

# Dynamic Modeling of Long-term Remediation Strategies for Heavy Metals in Mining-Impacted Agricultural Soil

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**Text S1. The equation of their's inequality coefficient(Bliemel, 1973)**

$$\text{TIC} = \frac{\sqrt{\frac{1}{n} \sum_{i=1}^n (C_{i,\text{sim}} - C_{i,\text{obs}})^2}}{\sqrt{\frac{1}{n} \sum_{i=1}^n C_{i,\text{sim}}^2 + \frac{1}{n} \sum_{i=1}^n C_{i,\text{obs}}^2}} \quad (1)$$

Where  $C_{i,\text{sim}}$  means the model simulation value at time  $i$  ( $\text{ng}\cdot\text{L}^{-1}$ );  $C_{i,\text{obs}}$  means the actual observation at time  $i$  ( $\text{ng}\cdot\text{L}^{-1}$ );  $n$  means the number of data points used for model validation.

**Table S1. Calculation of Z values**

Z Values	Equation(aquivalence)
Pure air ( $Z_A$ )	0
Pure water ( $Z_W$ )	1
Aerosol ( $Z_Q$ )	$K_{AW}Z_W$
Water particle ( $Z_P$ )/soil particle ( $Z_E$ )/sediment particle ( $Z_S$ )	$K_PZ_W/K_EZ_W/K_SZ_W$
Bulk air ( $Z_1$ )	$Z_A+v_QZ_Q$
Bulk water ( $Z_2$ )	$Z_W+v_PZ_P+v_FZ_F$
Bulk soil ( $Z_3$ )	$v_AZ_A+v_EZ_E + v_WZ_W$
Bulk sediment ( $Z_4$ )	$(1-v_S)Z_W+v_S Z_S$

Note: Subscripts A, W, Q, P, E, S, represent the sub-compartment of pure air, pure water, aerosol, suspended particle in water, soil, sediment particle.  $K_s$  is the partition coefficient between sediment and pore water,  $K_p$  is the partition coefficient between suspended solids and water,  $K_{AW}$  is aerosol-water partitioning coefficient,  $v$  is volume fraction for each phase.

**Table S2. Calculation of D values**

From	To	Process	Individual D (mol/Pa·h)
1.air	2.water	Diffusion	$D_{vw} = 1 / \left( \frac{1}{k_{awa}A_{aw}Z_A} + \frac{1}{k_{aww}A_{aw}Z_W} \right)$
		Wet deposition	$D_{ww} = A_{aw}U_RZ_W + A_{aw}U_RQv_QZ_Q$
		Dry deposition	$D_{dw} = A_{aw}U_Qv_QZ_Q$
		Total	$D_{12} = D_{vw} + D_{ww} + D_{dw}$
1.air	3.soil	Diffusion	$D_{vso} = 1 / \left( \frac{1}{k_{asa}A_{as}Z_A} + \frac{Y_{so}}{A_{as}(B_aZ_A + B_{sw}Z_W)} \right)$
		Wet deposition	$D_{wso} = A_{as}U_RZ_W + A_{as}U_RQv_QZ_Q$
		Dry deposition	$D_{dso} = A_{as}U_Qv_QZ_Q$
		Total	$D_{13} = D_{vso} + D_{wso} + D_{dso}$
2.water	1.air	Diffusion	$D_{21} = D_{vw}$
2.water	3.soil	Irrigation	$D_{23} = G_{sow}Z_W$
2.water	4.sediment	Diffusion	$D_{vse} = 1 / \left( \frac{1}{k_{wsw}A_{wse}Z_W} + \frac{Y_{se}}{A_{wse}B_wZ_W} \right)$
		Deposition	$D_{dse} = U_D A_{wse} Z_P$
		Total	$D_{24} = D_{vse} + D_{dse}$
3.soil	1.air	Diffusion	$D_{31} = D_{vso}$
3.soil	2.water	Rain-soil runoff	$D_{32} = A_{sow}U_{WW}Z_W + A_{sow}U_{EW}Z_E$
		Dry	$D_{32} = 0$
4.sediment	2.water	Re-suspension	$D_{42} = U_{RS}A_{wse}Z_S$
	Fossil	Burial	$D_{seb} = A_{se}U_BZ_S$
In each compartment		Apparent attenuation	$D_{Ri} = 0.693 V_i Z_i / \tau_{1/2,i}$
In air and water		Advection	$D_{Ai} = G_i Z_{Bi}$

