Geo-accumulation Index (Igeo)

Table S1. Assessment of Geo-Accumulation Index (Igeo)

I-geo class	Igeo value range	Soil Quality
0	I-geo<0	unpolluted
1	0≤I-geo<1	unpolluted to moderately polluted
2	1≤I-geo<2	moderately polluted
3	2≤I-geo<3	moderately to strongly polluted
4	3≤I-geo<4	strongly polluted
5	4≤I-geo<5	strongly to very strongly polluted
6	I-geo≥5	very strongly polluted

Data

Monster naam	Geoaccumulation Index (Igeo)											
	Mg	Al	Cr	Co	Ni	Cu	As	Se	Cd	Hg	Tl	Pb
S1	-0.32	-2.11	-0.05	-0.77	0.60	-0.71	1.49	-4.18	0.65	-2.91	-2.91	-0.03
S2	-1.01	-2.83	0.27	-1.41	-0.02	2.49	1.09	-4.70	1.82	-2.91	-3.57	2.46
S3	-0.07	-2.06	-0.05	-0.67	0.86	-0.58	1.60	-3.88	0.93	-2.91	-2.73	0.08
S4	-0.73	-2.74	-0.48	-1.21	0.08	0.55	1.26	-4.45	1.98	-2.10	-3.61	1.39
S5	-0.86	-2.74	-0.05	-1.36	-0.07	-0.64	1.15	-4.43	0.21	-2.91	-3.71	0.23
S6	-0.23	-2.67	0.17	-1.09	0.57	-1.14	1.21	-4.44	0.29	-2.91	-3.69	-1.49
S7	-0.62	-2.33	0.27	-0.97	0.51	-0.53	1.49	-4.38	0.98	-2.91	-3.23	0.42

S8	-0.32	-2.52	0.45	-1.09	0.20	-0.64	1.24	-4.36	0.77	-2.37	-3.35	0.37
S9	-0.07	-2.16	0.17	-0.58	0.98	-0.47	1.57	-3.99	0.71	-2.91	-3.01	-1.49
S10	-0.07	-2.27	0.27	-0.87	0.74	-0.91	1.51	-4.19	0.37	-2.91	-3.23	-1.21

Bioaccumulation Factor (BAF)

Data

	Bioaccumulation Factor (BAF)											
Monster naam	**Mg**	**Al**	**Cr**	**Co**	**Ni**	**Cu**	**As**	**Se**	**Cd**	**Hg**	**Tl**	**Pb**
E1	0.16	0.01	0.00	0.02	0.14	0.18	0.04	0.18	0.25	2.05	0.33	0.03
E2	0.56	0.02	0.01	0.04	0.15	0.03	0.05	0.26	0.19	1.75	0.53	0.01
E3	0.23	0.04	0.02	0.03	0.12	0.30	0.05	0.15	0.23	1.80	0.29	0.04
E4	0.25	0.03	0.03	0.03	0.14	0.20	0.05	0.22	0.11	0.66	0.54	0.03
E5	0.42	0.03	0.02	0.04	0.22	0.28	0.05	0.22	0.29	1.50	0.58	0.03
E6	0.12	0.04	0.03	0.08	0.08	0.33	0.15	0.22	0.42	1.00	0.57	0.15
E7	0.28	0.05	0.03	0.04	0.18	0.23	0.10	0.21	0.17	1.50	0.42	0.05
E8	0.13	0.02	0.01	0.02	0.11	0.26	0.10	0.20	0.27	1.34	0.45	0.03
E9	0.16	0.02	0.01	0.04	0.17	0.28	0.04	0.16	0.21	2.20	0.36	0.07
E10	0.21	0.01	0.01	0.05	0.01	0.29	0.03	0.18	0.27	1.40	0.42	0.05
N1	0.21	0.01	0.01	0.10	0.04	0.27	0.04	0.18	0.91	2.45	0.33	0.04
N2	0.27	0.03	0.01	0.05	0.05	0.03	0.04	0.26	0.33	1.00	0.53	0.01

