong contamination
	3<I_{geo}<4 (class 4)	Serious contamination
	4<I_{geo}< 5 (class 5)	Serious to extreme contamination
	I_{geo} > 5 (class 6)	Extreme contamination
Pollution Load index (PLI)	PLI < 1	Unpolluted
	PLI > 1	Polluted
Ecological risk (ER and PERI)	E_R^i < 40; PERI > 95	Low contamination
	40 ≤ E_R^i ≤ 80; 95 ≤ PERI ≤ 190	Moderate contamination
	80 ≤ E_R^i ≤ 160; 190 ≤ PERI ≤ 380	Considerable contamination
	160 ≤ E_R^i ≤; 320; PERI ≥ 380	High contamination
	320 ≤ E_R^i	Very high contamination

Table S2. Values of exposure factors for children and adults used in health risk assessments

Factor	Description (units)	Factor values		References
		Children	Adults	
C	Concentration of PTEs in dust (mg kg^{-1})	This study	This study	This study
IngR	Ingestion rate of dust (mg day^{-1})	200	100	RAIS [1]
E*f*	Exposure frequency (days year^{-1})	75	75	
E*d*	Exposure duration (years)	6	24	US EPA [2-4]
InhR	Inhalation rate of dust (m^3 day^{-1})	7.63	12.8	Li et al. [5]
CF	Conversion factor (kg mg^{-1})	1×10^{-6}	1×10^{-6}	
W_{ab}	Body weight (kg)	15	60	Omara et al. [6]
T_{aet}	Average time (days)	75 × E*d*	75 × E*d*	US EPA [7]
S_{AF}	Surface area of skin exposed to dust (cm^2)	1600	4350	Zheng et al. [8]
PEF	Particular emission rate (m^3 kg^{-1})	1.36×10^9	1.36×10^9	US EPA [2, 4]
AF	Skin adherence factor (mg cm^{-2})	0.2	0.7	Baguma et al. [9]
DAF	Dermal absorption factor (unitless)	0.001	0.001	US EPA [2, 4]

Table S3. Average daily dose, hazard quotient and indices through ingestion, inhalation and dermal adsorption of PTEs in dust from selected urban roads, highways and pedestrian bridges in Eastern Uganda

