Additional file 1

Human health and ecology at risk: A case study of metal pollution in Lahore, Pakistan

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Table S1: Detail of sampling locations with respect to water resource, site ID, sampling date and coordinates.

S #	Water Source	Site ID	Sampling Date	Longitude	Latitude
1	Groundwater	GW 1	2019-04-03	31.560097	74.400159
2	Groundwater	GW 2	2019-04-03	31.556271	74.404751
3	Groundwater	GW 3	2019-04-03	31.558635	74.388475
4	Groundwater	GW 4	2019-04-03	31.565224	74.396519
5	Groundwater	GW 5	2019-04-03	31.565914	74.416169
6	Groundwater	GW 6	2019-04-04	31.586775	74.398446
7	Groundwater	GW 7	2019-04-04	31.585327	74.390152
8	Groundwater	GW 8	2019-04-04	31.58956	74.388126
9	Groundwater	GW 9	2019-04-04	31.584116	74.37492
10	Groundwater	GW 10	2019-04-04	31.586125	74.373512
11	Groundwater	GW 11	2019-04-05	31.542301	74.399477
12	Groundwater	GW 12	2019-04-05	31.542603	74.409088
13	Groundwater	GW 13	2019-04-05	31.549696	74.384013
14	Groundwater	GW 14	2019-04-05	31.548453	74.37426
15	Groundwater	GW 15	2019-04-05	31.542628	74.3753
16	Groundwater	GW 16	2019-04-06	31.460196	74.339964
17	Groundwater	GW 17	2019-04-06	31.459149	74.337601
18	Groundwater	GW 18	2019-04-06	S31.459649	74.326788
19	Groundwater	GW 19	2019-04-06	31.451953	74.314313
20	Groundwater	GW 20	2019-04-06	31.454293	74.316643
21	Groundwater	GW 21	2019-04-06	31.539777	74.34605
22	Groundwater	GW 22	2019-04-06	31.529691	74.33642
23	Groundwater	GW 23	2019-04-06	31.522834	74.328909
24	Groundwater	GW 24	2019-04-06	31.527705	74.331489
25	Groundwater	GW 25	2019-04-06	31.539269	74.325198
26	Groundwater	GW 26	2019-04-08	31.600344	74.341838
27	Groundwater	GW 27	2019-04-08	31.598469	74.338629
28	Groundwater	GW 28	2019-04-08	31.607581	74.335493
29	Groundwater	GW 29	2019-04-08	31.608437	74.327673
30	Groundwater	GW 30	2019-04-08	31.609583	74.331536
31	Groundwater	GW 31	2019-04-09	31.515736	74.317057
32	Groundwater	GW 32	2019-04-09	31.514708	74.299796
33	Groundwater	GW 33	2019-04-09	31.505747	74.286435
34	Groundwater	GW 34	2019-04-09	31.502182	74.278244
35	Groundwater	GW 35	2019-04-09	31.509344	74.306825
36	Groundwater	GW 36	2019-04-10	31.588122	74.318517
37	Groundwater	GW 37	2019-04-10	31.586501	74.314677
38	Groundwater	GW 38	2019-04-10	31.585489	74.306843
39	Groundwater	GW 39	2019-04-10	31.580489	74.306494
40	Groundwater	GW 40	2019-04-10	31.577705	74.30267
41	Groundwater	GW 41	2019-04-11	31.542277	74.316527
42	Groundwater	GW 42	2019-04-11	31.542584	74.310198
43	Groundwater	GW 43	2019-04-11	31.540829	74.312108
44	Groundwater	GW 44	2019-04-11	31.539101	74.308773
45	Groundwater	GW 45	2019-04-11	31.528935	74.302545
46	Groundwater	GW 46	2019-04-12	31.595731	74.438635
47	Groundwater	GW 47	2019-04-12	31.607203	74.419019
48	Groundwater	GW 48	2019-04-12	31.589102	74.388268
49	Groundwater	GW 49	2019-04-12	31.599955	74.394215
50	Groundwater	GW 50	2019-04-12	31.597626	74.392458