N3	0.23	0.03	0.03	0.12	0.05	0.23	0.06	0.15	0.39	1.00	0.29	0.06
N4	0.17	0.04	0.03	0.07	0.07	0.17	0.06	0.22	0.26	0.57	0.54	0.06
N5	0.55	0.05	0.03	0.08	0.08	0.26	0.09	0.22	0.76	1.00	0.58	0.05
N6	0.21	0.03	0.02	0.06	0.24	0.31	0.10	0.22	0.42	2.10	0.57	0.12
N7	0.27	0.03	0.02	0.11	0.07	0.32	0.07	0.21	0.30	1.65	0.42	0.04
N8	0.16	0.01	0.01	0.04	0.03	0.22	0.04	0.20	0.44	0.69	0.45	0.03
N9	0.14	0.02	0.01	0.10	0.04	0.26	0.04	0.16	0.25	1.00	0.36	0.12
N10	0.25	0.01	0.01	0.02	0.09	0.31	0.03	0.18	0.35	1.80	0.42	0.03

Contamination Factor (CF)

Table S2. Contamination factor (CF) values' categories for describing the contamination level [55].

Range	Category
CF < 1	low contamination
$1 \leq CF < 3$	moderate contamination
$3 \leq CF < 6$	considerable contamination
$CF \geq 6$	very high contamination

Pollution Load Index

Table S3. PLI value representing soil quality

Range	Category
$0 < PLI \leq 1$	Unpolluted
$1 < PLI \leq 2$	Moderately polluted to unpolluted
$2 < PLI \leq 3$	Moderately polluted
$3 < PLI \leq 4$	Moderately to highly polluted
$4 < PLI \leq 5$	Highly polluted
$5 < PLI$	Very highly polluted

Data-

	Contamination Factor (CF)												Pollution Load Index (PLI)
Monster naam	**Mg**	**Al**	**Cr**	**Co**	**Ni**	**Cu**	**As**	**Se**	**Cd**	**Hg**	**Tl**	**Pb**	**Pollution Load Index (PLI)**
E1			0.01		2.31	0.41	1.45		0.23			0.03	0.19
E2			0.23		1.65	0.58	1.40		0.40			0.04	0.41
E3			0.33		2.31	0.75	1.79		0.26			0.04	0.46
E4			0.30		1.65	1.11	1.45		0.26			0.08	0.50
E5			0.27		2.31	0.68	1.34		0.20			0.03	0.38
E6			0.51		1.31	0.56	4.41		0.30			0.05	0.54
E7			0.55		2.81	0.61	3.52		0.20			0.07	0.59
E8			0.23		1.34	0.62	2.91		0.27			0.03	0.41
E9			0.23		3.64	0.76	1.40		0.20			0.02	0.40
E10			0.12		0.11	0.58	0.89		0.20			0.02	0.17
	Mg	**Al**	**Cr**	**Co**	**Ni**	**Cu**	**As**	**Se**	**Cd**	**Hg**	**Tl**	**Pb**	**Pollution Load Index (PLI)**
N1			0.14		0.60	0.63	1.34		0.84			0.03	0.36
N2			0.19		0.51	0.58	1.06		0.68			0.04	0.35
N3			0.45		1.07	0.58	2.35		0.44			0.05	0.50
N4			0.37		0.83	0.91	1.84		0.60			0.14	0.59
N5			0.46		0.88	0.63	2.51		0.52			0.05	0.51
N6			0.35		3.97	0.52	2.79		0.30			0.04	0.54
N7			0.32		1.14	0.84	2.57		0.35			0.04	0.48