Pathway	Age group	Sampling site	Average daily doses (× 10^{-6} mg kg^{-1} day^{-1})							Hazard quotient							Hazard index[1]
			Cu	Ni	Mn	Zn	Pb	Cd	Cr	Cu	Ni	Mn	Zn	Pb	Cd	Cr	
$ADD_{ingestion}$	Children	D1	170.1	109.7	15428.6	367.5	2537.1	2.4	425.1	0.0043	0.0055	0.3354	0.00123	0.6343	0.00024	0.1417	**1.12027**
		D2	156.3	2.7	9257.1	471.8	3228.3	3.0	131.7	0.0039	0.0001	0.2012	0.00157	0.8071	0.00030	0.0439	**1.15497**
		D3	463.5	161.8	31268.6	1001.1	3157.0	12.1	422.4	0.1159	0.0081	0.6975	0.00334	0.7893	0.00120	0.1408	**1.75614**
		D4	233.1	246.9	25165.7	2729.1	3074.7	27.3	74.1	0.0583	0.0123	0.5471	0.00910	0.7687	0.00273	0.0247	**1.42293**
		D5	318.2	318.2	36068.6	696.7	3329.8	12.1	776.2	0.0080	0.0159	0.7841	0.00232	0.8325	0.00120	0.2587	**1.89272**
		D6	274.3	101.5	10080.0	529.4	3346.3	15.1	153.6	0.0069	0.0051	0.2191	0.00176	0.8366	0.00151	0.0512	**1.12217**
		D7	200.2	41.1	6377.1	436.1	3340.8	15.1	120.7	0.0050	0.0021	0.1386	0.00145	0.8352	0.00151	0.0402	**1.02406**
		D8	260.3	65.8	12960.0	617.1	3335.3	15.1	216.7	0.0065	0.0033	0.2817	0.00206	0.8338	0.00151	0.0722	**1.19956**
	Adults	D1	20.7	13.3	1875.0	44.7	308.3	0.3	51.7	0.0005	0.0007	0.0408	0.00015	0.0771	0.00003	0.0172	0.13648
		D2	19.0	0.3	1125.0	57.3	392.3	0.4	16.0	0.0005	0.00002	0.0245	0.00019	0.0981	0.00004	0.0053	0.12865
		D3	56.3	19.7	3800.0	121.7	383.7	1.5	51.3	0.0014	0.0010	0.0826	0.00041	0.0959	0.00015	0.0170	0.19966
		D4	28.3	30.0	3058.3	331.7	373.7	3.3	9.0	0.0007	0.0015	0.1752	0.00111	0.0934	0.00033	0.0030	0.27524
		D5	38.7	38.7	4383.3	84.7	404.7	1.5	94.3	0.0010	0.0019	0.0953	0.00028	0.1012	0.00015	0.0314	0.23123
		D6	33.3	12.3	1225.0	64.3	406.7	1.8	18.7	0.0008	0.0006	0.0266	0.00021	0.1017	0.00018	0.0062	0.13629
		D7	24.3	5.0	775.0	53.0	406.0	1.8	14.7	0.0006	0.0003	0.0168	0.00018	0.1015	0.00018	0.0049	0.12446
		D8	31.0	8.0	1575.0	75.0	405.3	1.8	26.3	0.0008	0.0004	0.0342	0.00025	0.1013	0.00018	0.0088	0.14513
			R_fD*ingestion* (mg $kg^{-1}day^{-1}$)[1]							0.0400	0.0200	0.0460	0.3000	0.0040	0.00010	0.0030	
$ADD_{inhalation}$	Children	D1	0.0046	0.0030	0.4208	0.0100	0.0692	0.00007	0.0116	0.0000023	0.000033	0.0294	0.00000003	0.000230	0.000007	0.000405	0.03007733
		D2	0.0043	0.0007	0.2525	0.0129	0.0880	0.00008	0.0036	0.0000021	0.000008	0.0177	0.00000004	0.000290	0.000008	0.000126	0.01813414
		D3	0.0126	0.0044	0.8528	0.0273	0.0861	0.00033	0.0116	0.0000063	0.000049	0.0596	0.00000009	0.000287	0.000033	0.000406	0.06038139
		D4	0.0064	0.0067	0.6863	0.0744	0.0839	0.00075	0.0020	0.0000032	0.000074	0.0480	0.00000025	0.000279	0.000075	0.000070	0.04850123
		D5	0.0087	0.0087	0.9837	0.0190	0.0908	0.00033	0.0212	0.0000044	0.000097	0.0688	0.00000006	0.000300	0.000033	0.000741	0.06997546
		D6	0.0075	0.0028	0.2749	0.0144	0.0913	0.00041	0.0004	0.0000038	0.000031	0.0192	0.00000005	0.000304	0.000041	0.000014	0.01959385
		D7	0.0055	0.0011	0.1739	0.0119	0.0911	0.00041	0.0033	0.0000028	0.000012	0.0122	0.00000004	0.000303	0.000041	0.000115	0.01267384
		D8	0.0071	0.0018	0.3534	0.0168	0.0910	0.00041	0.0059	0.00000009	0.000020	0.2471	0.00000006	0.000304	0.000041	0.000206	0.24767115
	Adults	D1	0.0002	0.0013	0.1846	0.0044	0.0304	0.00003	0.0051	0.0000001	0.000014	0.0129	0.000000001	0.000101	0.000003	0.000178	0.01319610
		D2	0.0019	0.00003	0.1108	0.0056	0.0386	0.00004	0.0002	0.0000009	0.0000003	0.0077	0.00000009	0.000129	0.000004	0.000007	0.00784129
		D3	0.0055	0.0019	0.3742	0.0120	0.0378	0.00001	0.0051	0.0000028	0.000021	0.0262	0.00000004	0.000126	0.000001	0.000178	0.02652884
		D4	0.0028	0.0029	0.3011	0.0327	0.0368	0.00033	0.0009	0.0000014	0.00003	0.0211	0.00000001	0.000123	0.000033	0.000032	0.02131941
		D5	0.0038	0.0038	0.4316	0.0083	0.3984	0.00014	0.0093	0.0000019	0.000042	0.0302	0.00000003	0.000133	0.000014	0.000325	0.03071593
		D6	0.0033	0.0012	0.1206	0.0063	0.0404	0.00018	0.0018	0.0000017	0.000013	0.0084	0.00000002	0.000134	0.000018	0.000629	0.00919590
		D7	0.0024	0.00005	0.0763	0.0052	0.0400	0.00018	0.0014	0.0000012	0.0000006	0.0053	0.00000002	0.000133	0.000018	0.000049	0.00536900
		D8	0.0031	0.00008	0.1551	0.0074	0.0399	0.00018	0.0026	0.0000016	0.0000009	0.0108	0.00000003	0.000133	0.000018	0.000091	0.01104453
			R_fD*inhalation* (mg m^{-3}) [1]							0.002	0.00009	0.0000143	0.300	0.0003	0.00001	0.0000286	
$ADD_{dermal\ contact}$	Children	D1	0.2645	0.1707	24.000	0.0121	3.9467	0.0038	0.6613	0.0000066	0.0000090	0.000521	0.00000004	0.000987	0.0000038	0.000220	0.00174744
		D2	0.2432	0.0064	14.400	0.0149	5.0219	0.0047	0.2048	0.0000061	0.0000003	0.000313	0.0000005	0.001255	0.0000047	0.000068	0.00164760
		D3	0.7211	0.2517	48.640	1.5570	4.9109	0.0188	0.6571	0.0000180	0.000013	0.00106	0.0000052	0.01228	0.0000188	0.000219	0.01415400
		D4	0.3627	0.3840	39.150	4.2453	4.7829	0.0425	0.1152	0.0000091	0.000019	0.00085	0.000014	0.001195	0.0000425	0.000038	0.00216760
		D5	0.4949	0.4949	56.11	1.0837	5.1797	0.0188	1.2075	0.0000124	0.000025	0.00122	0.000004	0.001295	0.0000188	0.000403	0.00297820
		D6	0.4267	0.1579	15.680	0.8235	5.2053	0.0235	0.2389	0.0000107	0.0000008	0.00034	0.000003	0.001301	0.0000235	0.000079	0.00175800
		D7	0.3115	0.0640	9.920	0.6784	5.1968	0.0235	0.1877	0.0000078	0.0000032	0.00022	0.000002	0.001299	0.0000235	0.000062	0.00161048
		D8	0.4049	0.1024	20.160	0.9600	5.1883	0.0235	0.3371	0.0000100	0.0000051	0.00044	0.000003	0.001297	0.0000235	0.000112	0.00189060
	Adults	D1	0.6293	0.4060	57.094	1.3601	9.3888	0.0090	1.5732	0.000016	0.0000203	0.00120	0.0000045	0.002347	0.000009	0.000524	0.0042085
		D2	0.5786	0.0101	34.256	1.7458	11.9466	0.0111	0.4872	0.000014	0.0000005	0.00070	0.0000058	0.002986	0.0000111	0.000162	0.0038794
		D3	1.7154	0.5989	115.710	3.7048	11.6827	0.0447	1.5631	0.000043	0.0000299	0.00252	0.000012	0.002920	0.0000447	0.000521	0.0060906
		D4	0.8628	0.9135	93.126	10.099	11.3782	0.1012	0.2740	0.000022	0.0000457	0.00202	0.000033	0.002844	0.0001012	0.000091	0.0051569
		D5	1.1774	1.1774	133.473	2.5781	12.3221	0.0447	2.8725	0.000029	0.0000589	0.00291	0.0000086	0.003080	0.0000447	0.000957	0.0070882
		D6	1.0150	0.3756	37.301	1.9590	12.3830	0.0558	0.5684	0.000025	0.0000190	0.00081	0.0000065	0.003096	0.0000558	0.000189	0.0042013
		D7	0.7410	0.1523	23.599	1.6139	12.3627	0.0558	0.4466	0.000019	0.0000008	0.00051	0.000005	0.003090	0.0000558	0.000148	0.0038286
		D8	0.9632	0.2436	47.959	2.2838	12.3424	0.0558	0.8019	0.000024	0.0000122	0.00104	0.0000076	0.003085	0.0000558	0.000267	0.0044686
			R_fD*dermal contact* (mg $kg^{-1}day^{-1}$)							0.040	0.020	0.0460	0.300	0.004	0.001	0.003	