Note: subscripts i represents each bulk compartment; A is the contact area between compartments, k's mass transfer coefficients (MTCs) (m/h), B's molecular diffusivity (m<sup>2</sup>/h), U<sub>R</sub> the rain rate (m/h), U<sub>Q</sub> the dry deposition velocity (m/h); U<sub>WW</sub> and U<sub>EW</sub> are water and soil runoff rate from soil (m/h), respectively; U<sub>B</sub> is sediment burial rate (m/h), U<sub>G</sub> soil transfer rate to ground water (m/h), Q the scavenging ratio (Q=2.00E5); Y's are diffusion path length; τ<sub>1/2,i</sub> is apparent half-removal time in compartment i (h); G<sub>i</sub> is advection volume (m<sup>3</sup>/h).

**Table S3. Environmental migration parameter**

Parameter	Unit	Values	Definition
$k_{awa}$	m/h	3	Air-water MTC, air side
$k_{aww}$	m/h	0.03	Air-water MTC, water side
$k_{asa}$	m/h	1	Air-soil MTC, air side
$k_{wsw}$	m/h	0.01	Water-sediment MTC, water side
$B_a$	m <sup>2</sup> /h	0.04	Molecular diffusivity in air
$B_{sw}$	m <sup>2</sup> /h	4.0E-6	Molecular diffusivity in sediment pore water
$B_w$	m <sup>2</sup> /h	2.49E-4	Molecular diffusivity in water
$Y_{so}$	m	5.00E-2	Diffusion path length in soils
$Y_{se}$	m	5.00E-3	Diffusion path length in sediment
$U_W$	m/h	3	Wind speed
$U_R$	m/h	9.7E-5	Rain rated
$U_Q$	m/h	10.8	Aerosol dry deposition rate
$U_{EW}$	m/h	2.3E-8	Solids runoff rate from soil
$U_{WW}$	m/h	3.9E-5	Water runoff rate from soil
$U_D$	m/h	4.6E-8	Sediment deposition rate
$U_{RS}$	m/h	1.1E-8	Sediment resuspension rate
$U_B$	m/h	3.0E-7	sediment burial rate

**Table S4. Basic environmental parameters of the study area**

	Parameter	Unit	Values
$x_{oc}$	Organic carbon fraction	-	
	in aerosol		0.2
	in suspended solids		0.01
	in soil solids		0.02
	in sediments		0.01
$\rho_i$	Density	kg/m <sup>3</sup>	
	Aerosols		1.5
	Bulk water		1000
	Bulk soil		2650
	Bulk sediment		2240
$d_i$	Depth	m	
	Air		2000
	Water		0.7
	Soil		0.5
	Sediment		0.5
V	Volume fraction	-	
	Solids in aird		6.0E-11
	Solids in waterd		1.0E-5
	Solids in soil		0.5
	Air in soil		0.2
	Water in soil		0.3
	Water in sediments		0.7
A	Area (local parameters)	m <sup>2</sup>	
	Air		2.30E+08
	Water		2.30E+07
	Soil		2.07E+08
	Sediment		2.30E+07

