Supplementary materials

Title: Pollution and risk assessments of priority heavy metal(loid)s in the soil around lead-zinc smelteries via data integration analysis

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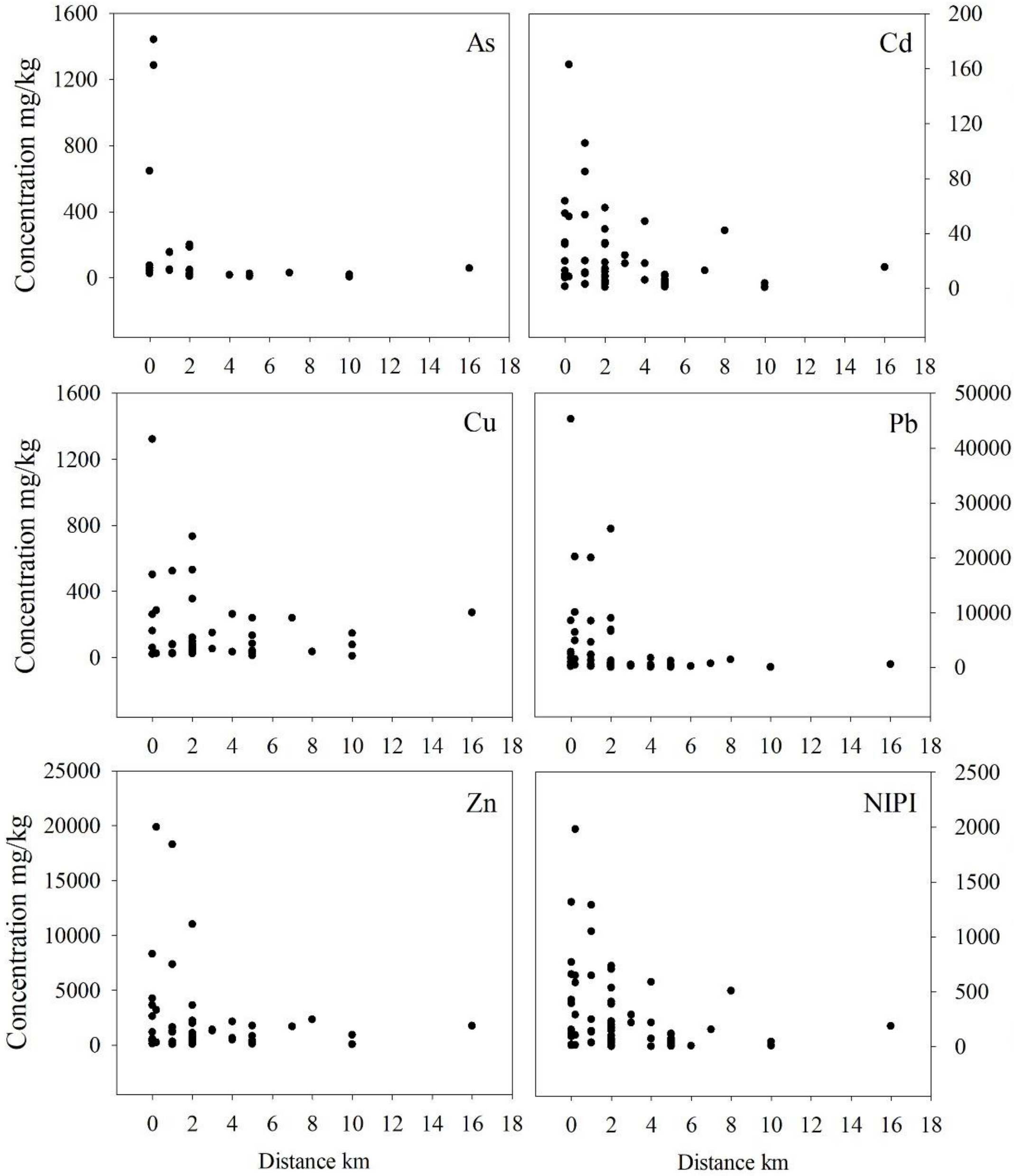

Figure S1 Heavy metal(loid) concentrations/NIPI in soils with varied sampling radius from Pb-Zn smelteries among the studies.