S #	Water Source	Site ID	Sampling Date	Longitude	Latitude
51	Canals	CW 1	2019-03-15	31.717698	74.470085
52	Canals	CW 2	2019-03-15	31.706321	74.469876
53	Canals	CW 3	2019-03-15	31.69356	74.473823
54	Canals	CW 4	2019-03-15	31.68443	74.479119
55	Canals	CW 5	2019-03-15	31.6761	74.482788
56	Canals	CW 6	2019-03-15	31.670934	74.483568
57	Canals	CW 7	2019-03-15	31.658322	74.486015
58	Canals	CW 8	2019-03-15	31.648579	74.487416
59	Canals	CW 9	2019-03-15	31.638448	74.484913
60	Canals	CW 10	2019-03-15	31.627665	74.490828
61	Canals	CW 11	2019-03-15	31.615653	74.492868
62	Canals	CW 12	2019-03-15	31.596634	74.496478
63	Canals	CW 13	2019-03-15	31.589814	74.501075
64	Canals	CW 14	2019-03-15	31.578266	74.502713
65	Canals	CW 15	2019-03-15	31.569242	74.501047
66	Canals	CW 16	2019-03-15	31.561355	74.501389
67	Canals	CW 17	2019-03-15	31.552219	74.501991
68	Canals	CW 18	2019-03-15	31.543443	74.502417
69	Canals	CW 19	2019-03-15	31.532122	74.503255
70	Canals	CW 20	2019-03-15	31.513248	74.5043
71	Canals	CW 21	2019-03-15	31.50143	74.504893
72	Canals	CW 22	2019-03-15	31.480744	74.506033
73	Canals	CW 23	2019-03-15	31.44645	74.504706
74	Canals	CW 24	2019-03-15	31.430048	74.505415
75	Canals	CW 25	2019-03-15	31.405093	74.507788
76	Canals	CW 26	2019-03-17	31.586262	74.498747
77	Canals	CW 27	2019-03-17	31.58314	74.482957
78	Canals	CW 28	2019-03-17	31.58181	74.476478
79	Canals	CW 29	2019-03-17	31.579693	74.466413
80	Canals	CW 30	2019-03-17	31.57763	74.456733
81	Canals	CW 31	2019-03-17	31.575551	74.446502
82	Canals	CW 32	2019-03-17	31.573849	74.437783
83	Canals	CW 33	2019-03-17	31.571163	74.4246
84	Canals	CW 34	2019-03-17	31.568701	74.412512
85	Canals	CW 35	2019-03-17	31.565944	74.398507
86	Canals	CW 36	2019-03-18	31.564002	74.389121
87	Canals	CW 37	2019-03-18	31.561435	74.376585
88	Canals	CW 38	2019-03-18	31.555357	74.361287
89	Canals	CW 39	2019-03-18	31.546619	74.35191
90	Canals	CW 40	2019-03-18	31.537574	74.343371
91	Canals	CW 41	2019-03-27	31.528321	74.333472
92	Canals	CW 42	2019-03-27	31.519902	74.32677
93	Canals	CW 43	2019-03-27	31.510956	74.318356
94	Canals	CW 44	2019-03-27	31.502718	74.310605
95	Canals	CW 45	2019-03-27	31.492886	74.301022
96	Canals	CW 46	2019-03-28	31.484044	74.288154
97	Canals	CW 47	2019-03-28	31.477641	74.271549
98	Canals	CW 48	2019-03-28	31.47467	74.257499
99	Canals	CW 49	2019-03-28	31.473499	74.252102
100	Canals	CW 50	2019-03-28	31471553	74.243411