**Table S5. Summary of Enterprises Emitting Heavy Metals in the Region**

<b>Industry Category</b>	<b>Waste heavy metals</b>	<b>Production Status</b>
<b>Cotton Printing and Dyeing Processing</b>	13.126215	on stream
<b>Other Feed Processing</b>	2.612147	on stream
<b>Lead-acid Battery Manufacturing</b>	23.8336	on stream
<b>Cement Manufacturing</b>	43.233629	on stream
<b>Lead-acid Battery Manufacturing</b>	5.076	close
<b>Refined Tea Processing</b>	0.129212	on stream
<b>Thermal Power Generation</b>	6.980497	on stream
<b>Industrial Pigment Manufacturing</b>	11.123949	on stream
<b>Iron Ore Mining and Processing</b>	0.071129	close
<b>Other Basic Chemical Raw Material Manufacturing</b>	173.867535	on stream
<b>Ferroalloy Smelting</b>	0.04157	on stream

**Table S6. Scale of Livestock Farms and Manure Utilization Status in the Region**

<b>project</b>	<b>content</b>
<b>Number of farms in the region</b>	102 companies
<b>Laying hen farm</b>	2 companies
<b>Broiler farm</b>	5 companies
<b>Swine farm</b>	95 companies
<b>Fecal collection volume</b>	16147.72 t
<b>Fecal utilization rate</b>	11429.2 t

**Table S7. Monitoring Results of Livestock and Poultry Manure**

<b>point location</b>	<b>pH</b>	<b>Cd</b>	<b>Hg</b>	<b>As</b>	<b>Pb</b>	<b>Cr</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>
		<b>mg/kg</b>	<b>mg/kg</b>	<b>mg/kg</b>	<b>mg/kg</b>	<b>mg/kg</b>	<b>mg/kg</b>	<b>mg/kg</b>	<b>mg/kg</b>
B-FB1	9.785	0.44	3.33	151.5	127	47.5	153.5	525.5	18.5
B-FB2	5.99	0.44	28.7	4.89	27	28	1650	20200	12
B-FB3	5.92	0.46	2.2	3.18	17	12	272	2270	12
C-FB1	7.09	0.46	7.89	4.32	17	20	299	1500	17
C-FB2	6.1	0.29	2.87	3.95	16	26	410	2490	12
C-FB3	6.17	0.25	18.4	23.3	24	58	85	353	18
C-FB4	5.9	0.46	11.7	5.93	24	42	530	1860	17
C-FB5	6.12	0.15	9.87	1.29	14	15	502	3470	7
C-FB6	5.5	0.46	2.68	4.975	16	35	186.5	1785	17
L-FB1	6.44	0.515	10.25	14.05	19	19.5	328.5	2810	10.5
L-FB2	7.46	0.42	28.4	6.06	12	27	413	1410	9
L-FB3	5.05	0.81	2.64	8.46	15	14	217	1100	9
L-FB4	6.52	0.93	19.6	2.04	16	23	420	3280	16
L-FB5	6.75	0.45	4.78	3.13	11	15	250	1550	15
L-FB6	6.93	0.74	35.2	7.68	22	27	1580	4200	14