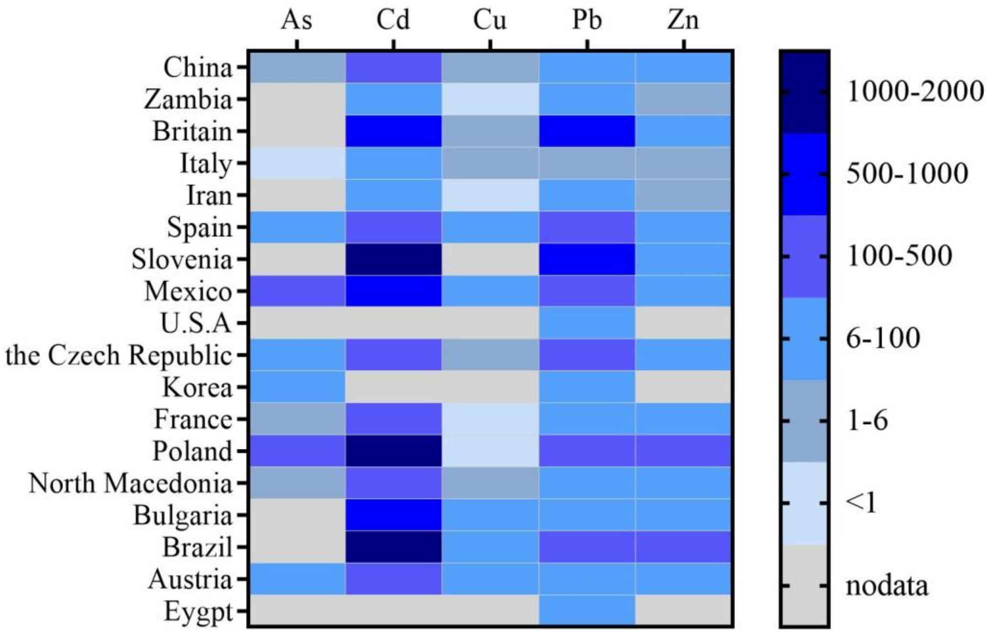

Figure S2 Heat maps of PI[b] mean values in soils near Pb-Zn smelteries among various countries.

Table S1 Literature information on heavy metal(loid) concentrations in soils near Pb-Zn smelteries globally.

Countary	City	Landuse[a]	n[b]	depth[c]	range[d]	Concentrations（mg/kg）					Reference
						As	Cd	Cu	Pb	Zn	
China	Chongqin	3	8	20	1	26.37	33.47		8528		**Zhang et al., 2018**
China	Guizhou	3	14	10	1		9.6		234	400	**Lin et al., 2009**
China	Hunan	3	9	20	1		31.89	1321	946.8	2625	**Deng et al., 2015**
China	Shanxi	3	13	10	1	43.49	63.48	260.6	2509	4244	**Liu et al., 2014**
China	Shanxi	3	9	20	1		12.72	59.14	412	556	**Liu et al., 2019**
China	Yunnan	3	4	20	1	646			2830	8304	**Ma et al., 2019**
China	Guizhou	2	22	10	1				20185		**Liu et al., 2007**
China	Guizhou	2	12	10	1				1005		**Liu et al., 2007**
China	Guizhou	2	26	10	1				453		**Liu et al., 2007**
China	Gansu	2	7	10	1		2.82	27.23	205	84.7	**Hu et al., 2015**
China	Gansu	1	4	10	1		3.06	26.88	261	67.9	**Hu et al., 2015**
China	Guangdong	2	17	20	1	44.83	2.77		211		**Luo, 2016**
China	Guangxi	2	22	5	1		11.4	21.49	532	320	**Cui et al., 2004**
China	Henan	2	20	20	1		4.96		332		**Xing et al., 2019**
China	Shanxi	2	20	20	1				58.1	115	**Liu et al., 2015**
China	Shanxi	2	17	20	1	13.3	0.7	26.9	35.2	98.6	**Xu et al., 2013**
China	Henan	2	33	20	1		5.59	23.2	144	89.6	**Gao et al., 2012**
China	Shanxi	5	15	20	1		58.5	45.3	256	3621	**Xiao et al., 2018**
China	Shanxi	5	76	20	1			31.8	41.3	102.6	**Wang et al., 2012**
China	Hunan	2	50	20	1	45.4	14.3	77.3	499	1048.3	**Li et al., 2011**
China	Hunan	1	3	20	1	24	4.1	31	209	244	**Li et al., 2011**
China	Hubei	2	101	20	2				62		**Zhou et al., 2016**
China	Fujian	5	25	20	2			84.2	1219	824	**Chen et al., 2012**
China	Shanxi	2	27	10	2	15.8	0.95	30.8	53.5	118	**Liu et al., 2015**
China	Yunnan	2	75	20	2		1.6	132	250	412	**Li et al., 2013**
China	Yunnan	2	346	20	2	25	9.1	239	512	1760	**Wu et al., 2018**
China	Yunnan	2	27	20	2	20	3.61	146	87	923	**Liu et al., 2016**
China	Yunnan	2	15	20	2	57.1	15.4	271.7	565.6	1745.1	**Liu et al., 2016**
China	Henan	2	68	20	2		3.29	31.8	184	99.2	**Xing et al., 2019**
China	Guizhou	5	7	10	2		18	52	520	1300	**Bi et al., 2006**
China	Guizhou	5	11	10	2		24	150	260	1400	**Bi et al., 2006**
China	Guizhou	5	8	10	1		43	120	9000	11000	**Bi et al., 2006**
China	Yunnan	5	23	20	2	29.9	12.8	239	712	1688	**Li et al., 2015**
Zambia	Kabwe	3	14	15	1		7.69	19.7	271.7	110.95	**Tembo et al., 2006**
Zambia	Kabwe	3	27	15	2		4.218	12.71	232.7	100.8	**Tembo et al., 2006**
Britain	Avonmouth	2	5	15	1		54.5	161	1704	3630	**Nahmani et al., 2007**
Britain	Derbyshire	3	9	15	1		19.7		45272	1173	**Li and Thornton, 2001**
Italy	Villadossola	1	18	20	2	5.15	0.63	76.87	45	75.5	**Gallini et al., 2018**
Iran	Zanjan	1	272	10	2		1.7	11.7	147.3	157.1	**Jamal et al., 2018**
Iran	Zanjan	1	21	20	2		9.82	24.8	302	311	**Ghayoraneh and Qishlaqi, 2017**