S #	Water Source	Site ID	Sampling Date	Longitude	Latitude
101	River Ravi	RW 1	2019-04-07	31.606715	74.295778
102	River Ravi	RW 2	2019-04-07	31.607078	74.294592
103	River Ravi	RW 3	2019-04-07	31.604989	74.294453
104	River Ravi	RW 4	2019-04-07	31.605273	74.293026
105	River Ravi	RW 5	2019-04-07	31.602031	74.291878
106	River Ravi	RW 6	2019-04-07	31.602483	74.290301
107	River Ravi	RW 7	2019-04-07	31.600665	74.291057
108	River Ravi	RW 8	2019-04-07	31.601396	74.289507
109	River Ravi	RW 9	2019-04-07	31.598586	74.288287
110	River Ravi	RW 10	2019-04-07	31.599267	74.286217
111	River Ravi	RW 11	2019-04-07	31.596841	74.286286
112	River Ravi	RW 12	2019-04-07	31.597608	74.283686
113	River Ravi	RW 13	2019-04-07	31.59541	74.284117
114	River Ravi	RW 14	2019-04-07	31.596486	74.281792
115	River Ravi	RW 15	2019-04-07	31.593538	74.281715
116	River Ravi	RW 16	2019-04-07	31.594828	74.279108
117	River Ravi	RW 17	2019-04-07	31.591305	74.279421
118	River Ravi	RW 18	2019-04-07	31.591769	74.275769
119	River Ravi	RW 19	2019-04-07	31.587476	74.275648
120	River Ravi	RW 20	2019-04-07	31.587803	74.271592
121	River Ravi	RW 21	2019-04-07	31.583139	74.273803
122	River Ravi	RW 22	2019-04-07	31.583714	74.269903
123	River Ravi	RW 23	2019-04-07	31.578942	74.270950
124	River Ravi	RW 24	2019-04-07	31.579797	74.267522
125	River Ravi	RW 25	2019-04-07	31.574714	74.269486
126	River Ravi	RW 26	2019-04-07	31.575747	74.264239
127	River Ravi	RW 27	2019-04-07	31.570683	74.268086
128	River Ravi	RW 28	2019-04-07	31.573344	74.261817
129	River Ravi	RW 29	2019-04-07	31.567758	74.264897
130	River Ravi	RW 30	2019-04-07	31.570111	74.259097
131	River Ravi	RW 31	2019-04-07	31.607497	74.296587
132	River Ravi	RW 32	2019-04-07	31.607933	74.294947
133	River Ravi	RW 33	2019-04-07	31.60849	74.297739
134	River Ravi	RW 34	2019-04-07	31.608975	74.295539
135	River Ravi	RW 35	2019-04-07	31.60966	74.29931
136	River Ravi	RW 36	2019-04-15	31.610419	74.296667
137	River Ravi	RW 37	2019-04-15	31.611229	74.301956
138	River Ravi	RW 38	2019-04-15	31.612572	74.299967
139	River Ravi	RW 39	2019-04-15	31.611900	74.304694
140	River Ravi	RW 40	2019-04-15	31.613731	74.302076
141	River Ravi	RW 41	2019-04-15	31.613125	74.307156
142	River Ravi	RW 42	2019-04-15	31.614461	74.303139
143	River Ravi	RW 43	2019-04-15	31.637964	74.343381
144	River Ravi	RW 44	2019-04-15	31.639675	74.338486
145	River Ravi	RW 45	2019-04-15	31.666211	74.372119
146	River Ravi	RW 46	2019-04-15	31.669289	74.378625
147	River Ravi	RW 47	2019-04-15	31.698364	74.436214
148	River Ravi	RW 48	2019-04-15	31.699886	74.434936
149	River Ravi	RW 49	2019-04-15	31.718231	74.463003
150	River Ravi	RW 50	2019-04-15	31.720481	74.458878

S #	Water Source	Site ID	Sampling Date	Longitude	Latitude
151	Drains	DW 1	2019-04-20	31.549447	74.389819
152	Drains	DW 2	2019-04-20	31.549304	74.408894
153	Drains	DW 3	2019-04-20	31.551423	74.382216
154	Drains	DW 4	2019-04-20	31.551464	74.374427
155	Drains	DW 5	2019-04-20	31.549478	74.370402
156	Drains	DW 6	2019-04-20	31.546933	74.362733
157	Drains	DW 7	2019-04-20	31.540079	74.35432
158	Drains	DW 8	2019-04-20	31.533095	74.343631
159	Drains	DW 9	2019-04-22	31.535762	74.337984
160	Drains	DW 10	2019-04-22	31.538459	74.325625
161	Drains	DW 11	2019-04-22	31.546683	74.295603
162	Drains	DW 12	2019-04-22	31.547047	74.291382
163	Drains	DW 13	2019-04-22	31.543217	74.285050
164	Drains	DW 14	2019-04-22	31.544029	74.268022
165	Drains	DW 15	2019-04-22	31.538474	74.26712
166	Drains	DW 16	2019-04-22	31.535653	74.26561
167	Drains	DW 17	2019-04-22	31.528471	74.258979
168	Drains	DW 18	2019-04-22	31.520486	74.255387
169	Drains	DW 19	2019-04-22	31.5145538	74.250316
170	Drains	DW 20	2019-04-22	31.511134	74.247548
171	Drains	DW 21	2019-04-29	31.490877	74.589231
172	Drains	DW 22	2019-04-29	31.477289	74.594928
173	Drains	DW 23	2019-04-29	31.46996	74.578457
174	Drains	DW 24	2019-04-29	31.453566	74.566736
175	Drains	DW 25	2019-04-29	31.443804	74.551167
176	Drains	DW 26	2019-04-29	31.443494	74.535117
177	Drains	DW 27	2019-04-29	31.439951	74.524545
178	Drains	DW 28	2019-04-29	31.444746	74.504961
179	Drains	DW 29	2019-04-29	31.437702	74.477915
180	Drains	DW 30	2019-04-29	31.421466	74.45092
181	Drains	DW 31	2019-04-29	31.402513	74.412414
182	Drains	DW 32	2019-04-29	31.400137	74.394
183	Drains	DW 33	2019-04-29	31.398405	74.377451
184	Drains	DW 34	2019-04-29	31.39321	74.358356
185	Drains	DW 35	2019-04-29	31.391152	74.33133
186	Drains	DW 36	2019-04-30	31.392173	74.323166
187	Drains	DW 37	2019-04-30	31.392582	74.3163869
188	Drains	DW 38	2019-04-30	31.391865	74.310308
189	Drains	DW 39	2019-04-30	31.389355	74.308285
190	Drains	DW 40	2019-04-30	31.386226	74.306476
191	Drains	DW 41	2019-04-30	31.494189	74.373786
192	Drains	DW 42	2019-04-30	31.487247	74.367306
193	Drains	DW 43	2019-04-30	31.473989	74.340046
194	Drains	DW 44	2019-04-30	31.459942	74.315574
195	Drains	DW 45	2019-04-30	31.456394	74.313828
196	Drains	DW 46	2019-04-30	31.452103	74.307963
197	Drains	DW 47	2019-04-30	31.445701	74.303555
198	Drains	DW 48	2019-04-30	31.437845	74.29769
199	Drains	DW 49	2019-04-30	31.434655	74.290087
200	Drains	DW 50	2019-04-30	31.431849	74.276807