**Table S8. Atmospheric Sediment Monitoring Results (Spring and Summer)**

point location	Monitoring items								
	pH	Cd mg/kg	Hg mg/kg	As mg/kg	Pb mg/kg	Cr mg/kg	Cu mg/kg	Zn mg/kg	Ni mg/kg
DQ-1	4.37	1.6	0.18	7.64	25.5	28.5	17.5	238	7.7
DQ-2	3.68	1.4	0.089	3.39	19.2	38.1	12.5	190	14.3
DQ-3	4.95	0.8	0.111	5.24	14.3	20.7	12.2	141	4.6
DQ-4	3.77	1.4	0.204	6.29	34	30.6	18.9	172	5.5
DQ-5	5.51	2.7	0.209	53.6	55.1	40	35.9	416	9.9
DQ-6	4.82	2.4	0.165	13.6	25.1	22.6	32	160	7.4
DQ-7	4.01	1.5	0.159	6.14	35	19.9	11.5	259	5
DQ-8	7.26	2	0.301	37.4	39.4	71.6	25.2	225	19.4
DQ-9	5.05	3	0.237	33.7	52.6	39.5	24.8	344	10.2
DQ-10	4.95	2.3	0.238	21.7	51.8	32.2	36.4	367	10.8
DQ-11	2.6	6.3	0.34	33.5	48.7	36.9	31.1	325	14.1
DQ-12	3.82	2.6	0.224	12.2	47.9	26.3	25	341	11.5
DQ-13	3.33	3.6	0.459	14.4	62.9	91.4	33.3	502	17.6
DQ-14	4.11	3.2	0.415	20.6	61.3	217	35.1	552	52.5
DQ-15	4.03	2.5	0.261	10.2	39.1	41.4	17.7	320	13.7
DQ-16	5.95	2.5	0.206	10.7	45.9	85.8	28.8	408	16
DQ-17	2.31	2.9	0.757	22.6	51.3	28.5	23.1	303	10.5
DQ-18	5.56	1.9	0.248	19	35.5	27.8	23.1	310	6.2
DQ-19	6.52	2.8	0.289	17.7	71.9	31.6	25.7	420	10.4
DQ-20	10.32	1.1	0.213	10.9	21.8	18.3	12.5	128	6
DQ-21	5.95	2.4	0.415	67.4	61.8	50	52	311	11.1
DQ-22	3.48	1.9	0.341	23	43.7	24.2	27.9	300	12
DQ-23	5.6	2.7	0.367	34.6	103	48.9	45.1	659	11.3
DQ-24	6.81	1.2	0.181	24	27.7	14.9	17.5	231	5.9
DQ-25	5.06	3.5	0.279	41.7	72.9	82.2	36.4	536	34.9
DQ-26	4.15	2.2	0.215	16.2	43.7	40.2	24.1	302	11.1
DQ-27	4.22	1.8	0.209	9.99	34.1	28.5	17.4	301	7.8
DQ-28	5.79	2.5	0.237	9.67	39.7	43	24.3	422	11.6
DQ-29	6.11	2.8	0.409	22.5	52.5	89.3	27.3	455	15.4
DQ-30	6.51	2	1.34	26.3	38.1	230	25.9	302	10.7
DQ-31	4.38	2.6	0.388	17.3	50.3	45	26.7	336	15.6
DQ-32	5.73	2	0.209	11.6	34.6	27.9	21	238	7.9
DQ-33	4.87	2.7	0.234	25.2	63	38.9	24.2	377	12.4
DQ-34	4.94	2.3	0.207	18.8	42	31	20.5	241	7.4
DQ-35	5.78	1.9	0.223	35	49.4	35.5	18.2	274	9.5
DQ-36	4.7	3	0.326	25	55.3	316	34.2	368	26.8