Spain	Iberian Peninsula	1	34	20	1	48.4	8.47	733	6597	424.14	**Cortada et al., 2018**
Spain	Iberian Peninsula	3	8	20	1	201	32.9	530	6877	718	**Cortada et al., 2018**
Slovenia	Žerjav	1	8	20	1		84.8		19993	1632	**Vidic et al., 2006**
Mexico	Monterrey	3	12	20	1	1442	52.1	285.4	6413	3199.7	**Gutiérrez-Ruiz et al., 2012**
U.S.A	Glover	1	4	25	1				388.4		**Prapaipong et al., 2008**
U.S.A	Glover	1	8	25	2				221.3		**Prapaipong et al., 2008**
Czekh	Pribram	2	61	5	1	153	10.6	77	2225	1180	**Rieuwerts et al., 1997**
Czekh	Pribram	2	19	5	1	156	11.4	80	2361	1237	**Rieuwerts et al., 2000**
Czekh	Trzyniec	2	1229	20	2	8.84	0.8	8.47	39.8	62.47	**Loska et al., 2004**
Czekh	Pribram	1	8	23	1	186	9.185	354.5	25270	358.5	**Komarek et al., 2007**
Korea	Chungcheongnam-do	3	153	20	1	74.5			196.9		**Kim et al., 2019**
France	Limoges	3	3	20	1		8.4	24.4	1515	244	**Michalkova et al., 2014**
France	Auby	4	26	20	1		53.4		1300	7357	**Dumoulin et al., 2017**
France	Mortagne	2	10	25	1		5.71		362.8		**Douay et al., 2007b**
France	Mortagne	4	10	25	1		2.64		323.23		**Douay et al., 2007b**
France	Calais	2	15	25	1	25.79	18.85	96.24	1274	2220	**Douay et al., 2007a**
France	Calais	4	12	25	1	21.16	13.88	73.96	880	1987	**Douay et al., 2007a**
France	Viviez	2	4	20	2					392	**Sivry et al., 2008**
France	Lille	2	31	20	2	16.2	18.07	33.8	522.7	644.6	**Sterckeman et al., 2002**
France	Lille	2	15	20	1	8.7	8.25	23.4	167.2	971	**Sterckeman et al., 2002**
France	Calais	2	36	25	2		5.9		279	486	**Pelfrene et al., 2011**
Poland	Piekary Slaskie	2	20	15	1	1286	163		4876	19859	**Siebielec et al., 2018**
Poland	Olkusz	1	12	10	2		42.03	34.6	1414	2333	**Tosza et al., 2010**
North Macedonia	Veles	4	54	5	1	13	12	52	340	460	**Stafilov et al., 2010**
North Macedonia	Veles	3	43	5	1	15	32	69	800	1100	**Stafilov et al., 2010**
North Macedonia	Veles	2	79	5	2	7.8	6.1	38	170	210	**Stafilov et al., 2010**
North Macedonia	Veles	1	26	5	2	11	4.8	41	140	180	**Stafilov et al., 2010**
Bulgaria	Kuklen	5	50	20	2		48.67	262	1738	2138	**Bacon and Dinev, 2005**
Brazil	Bahia	3	8	20	1		105	523	8472	18276	**Niemeyer et al., 2010**
Austria	Styria	2	4	30	1	59	1.24	502	347.5		**Jelecevic et al., 2019**
Austria	Arnoldstein	2	36	15	1	49.8	20	76.6	4609	1292	**Friesl et al., 2006**
Eygpt	Cairo	4	9	2	1				458		**Menrath et al., 2015**