Table S2: Physicochemical properties of the water samples collected from groundwater, canals, river Ravi, drains, and respective National Environmental Quality Standards.

Parameters	**GW**		**CW**		**RW**		**DW**		**NEQS**
	Min – Max	***Mean ± SD***	***Min – Max***	***Mean ± SD***	***Min – Max***	***Mean ± SD***	***Min – Max***	***Mean ± SD***	***mg/L***
pH	7.2 – 9.9	7.8 ± 0.4	7.7 – 8.8	8.1 ± 0.3	7.1 – 8.1	7.9 ± 0.2	7.5 – 8.7	8.0 ± 0.2	6.5 – 8.5
Temperature	26.1 – 36.9	31.5 ± 2.5	19.6 – 24.2	21.9 ± 1.1	22.4 – 30.9	26.2 ± 2.3	27.3 – 32.8	30.2 ± 1.4	–
TDS (*mg/L)*	126 – 598	300.4 ± 101.3	375 – 470	420.5 ± 21.8	500 – 760	614.1 ± 54.7	924 – 1750	1355 ± 209.6	3500
EC (μs/cm)	222 – 1439	732.7 ± 297.0	592 – 1824	876.3 ± 322	889 – 8485	1702 ± 1029	1135 – 2952	1922 ± 615.4	<400μs/cm
Ca^{2+}	2.0 – 64	31.5 ± 15.7	26 – 52	37.1 ± 4.7	42 – 146	103.1 ± 24.2	64 – 208	133.4 ± 34.0	75
Mg^{2+}	2.4 – 25.2	9.1 ± 5.1	4.8 – 19.2	9.7 ± 3.6	3.6 – 46.8	23.5 ± 12.3	4.8 – 51.6	20.4 ± 9.1	50
Na^{+}	20.7 – 236	98.0 ± 49.1	59.8 – 338	136. ± 65.7	43.7 – 285.2	182. ± 66.9	62.1 – 524.4	250. ± 150.4	–
HCO_3^{-}	67.1 – 433	209.2 ± 89.7	189.1 – 439	308.7 ± 70.2	250.1 – 805	608.4 ± 138.2	317.2 – 927.2	718.6 ± 152.4	–
Cl^{-}	3.1 – 63	23.5 ± 14.0	3.1 – 135	46.9 ± 31.5	6 – 123	63.4 ± 36.7	15 – 690	280.2 ± 188.1	1000
SO_4^{2-}	4.8 – 312	76.2 ± 65.9	0 – 446.4	131.4 ± 106.9	0 – 475.2	141.8 ± 111.2	0 – 820.8	270.1 ± 261.8	600

Table S3: Parameters used for the calculation of Chronic Daily Intake (CDI) through oral and dermal exposures are enlisted in the table. Values are presented with units and references.

Parameters	Value	Unit	Reference
Body Weight (BW) Female	66	Kg	USEPA [1]
Body Weight (BW) Male	78	Kg	USEPA [1]
Body Weight (BW) Child	32.7	Kg	Khan, Israili [2]
Water Intake Rate (IR) Child	1	L/day	ATSDR [3]
Water Intake Rate (IR) Child	2	L/day	ATSDR [3]
Skin surface area (SA) Female	16450	cm^2	ATSDR [3]
Skin surface area (SA) Male	18450	cm^2	ATSDR [3]
Exposure Rate (ER)	1	–	ATSDR [3]
Exposure Time (ET) Dermal Adult	0.58	hour/day	Naz, Mishra [4]
Exposure Time (ET) Dermal Child	1	hour/day	Naz, Mishra [4]
Conversion Factor (CF)	0.001	$1/cm^3$	ATSDR [3]
Permeability coefficient (P)			
Cu	1×10^{-3}		
Cr	2×10^{-3}	–	USEPA [1]
Ni	2×10^{-4}		
Pb	1×10^{-4}		
Reference Dose (RfD) Oral			
Cu	40		
Cr	3	µg/kg/day	ATSDR [3]
Ni	20		
Pb	1.4		
Reference Dose (RfD) Dermal			
Cu	12		
Cr	0.015	µg/kg/day	ATSDR [3]
Ni	5.4		
Pb	0.42		

Table S4: Reference values of EC_{50}/LC_{50} (µg/L) for algae, fish and crustaceans used for the calculation of Toxic Units (TU).