**Table S9. Atmospheric Sediment Monitoring Results (Autumn and Winter)**

point location	Monitoring items							
	Cd mg/kg	Hg mg/kg	As mg/kg	Pb mg/kg	Cr mg/kg	Cu mg/kg	Zn mg/kg	Ni mg/kg
DQ-1	3.1	0.052	6.12	55.2	48.1	23.9	312	8.0
DQ-2	1.7	0.132	32.1	63.7	57.1	23.6	212	11.1
DQ-3	3.0	0.163	9.80	63.3	30.8	31.2	255	8.4
DQ-4	4.1	0.296	74.4	117	40.1	92.4	410	11.9
DQ-5	3.7	0.115	12.3	61.9	31.6	27.8	324	10.8
DQ-6	1.5	0.069	25.0	55.8	36.1	21.4	192	9.9
DQ-7	4.1	0.115	9.51	82.1	32.0	35.2	432	10.7
DQ-8	4.1	0.256	47.8	93.0	57.4	86.5	467	14.4
DQ-9	3.9	0.046	10.5	62.3	27.0	24.8	324	7.8
DQ-10	9.6	0.167	54.8	190	275	105	1290	75.8
DQ-11	3.8	0.114	47.4	82.1	46.5	49.4	459	15.8
DQ-12	5.9	0.201	88.5	117	55.5	56.6	736	23.4
DQ-13	10.0	1.21	44.7	227	115	102	1590	40.0
DQ-14	2.9	0.112	58.2	65.5	41.4	33.8	270	9.8
DQ-15	3.2	0.211	10.7	50.5	29.8	32.1	262	11.9
DQ-16	3.5	0.312	9.19	70.6	34.8	39.1	677	15.5
DQ-17	8.4	0.107	50.6	189	106	91.4	969	34.9
DQ-18	5.0	0.193	24.8	109	110	53.6	628	17.7
DQ-19	7.6	0.173	46.3	169	142	98.1	972	28.0
DQ-20	3.5	0.320	32.2	74.6	75.8	51.9	496	18.5
DQ-21	3.0	0.063	11.0	63.2	24.3	28.4	292	7.5
DQ-22	2.0	0.039	5.00	38.7	18.2	18.4	169	5.5
DQ-23	4.1	0.140	16.9	73.4	40.7	33.4	324	13.1
DQ-24	4.0	0.100	17.4	78.3	33.2	29.7	410	10.9
DQ-25	5.7	0.084	29.0	110	44.8	48.5	545	15.3
DQ-26	2.2	0.065	14.5	42.8	20.4	21.9	196	7.9
DQ-27	0.9	0.052	2.89	16.0	9.0	9.9	80.0	2.7
DQ-28	1.5	0.081	5.37	24.3	13.5	12.6	132	4.1
DQ-29	2.0	0.193	6.69	36.3	15.7	17.5	230	6.3
DQ-30	2.6	0.087	36.7	54.0	29.2	26.7	270	8.6
DQ-31	2.3	0.064	9.44	42.0	18.5	21.8	196	11.7
DQ-32	3.1	0.073	24.4	83.2	33.0	54.8	1010	9.1
DQ-33	4.2	0.080	38.8	98.5	43.1	38.0	613	14.2
DQ-34	3.7	0.066	15.0	74.4	30.3	37.0	309	12.7
DQ-35	2.7	0.062	27.5	82.6	46.2	32.1	323	25.8
DQ-36	2.2	0.219	25.1	52.5	30.2	24.1	278	9.3

**Table S10. Monitoring results of spring atmospheric deposition**

quarter	point location	dustfall content (t/km <sup>2</sup> 30d)
1	DQ1	1.15
1	DQ2	0.75
1	DQ3	1.05
1	DQ4	2.3
1	DQ5	5.4
1	DQ6	2.25
1	DQ6	6.35
1	DQ7	0.8
1	DQ8	6.7
1	DQ9	2
1	DQ10	1.65
1	DQ11	0.85
1	DQ12	0.75
1	DQ13	1.15
1	DQ14	0.85
1	DQ15	1.1
1	DQ16	1.7
1	DQ17	0.7
1	DQ18	0.75
1	DQ20	0.7
1	DQ21	4.55
1	DQ22	2.4
1	DQ23	2.35
1	DQ24	1.1
1	DQ25	2.7
1	DQ26	1.1
1	DQ27	1.95
1	DQ28	1.6
1	DQ29	1.5
1	DQ30	1.1
1	DQ31	2.5
1	DQ32	1.9
1	DQ33	2.65
1	DQ34	1.75
1	DQ35	5.3
1	DQ36	1.55