	Mg	Al	Cr	Co	Ni	Cu	As	Se	Cd	Hg	Tl	Pb	Pollution Load Index (PLI)
N8			0.10		0.43	0.53	1.06		0.44			0.03	0.26
N9			0.23		0.93	0.70	1.51		0.24			0.04	0.36
N10			0.14		1.62	0.62	1.23		0.27			0.01	0.29
	Mg	Al	Cr	Co	Ni	Cu	As	Se	Cd	Hg	Tl	Pb	Pollution Load Index (PLI)
S1	1.20	0.35	1.45	0.88	2.27	0.92	4.20	0.08	2.35	0.20	0.20	1.47	0.78
S2	0.74	0.21	1.81	0.56	1.48	8.40	3.20	0.06	5.31	0.20	0.13	8.24	0.93
S3	1.43	0.36	1.45	0.94	2.73	1.00	4.53	0.10	2.86	0.20	0.23	1.59	0.87
S4	0.90	0.22	1.07	0.65	1.59	2.20	3.60	0.07	5.92	0.35	0.12	3.94	0.84
S5	0.83	0.22	1.45	0.58	1.43	0.96	3.33	0.07	1.73	0.20	0.11	1.76	0.62
S6	1.28	0.24	1.69	0.71	2.23	0.68	3.47	0.07	1.84	0.20	0.12	0.54	0.62
S7	0.98	0.30	1.81	0.76	2.14	1.04	4.20	0.07	2.96	0.20	0.16	2.00	0.78
S8	1.20	0.26	2.05	0.71	1.73	0.96	3.53	0.07	2.55	0.29	0.15	1.94	0.77
S9	1.43	0.34	1.69	1.00	2.95	1.08	4.47	0.09	2.45	0.20	0.19	0.54	0.78
S10	1.43	0.31	1.81	0.82	2.50	0.80	4.27	0.08	1.94	0.20	0.16	0.65	0.72

Determination of Potential Ecological Risk

Table S4. Interpretation categories of potential ecological risk and ecological risk index

Potential ecological risk (E_r^i)		Potential ecological risk index (RI)	
Range	Category	Range	Category
$E_r^i < 40$	Low	$RI \le 150$	Low
$40 \le E_r^i < 80$	Moderate	$150 \le RI < 300$	Moderate
$80 \le E_r^i < 160$	Considerable	$300 \le RI < 600$	Considerable
$160 \le E_r^i < 320$	High	$600 \le RI$	Very high

Data-

Monster naam	Ecological Risk (Eri)											Potential Ecological Risk (PER)
	Mg	Al	Cr	Co	Ni	Cu	As	Se	Cd	Hg	Tl	Pb	
E1			0.01		13.88	2.06	14.53		6.96			0.13	37.57
E2			0.45		9.92	2.91	13.97		12.00			0.18	39.43
E3			0.67		13.88	3.77	17.88		7.80			0.18	44.18
E4			0.60		9.92	5.53	14.53		7.80			0.40	38.77
E5			0.55		13.88	3.42	13.41		6.00			0.14	37.40
E6			1.02		7.83	2.81	44.13		9.00			0.25	65.06
E7			1.10		16.86	3.07	35.20		6.00			0.33	62.54
E8			0.45		8.03	3.12	29.05		8.04			0.17	48.86
E9			0.45		21.82	3.82	13.97		6.00			0.12	46.18
E10			0.24		0.66	2.91	8.94		6.12			0.10	18.98
	Mg	Al	Cr	Co	Ni	Cu	As	Se	Cd	Hg	Tl	Pb	Potential Ecological Risk (PER)
N1			0.29		3.57	3.17	13.41		25.2			0.17	45.80
N2			0.38		3.07	2.91	10.61		20.4			0.22	37.60
N3			0.90		6.45	2.91	23.46		13.2			0.27	47.20