Metal	LC_{50}/EC_{50}	Species	Author	Median LC_{50}/EC_{50}
		Algae		
	245	Green algae *Closterium*	[5]	
	342	*Chlorella vulgaris*	[6]	
Cu	710	*Pseudokirchneriella subcapitata*	[7]	342
	3200	*Chlorella vulgaris*	[8]	
	11550	*Pseudokirchneriella subcapitata*	[7]	
	17.4	*Pseudokirchneriella subcapitata*	[9]	
	65600	*Chlorella vulgaris*	[8]	
Cr	357	*Desmodesmus subspicatus*	[10]	78600
	85900	*Scenedesmus subspicatus*	[11]	
	78600	*Scenedesmus subspicatus*	[11]	
	2480	*Phaeodactylum tricornutum*	[12]	
	121	*Desmodesmus subspicatus*	[10]	
Ni	21.4	*Chlorella vulgaris*	[13]	121
	6.9	*Pseudokirchneriella subcapitata*	[13]	
	32280	*Chlorella vulgaris*	[14]	
	2600	*Tetraselmis chuii*	[15]	
	23,330	*Chlorella vulgaris*	[13]	
Pb	20,821	*Pseudokirchneriella subcapitata*	[13]	4,760
	877	*Ulva pertusa* (Chlorophyta)	[16]	
	4760	*Scenedesmus* sp	[17]	
		Crustaceans		
	117	*Daphnia magna*	[6]	
	3200	*Daphnia magna*	[18]	
Cu	790	*Daphnia magna*	[19]	117
	15	*Moina macrocopa*	[6]	
	52	*Daphnia magna*	[20]	
	268	*Mesocyclops pehpeiensis*	[21]	
	310	*Daphnia magna*	[22]	
Cr	11960	*Daphnia magna*	[20]	310
	86700	*Daphnia magna*	[11]	
	310	*Daphnia magna*	[22]	
	410	*Mesocyclops pehpeiensis*	[21]	
	171	*Amphibalanus amphitrite*	[23]	
Ni	8.6	*Amphibalanus amphitrite*	[23]	290.5
	19 700	*Stenocypris major (ostracod*	[24]	
	8060	*Macrobrachium lanchesteri*	[24]	
	1080	*Daphnia magna*	[25]	
	5770	*Daphnia magna*	[26]	
Pb	174	*Daphnia magna*	[20]	694.6
	694.6	*Daphnia magna*	[27]	
	440	*Daphnia magna*	[28]	
		Fish		
	280	*Pimephales promelas*	[29]	
	100	*Oncorhynchus tshawytscha*	[30]	
Cu	90	*Cynopoecilus melanotaenia*	[31]	178
	354	*Danio rerio*	[13]	
	178	*Danio rerio*	[13]	
	16,880	*Poecilia reticulata*	[13]	
	7,800	*Poecilia reticulata*	[13]	
Cr	34000	*Etroplus suratensis*	[32]	16880
	15,780	*Danio rerio*	[13]	
	22,340	*Danio rerio*	[13]	
	11800	*Gambusia affinis*	[33]	
	265,600	*Atherinops affinis*	[34]	
Ni	33,000	*Danio rerio*	[35]	33000
	30,330	*Danio rerio*	[13]	
	51,870	*Poecilia reticulata*	[13]	
	3290	*Mugil cephalus*	[26]	
	290	*Zebrafish.*	[36]	
Pb	384	*Sparus aurata L.*	[37]	3290
	18,950	*Danio rerio*	[13]	
	16,150	*Poecilia reticulata*	[13]	

Table S5: Descriptive summary of the metal concentration (μg/L) in water bodies.

Metals (*μg/L*)	**GW**		**CW**		**RW**		**DW**		**WHO**	**NEQS**
	Min – Max	***Mean ± SD***	***Min – Max***	***Mean ± SD***	***Min – Max***	***Mean ± SD***	***Min – Max***	***Mean ± SD***	***μg/L***	***μg/L***
Cu	0 – 125.6	17.9 ± 25.2	410 – 1650	795 ± 387.5	0 – 2910	1360 ± 549	0 – 3960	2048 ± 1036	2000	1000
Cr	0 – 98	26.2 ± 23	0 – 832	311 ± 230.9	0 – 990	238 ± 314	0 – 1990	970 ± 613.6	50	1000
Ni	0 – 98.7	13.8 ± 23.8	0 – 890	477.9 ± 295	0 – 720	214 ± 228	3 – 1789	783 ± 383	20	–
Pb	0 – 98	18.6 ± 30.1	0 – 9.2	4.5 ± 2.01	4.1 – 98	31.5 ± 34.2	0 – 980	564 ± 208	10	500