**Table S11. Monitoring results of summer atmospheric deposition**

quarter	point location	dustfall content (t/km <sup>2</sup> 30d)
2	DQ1	3.75
2	DQ2	3.7
2	DQ3	7.55
2	DQ4	4.3
2	DQ6	5
2	DQ7	9
2	DQ8	9.7
2	DQ9	6.2
2	DQ10	4.65
2	DQ11	3.35
2	DQ11	4.2
2	DQ12	5
2	DQ12	3.9
2	DQ13	3.95
2	DQ14	3.2
2	DQ15	2.95
2	DQ16	4.6
2	DQ17	4.65
2	DQ18	5.6
2	DQ19	1.05
2	DQ19	3.25
2	DQ20	34.1
2	DQ21	13.65
2	DQ22	5
2	DQ23	7.8
2	DQ24	3
2	DQ25	5.6
2	DQ26	5.7
2	DQ27	2.95
2	DQ28	3.6
2	DQ29	3.75
2	DQ30	7.1
2	DQ31	4.75
2	DQ32	5
2	DQ33	5.2
2	DQ34	3.85
2	DQ35	9.05
2	DQ36	4.35

**Table S12. Monitoring results of autumn atmospheric deposition**

quarter	point location	dustfall content (t/km <sup>2</sup> 30d)
3	DQ1	7.55
3	DQ2	2.35
3	DQ3	7
3	DQ4	7.25
3	DQ6	7.25
3	DQ7	6.4
3	DQ8	4.3
3	DQ9	4.55
3	DQ10	3.9
3	DQ11	10
3	DQ12	-
3	DQ13	3.45
3	DQ14	1.85
3	DQ15	2.8
3	DQ16	2.9
3	DQ17	11.3
3	DQ18	5.3
3	DQ19	8.2
3	DQ19	4.3
3	DQ20	11.95
3	DQ21	6.1
3	DQ22	5.45
3	DQ23	4.5
3	DQ24	2.65
3	DQ25	3.75
3	DQ26	5.55
3	DQ27	7.9
3	DQ28	5.75
3	DQ29	6.6
3	DQ30	7.45
3	DQ31	6.35
3	DQ32	8.05
3	DQ33	7.55
3	DQ34	5.5
3	DQ35	13.5
3	DQ36	8.35

**Table S13. Monitoring results of winter atmospheric deposition**

quarter	point location	dustfall content (t/km <sup>2</sup> 30d)
4	DQ1	1.95
4	DQ2	1.1
4	DQ3	0.6
4	DQ4	0.95
4	DQ6	1
4	DQ7	1.25
4	DQ8	0.7
4	DQ9	3.05
4	DQ10	1
4	DQ11	0.8
4	DQ12	2.5
4	DQ13	0.55
4	DQ14	0.5
4	DQ15	3
4	DQ16	1.95
4	DQ17	1.75
4	DQ18	0.9
4	DQ19	1.45
4	DQ19	0.85
4	DQ20	1.3
4	DQ21	3.5
4	DQ22	3.15
4	DQ23	1.3
4	DQ24	1.75
4	DQ25	1.35
4	DQ26	2.65
4	DQ27	1.95
4	DQ28	0.8
4	DQ29	1.25
4	DQ30	2.2
4	DQ31	1.75
4	DQ32	1.25
4	DQ33	2.65
4	DQ34	2.05
4	DQ35	3
4	DQ36	1.85