[a] Land use are divided into five categories， 1 refers to forest land， 2 refers to farmland ,3 refers to smelting production area,4 refers to living area,5 refers to soil sround the smelting site

[b] Number of sampling points

[c] Depth(cm) of sampling points

[d] The trace metal concentrations in soils surrounding global lead and zinc smelter are divided into two ranges: 1 refers to 0-2 km ,2 refers to 0-20 km.

Table S2 Classification of the geo-accumulation index for soil pollution.

Class	Value	Soil quality
0	$I_{geo} \le 0$	Practically uncontaminated
1	$0 \le I_{geo} < 1$	Uncontaminated to moderately contaminated
2	$1 \le I_{geo} < 2$	Moderately contaminated
3	$2 \le I_{geo} < 3$	Moderately to heavily contaminated
4	$3 \le I_{geo} < 4$	Heavily contaminated
5	$4 \le I_{geo} < 5$	Heavily to extremely contaminated
6	$I_{geo} \ge 5$	Extremely contaminated

Table S3 Soil environment standard values in different countries.

Country	Standard value of each land type	Standard value	The purpose of risk prevention and control	Source
China	Farmland	Screening Levels	Quality and safety of agricultural products	**MEEPRC, 2018a**
China	Living Area/Industrial Area	Screening Levels	Human health	**MEEPRC, 2018b**
Canada	Farmland/Living Area/ Industrial Area	Soil Quality Guidelines	Human health / Environmental health	**CCME, 2001**
Belgium	Farmland / Living Area / Industrial Area /Forest	Trigger Levels	Groundwater security	**Halen et al., 2004**
Japan	Farmland	Pollution Indicators	Quality and safety of agricultural products	**Zhang et al., 2020**
Czech	Farmland	Pollution Indicators	Quality and safety of agricultural products	**Zhang et al., 2020**
New Zealand	Living Area / Industrial Area	Pollution Indicators	Human health	**NZME, 2011**
U.S.A	Forest	Screening Levels	Ecological risks of terrestrial plants	**USEPA, 2005**
U.S.A	Living Area	Screening Levels	Groundwater security	**USEPA, 2001**
U.S.A	Industrial Area	Screening Levels	Groundwater security	

Table S4 Classification of pollution index (PI) and Nemerow integrated pollution index (NIPI).

Class	Value	Soil quality	Value	Soil quality
0	PI ≤ 1	low degree	NIPI ≤ 0.7	Safe
1	1 ≤ PI < 3	moderate degree	0.7 ≤ NIPI < 1	Precaution
2	3 ≤ PI < 6	considerable degree	1 ≤ NIPI < 2	Slight Pollution
3	PI ≥ 6	very high degree	2 ≤ NIPI < 3	Moderate Pollution
4			NIPI ≥ 3	Heavy Pollution

Table S5 Classification of potential ecological pollution index (ER/RI).

Class	Value	Value	Soil quality
0	ER ≤ 40	RI ≤ 98	none
1	40 ≤ ER < 80	98 ≤ RI < 196	general
2	80 ≤ ER < 160	196 ≤ RI < 392	moderate
3	160 ≤ ER < 320	RI ≥ 392	high
4	ER ≥ 320		very high

Table S6 Correlation analysis of trace metal concentrations in soils around Pb-Zn smelteries.

	As	Cd	Cu	Pb	Zn
As	1	0.835**	0.926**	0.795**	0.922**
Cd		1	0.903**	0.981**	0.973**
Cu			1	0.890**	0.941**
Pb				1	0.954**
Zn					1

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