Table S6: Hazard quotients and Health Risk Index: Oral Hazard Quotients (HQ_{oral}) and Oral Health Index (HRI_{oral}) are presented only for groundwater samples, as other water resources are not commonly used for drinking. Dermal Hazard Quotient (HQ_{dermal}) and *Dermal Health Index (HRI_{dermal})* are presented for all water samples collected from grounderwater, canals, river and drains. Data is presented in the form of minimum (Min), maximum (Max), average (Mean) and standard deviation.

Metal	**Population**	**Ground Water**		**Canal Water**		**River Water**		**Drain Water**	
		Min – Max	**Mean ± SD**	**Min – Max**	**Mean ± SD**	**Min – Max**	**Mean ± SD**	**Min – Max**	**Mean ± SD**
				Oral Hazard Quotient (HQ_{oral})					
Cu	Child	0 – 0.09	0.013 ± 0.01	–	–	–	–	–	–
	Male	0 – 0.08	0.010 ± 0.01	–	–	–	–	–	–
	Female	0 – 0.09	0.013 ± 0.01	–	–	–	–	–	–
Cr	Child	0 – 1.09	0.260 ± 0.23	–	–	–	–	–	–
	Male	0 – 0.83	0.220 ± 0.19	–	–	–	–	–	–
	Female	0 – 1.09	0.260 ± 0.23	–	–	–	–	–	–
Ni	Child	0 – 0.15	0.020 ± 0.03	–	–	–	–	–	–
	Male	0 – 0.12	0.010 ± 0.03	–	–	–	–	–	–
	Female	0 – 0.14	0.020 ± 0.03	–	–	–	–	–	–
Pb	Child	0 – 2.14	0.407 ± 0.65	–	–	–	–	–	–
	Male	0 – 1.79	0.340 ± 0.54	–	–	–	–	–	–
	Female	0 – 2.12	0.400 ± 0.64	–	–	–	–	–	–
				Dermal Hazard Quotient (HQ_{dermal})					
Cu	Child	0 – 0.003	0.0004 ± 0.0006	0 – 0.0400	0.02 ± 0.01	0 – 0.07	0.03 ± 0.01	0 – 0.10	0.05 ± 0.02
	Male	0 – 0.002	0.0003 ± 0.0006	0 – 0.0300	0.01 ± 0.01	0 – 0.05	0.02 ± 0.01	0 – 0.07	0.04 ± 0.02
	Female	0 – 0.002	0.0003 ± 0.0005	0 – 0.0300	0.01 ± 0.01	0 – 0.06	0.02 ± 0.01	0 – 0.08	0.042 ± 0.02
Cr	Child	0 – 4.28	1.1493 ± 0.9981	0 – 36.300	13.6 ± 9.9	0 – 43.2	10.4 ± 13.6	0 – 87	42.4 ± 26.5
	Male	0 – 3.09	0.829 ± 0.71	0 – 26.200	9.81 ± 7.21	0 – 31.2	7.5 ± 9.81	0 – 62.7	30.5 ± 19.1
	Female	0 – 3.256	0.8736 ± 0.75	0 – 27.600	10.3 ± 7.59	0 – 32.9	7.9 ± 10.30	0 – 66.1	32.2 ± 20.1
Ni	Child	0 – 0.0009	0.0001 ± 0.0002	0 – 0.0090	0.005 ± 0.003	0 – 0.008	0.002 ± 0.002	0 – 0.02	0.009 ± 0.004
	Male	0 – 0.0008	0.0001 ± 0.0002	0 – 0.0070	0.004 ± 0.002	0 – 0.006	0.001 ± 0.001	0 – 0.01	0.006 ± 0.003
	Female	0 – 0.0009	0.0001 ± 0.0002	0 – 0.0080	0.004 ± 0.002	0 – 0.006	0.001 ± 0.002	0 – 0.01	0.007 ± 0.003
Pb	Child	0 – 0.007	0.0015 ± 0.0023	0 – 0.0007	0.0003 ± 0.0001	0 – 0.007	0.002 ± 0.002	0 – 0.07	0.04 ± 0.016
	Male	0 – 0.005	0.0012 ± 0.0016	0 – 0.0005	0.0002 ± 0.0001	0 – 0.005	0.001 ± 0.001	0 – 0.05	0.03 ± 0.01
	Female	0 – 0.005	0.0011 ± 0.0017	0 – 00005	0.0002 ± 0.0001	0 – 0.005	0.001 ± 0.002	0 – 0.05	0.03 ± 0.01
				Oral Health Index (HRI_{oral})					
	Child	0.01 – 2.25	0.71 ± 0.68	–	–	–	–	–	–
	Male	0.01 – 1.89	0.59 ± 0.57	–	–	–	–	–	–
	Female	0.01 – 2.23	0.70 ± 0.67	–	–	–	–	–	–
				Dermal Health Index (HRI_{dermal})					
	Child	0 – 4.28	1.1 ± 0.99	0.01 – 36.4	13.63 ± 10	0 – 43.32	10.4 ± 13.6	0.05 – 87.13	42.5 ± 26.5
	Male	0 – 3.09	0.83 ± 0.71	0 – 26.27	9.83 ± 7.21	0 – 31.24	7.5 ± 9.81	0.03 – 62.84	30.6 ± 19.1
	Female	0 – 3.25	0.87 ± 0.75	0 – 27.68	10.35 ± 7.6	0 – 32.92	7.95 ± 10.3	0.04 – 66.21	32.3 ± 20.2