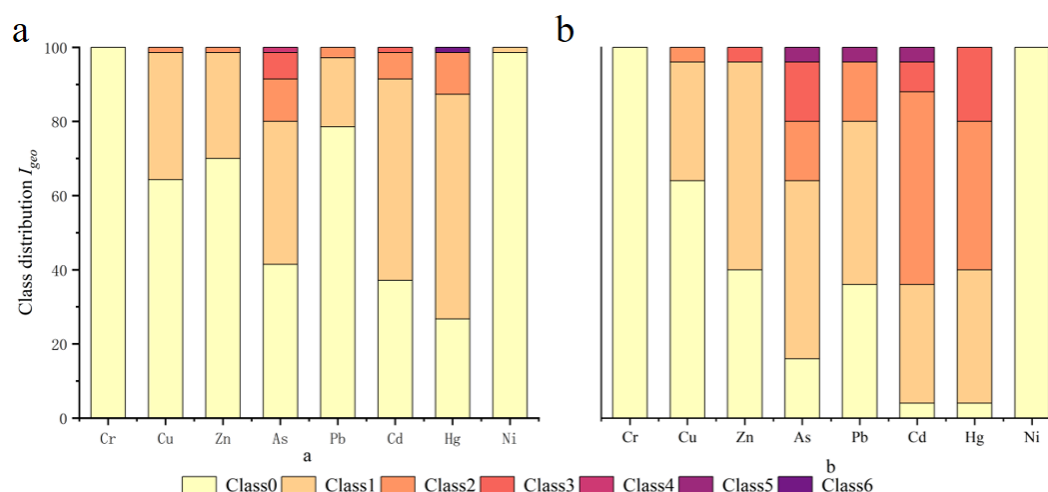
**Table S14. Descriptive statistics of heavy metal concentrations in soil, sediments, and irrigation channels**

		Cd	Hg	As	Pb	Cr	Cu	Zn	Ni
Agricultural soil	Mean	0.317	0.2655	26.646	58.9	76	45.6	86.5	14.5
	Median	0.345	0.18	19.95	56.5	78	24.5	76	14
	Maximum	0.54	0.758	91.7	111	92	249	134	21
	Minimum	0.1	0.153	8.53	39	58	14	55	7
	Std. deviation	0.12	0.18	24.71	21.53	12.85	71.72	24.19	5.08
	CV(%)	39.32	69.58	92.74	36.56	16.91	157.29	27.97	35.05
	Skewness	-0.1	2.507	2.366	1.679	-0.247	3.12	0.798	-0.01
	Kurtosis	0.341	6.807	6.338	3.573	-1.473	9.806	-0.043	-1.741
Sediment	Mean	0.762	0.1199 6	57.016	94.36	59.92	42.44	114.76	18.36
	Median	0.6	0.07	51.8	44	60	45	95	19
	Maximum	1.96	0.577	145	1000	91	77	337	30
	Minimum	0.16	0.03	11.5	13	40	14	42	8
	Std. deviation	0.46	0.13	38.61	195	11.04	20.99	66.36	5.69
	CV(%)	59.952	104.45 4	67.709	206.65 2	18.42	49.454	57.828	31.006
	Skewness	1.154	2.544	1.03	4.531	0.506	0.159	1.889	0.347
	Kurtosis	1.3641 936	7.0827 291	0.4173 582	21.514 001	1.3330 423	-1.335 295	4.2213 901	-0.319 597
Irrigation water	Mean	0	0.09	4.7208	0.1393 75	0.1833 333	3.7632	4.7552	0.7164
	Median	0	0.09	5.69	0.135	0.155	3.35	4.6	0.45
	Maximum	0	0.15	7.65	0.21	0.38	8.66	8.72	4.79
	Minimum	0	0.04	0.48	0.1	0.11	1.92	3.32	0.21
	Std. deviation	0	0.0287 849	2.4084 468	0.0302 145	0.0643 135	1.6595 826	1.1554 369	0.9707 938
	CV(%)	0	31.983 241	51.017 768	21.678 573	35.080 115	44.100 302	24.298 386	135.51 003
	Skewness	0	0.6012 764	-0.677 581	0.8968 279	1.4395 614	1.6781 644	1.6875 261	3.6932 648
	Kurtosis	0	0.5461 447	-1.006 979	0.7945 517	2.4108 849	2.5460 678	4.6264 198	14.131 554