[1] Values in **bold** indicate exceedance of 1.0, indicating the possibility of non-carcinogenic health risks. R_fD*dermal contact* were computed as the product of R_fD*ingestion* and the fraction of contaminant absorbed in gastrointestinal tract (dimensionless) in the critical toxicity study ($ABSGI_i$).

Table S4. Carcinogenic risks due to ingestion, dermal contact and inhalation of carcinogenic PTEs in dusts sampled from selected urban roads, highways and pedestrian bridges in Eastern, Uganda

Cancer risk	Sampling site	Ni ($\times 10^{-8}$)	Pb ($\times 10^{-8}$)	Cd ($\times 10^{-8}$)	Cr ($\times 10^{-8}$)
$CR_{ingestion}$	D1	0.3990	0.2621	0.015	1.965
	D2	0.0090	0.3335	0.020	0.608
	D3	0.5700	0.3261	0.075	1.949
	D4	0.9000	0.3176	0.165	0.342
	D5	1.1061	0.3440	0.075	3.583
	D6	0.3690	0.3470	0.090	0.711
	D7	0.1500	0.3451	0.090	0.559
	D8	0.2400	0.3445	0.090	0.999
$CR_{inhalation}$	D1	0.2438	0.0129	0.0306	96.900
	D2	0.0056	0.0164	0.0408	38.000
	D3	0.3562	0.0161	0.0102	96.900
	D4	0.5438	0.0156	0.3369	17.100
	D5	0.7125	0.1693	0.1429	176.700
	D6	0.2250	0.0172	0.1838	1.838
	D7	0.0094	0.0170	0.1838	26.600
	D8	0.0150	0.0170	0.1838	49.400
$CR_{dermal\ contact}$	D1	0.0120	0.0080	0.00045	0.0598
	D2	0.0003	0.0101	0.00056	0.0185
	D3	0.0179	0.0099	0.0022	0.0594
	D4	0.0275	0.0097	0.0051	0.0104
	D5	0.0353	0.0105	0.0022	0.1092
	D6	0.0112	0.0105	0.0028	0.0216
	D7	0.0046	0.0105	0.0028	0.0170
	D8	0.0073	0.0105	0.0028	0.0305

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