Table S7: Ecological risk of metal contamination based on the toxic unit (TU) is presented for three trophic levels: algae, fish and crustaceans. Toxic Units (TU) are given for each metal, and for the total toxicity of all metals detected at each site (TU_{sum}). For illustration purposes, log-transformation was performed.

Reference Organism	Metal	Ground Water		Canal Water		River Water		Drain Water	
		Toxic Unit (logTU)							
		Min – Max	Mean ± SD	Min – Max	Mean ± SD	Min – Max	Mean ± SD	Min – Max	Mean ± SD
Algae	Cu	ND to –0.42	–1.2 ± –1.174	0.07 – 0.68	0.36 ± 0.04	ND to 0.92	0.59 ± 0.2	ND to 1.06	0.77 ± 0.47
	Cr	ND to –2.67	–3.40 ± –3.58	ND to 1.970	–2.41± –2.11	ND to 1.89	–2.54 ± –2.44	ND to 1.05	–1.94 ± –2.14
	Ni	ND to –0.069	–0.91 ± –0.75	ND to 0.840	0.571 ± 0.32	ND to 0.77	0.24 ± 0.27	–0.62 – 1.16	0.81 ± 0.491
	Pb	ND to –1.56	–2.49 ± –2.29	ND to –2.750	–3.075 ± –3.31	–3.09 to –1.6	–2.19 ± –2.14	ND to –0.68	–0.96 ± –1.3
Crustacean	Cu	ND to 0.03	–0.81± –0.67	0.54 – 1.14	0.83 ± 0.51	ND to 1.390	1.06 ± 0.66	ND to 1.520	1.24 ± 0.94
	Cr	ND to –0.53	–1 ± –1.160	ND to 0.420	0.001 ± –0.13	ND to 0.560	–0.12 ± 0.001	ND to 0.80	0.49 ± 0.29
	Ni	ND to –0.43	–1.39 ± –1.08	ND to 0.481	0.24 ± 0.003	ND to 0.390	–0.13 ± –0.10	–0.95 – 0.78	0.43 ± 0.11
	Pb	ND to –0.86	–1.48 ± –1.28	ND to– 1.79	–2.1 ± –2.46	–2.24 to –0.76	–1.36 ± –1.31	ND to 0.141	–0.09 ± –0.54
Fish	Cu	ND to 0.15	–0.95 ± –0.85	0.36 – 0.900	0.65 ± 0.337	ND to 1.210	0.82 ± 0.48	ND to 1.38	1.069 ± 0.79
	Cr	ND to –2.23	–2.80 ± –2.86	ND to –1.36	–1.79 ± –1.802	ND to –1.230	–1.87 ± –1.79	ND to –0.98	–1.20 ± –1.4
	Ni	ND to –2.52	–3.32 ± –3.19	ND to –1.52	–1.83 ± –2.60	ND to –1.610	–2.18 ± –2.17	–3.59 to –1.8	–1.67 ± –1.99
	Pb	ND to –1.52	–2.21 ± –2.00	ND to –2.51	–2.82 ± –3.28	–2.96 to –1.98	–2.08 ± –1.95	ND to 0.500	–0.76 ± –1.23
		Sum of Toxic Units ($logTU_{sum}$)							
Algae		–2.04 to –0.045	–0.09 ± 0.40	0.15 to 1.07	0.73 ± 0.21	–0.29 to 1.03	0.68 ± 0.32	0.1 to 1.30	1.0 ± 0.20
Crustacean		–1.91 to 0.171	–0.69 ± 0.43	0.57 to 1.22	0.93 ± 0.10	–0.34 to 1.45	–0.5 ± 1.41	–1.1 to 1.35	0.92 ± 0.44
Fish		–3.81 to 0.10	–1.60 ± 0.42	0.36 to 0.96	0.61 ± 0.18	–2.42 to 1.25	0.64 ± 0.80	–1.2 to 2.0	1.5 ± 0.54

Table S8: Risk Quotients: Risk Quotients (RQ) and sum of the Risk Quotients (RQ_{sum}) are presented for all water samples collected from grounder water, canals, river and drains. Data is presented in the form of minimum (Min), maximum (Max), average (Mean) and standard deviation.