	Mg	Al	Cr	Co	Ni	Cu	As	Se	Cd	Hg	Tl	Pb	Potential Ecological Risk (PER)
N4			0.74		4.96	4.57	18.44		18			0.71	47.41
N5			0.93		5.26	3.17	25.14		15.6			0.25	50.34
N6			0.69		23.80	2.61	27.93		9.12			0.20	64.36
N7			0.64		6.84	4.22	25.70		10.44			0.22	48.06
N8			0.20		2.58	2.66	10.61		13.2			0.16	29.42
N9			0.45		5.55	3.52	15.08		7.32			0.20	32.13
N10			0.29		9.72	3.12	12.29		8.04			0.07	33.52
	Mg	Al	Cr	Co	Ni	Cu	As	Se	Cd	Hg	Tl	Pb	Potential Ecological Risk (PER)
S1			2.89	4.41	13.64	4.60	42.00		70.41	8		7.35	145.30
S2			3.61	2.82	8.86	42.00	32.00		159.18	8		41.18	289.66
S3			2.89	4.71	16.36	5.00	45.33		85.71	8		7.94	167.95
S4			2.14	3.24	9.55	11.00	36.00		177.55	14		19.71	259.18
S5			2.89	2.91	8.59	4.80	33.33		52.04	8		8.82	113.39
S6			3.37	3.53	13.36	3.40	34.67		55.10	8		2.68	116.11
S7			3.61	3.82	12.82	5.20	42.00		88.78	8		10.00	166.23
S8			4.10	3.53	10.36	4.80	35.33		76.53	11.6		9.71	144.36
S9			3.37	5.00	17.73	5.40	44.67		73.47	8		2.68	152.31

| S10 | | | 3.61 | 4.12 | 15.00 | 4.00 | 42.67 | | 58.16 | 8 | | 3.24 | 130.80 |

Table S5. Permissible limits of heavy metals in soil and plants

No.	Elements	*Target Values of soil (mg/kg)	**Intervation Values of soil (mg/kg)	***Permissible Value of plants (mg/kg)
1	Cd (Cadmium)	0.8	12	0.02
2	Cr (Chromium)	100	360	1.3
3	Cu (Coper)	36	190	10
4	Pb (Lead)	85	530	2
5	Ni (Nickel)	35	210	10

*Target values are specified to indicate desirable maximum levels of elements in unpolluted soils.
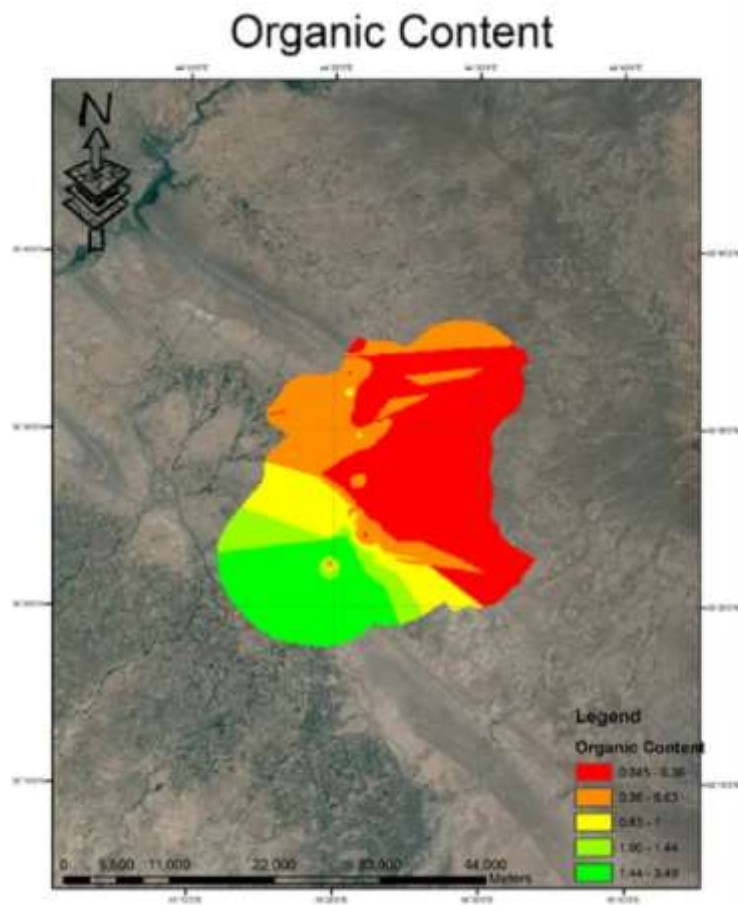**Intervention when remedial action is necessary; Source: Denneman and Robberse 1990 and Ministry of Housing, Netherland 1994. ***Source: WHO (1996).

Figure S1: Organic distribution in Kirkuk city [26]