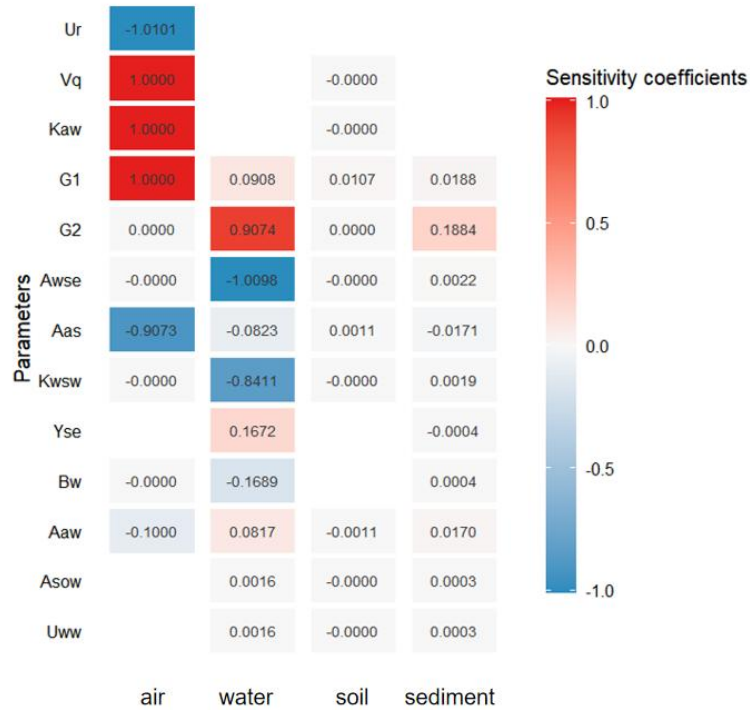
Note: Concentrations in soil and sediment are reported in mg/kg (dry weight). Concentrations in water are reported in mg/L.

**Table S15. Geo-accumulation index ( $I_{geo}$ ) class levels. (Charzyński et al., 2017).**

Class	$I_{geo}$ value	Soil quality
0	$I_{geo} \leq 0$	Practically unpolluted
1	$0 < I_{geo} \leq 1$	Unpolluted to moderately polluted
2	$1 < I_{geo} \leq 2$	Moderately polluted
3	$2 < I_{geo} \leq 3$	Moderately to heavily polluted
4	$3 < I_{geo} \leq 4$	Heavily polluted
5	$4 < I_{geo} \leq 5$	Heavily to extremely polluted
6	$5 < I_{geo}$	Extremely polluted



**Figure S1.  $I_{geo}$  class distribution of HMs in (a) soils and (b) sediments. Class 0–6 represent the  $I_{geo}$  categories: 0 = practically unpolluted ( $I_{geo} \leq 0$ ); 1 = unpolluted to moderately polluted ( $0 < I_{geo} \leq 1$ ); 2 = moderately polluted ( $1 < I_{geo} \leq 2$ ); 3 = moderately to heavily polluted ( $2 < I_{geo} \leq 3$ ); 4 = heavily polluted ( $3 < I_{geo} \leq 4$ ); 5 = heavily to extremely polluted ( $4 < I_{geo} \leq 5$ ); 6 = extremely polluted ( $I_{geo} > 5$ ).**



**Figure S2. Sensitivity coefficients and coefficients of variation of the level IV model.**  $U_r$  is the rainfall rate;  $V_q$  is the volume fraction of solids in the air;  $K_{aw}$  is the air-water partition coefficient;  $G_1$  and  $G_2$  is the air and water compartments advection input;  $A_{wse}$  is the surface area of contact between water and sediment compartments;  $A_{as}$  is the surface area of contact between air and soil compartments;  $K_{sw}$  is the mass transfer coefficient from the water phase to the sediment phase;  $Y_{se}$  is the diffusion path length in sediment;  $B_w$  is the molecular diffusivity in water;  $A_{aw}$  is the surface area of contact between air and water compartments;  $A_{sow}$  is the surface area of contact between soil and water compartments;  $U_{ww}$  is the soil runoff rate.

### References

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Charzyński P, Plak A, Hanaka A (2017). Influence of the soil sealing on the geoaccumulation index of heavy metals and various pollution factors. *Environmental Science and Pollution Research*, 24(5): 4801-4811