	Ground Water		Canal Water		River Water		Drain Water	
Heavy Metals	**Min – Max**	**Mean ± SD**	**Min – Max**	**Mean ± SD**	**Min – Max**	**Mean ± SD**	**Min – Max**	**Mean ± SD**
	Risk Quotient for each metal (RQ)							
Cu	0 – 15.8	2.2 ± 3.1	51.8 – 208.8	100.6 ± 48.5	0 – 368	172.2 ± 68.8	0 – 501.2	259.3 ± 129.8
Cr	0 – 28.8	7.7 ± 6.7	0 – 244.7	91.5 ± 67.2	0 – 291	70.1 ± 91.5	0 – 585.2	285.3 ± 178.6
Ni	0 – 24.6	3.4 ± 3.4	0 – 222.5	119 ± 119.4	0 – 180	53.6 ± 53.6	7.5 – 447.2	195.6 ± 195.6
Pb	0 – 81.6	19.8 ± 24.8	0 – 7.6	1.30 ±1.6	3.4 –81.6	26 ± 28.2	0 – 816.6	121 ± 171.6
	Sum of the Risk Quotients (RQ_{sum})							
	0.8 – 87.9	29 ± 27.8	70.9 – 637.4	315 ± 140	23.3 – 759	322 ± 158.3	347 – 1905	1210.1 ± 373.9

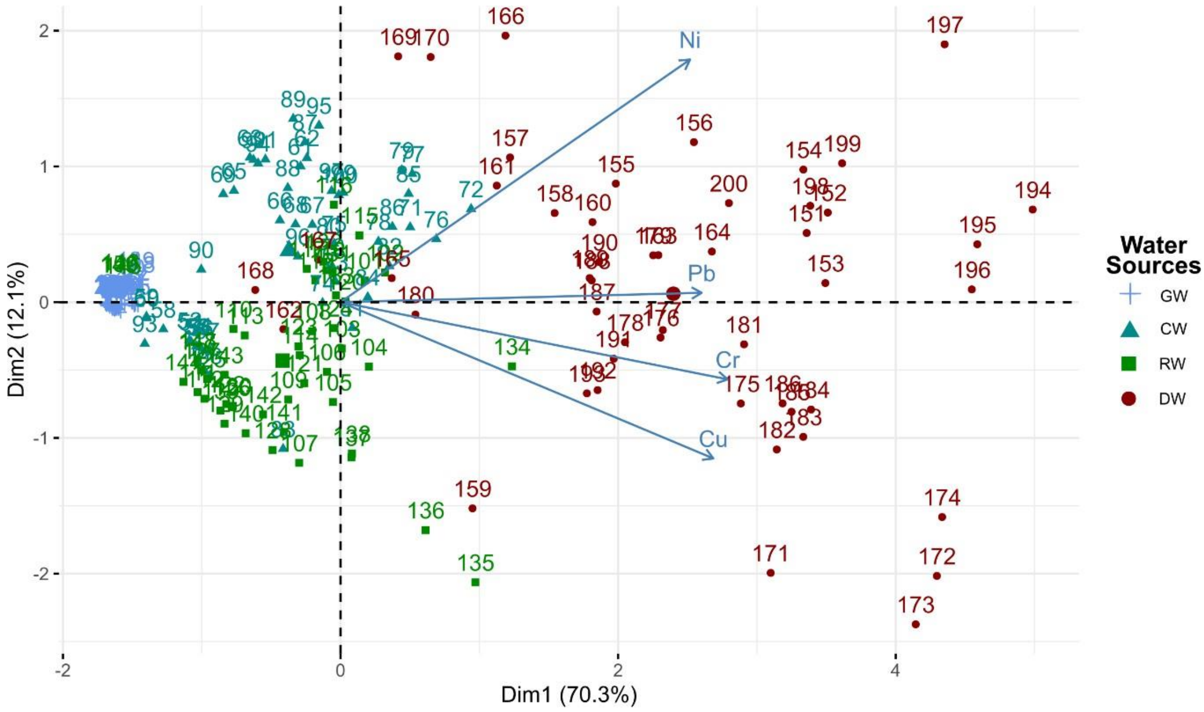

Figure S1: Principal component analysis of heavy metals: Each vector in the plot represents a variable, and the direction and length of the vector indicate the contribution and correlation of each variable to the top two principal components.

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