

Supplementary Table

Table S1. The results for the GSS-1 standard soil sample and a blank sample.

Measurement batch	Element VIS	Mass	ISTD	CPS	Conc.(mg/kg)	RSD(%)	Time(sec)	Rep
GSS-1(a)	Cr	53	103	0.1123062M	76.33	4.39	0.3	3
	Ni	60	103	0.06333884P	21.24	4.85	0.3	3
	Cu	63	103	0.1227121M	20.79	4.46	0.3	3
	Zn	66	---	0.9860815A	447.4g	4.34	0.3	3
	Ge	72	72	1086014A	[1.000]	---	0.3	3
	As	75	---	0.2941305P	28.99	6.62	0.3	3
	Rh	103	---	6988909A	[1.000]	---	0.3	3
	Cd	111	103	0.006485183P	3.142	3.13	0.3	3
	In	115	---	8030326A	[1.000]	---	0.3	3
	Pb	208	115	1.234288A	72.23	4	0.3	3
GSS-1(b)	Cr	53	72	1.461278P	135.7	5.43	0.3	3
	Ni	60	72	0.5278766P	21.56	5.28	0.3	3
	Cu	63	72	1.245618P	22.59	5.63	0.3	3
	Zn	66	72	5.335753P	337.6	3.85	0.3	3
	Ge	72	---	142218.8P	[1.000]	---	0.3	3
	As	75	72	0.4808808P	38.87	4.8	0.3	3
	Rh	103	---	849179.8P	[1.000]	---	0.3	3
	Cd	111	103	0.008941508P	3.875	3.62	0.3	3
	In	115	---	1190804A	[1.000]	---	0.3	3
	Pb	208	72	22.71698A	134	4.37	0.3	3
GSS-1(c)	Cr	53	72	1.443051P	140.7	0.8	0.3	3
	Ni	60	72	0.5213098P	23.05	0.36	0.3	3
	Cu	63	72	1.434594P	25.7	0.73	0.3	3
	Zn	66	103	0.9743055P	557.8	2.01	0.3	3
	Ge	72	---	143297.7P	[1.000]	---	0.3	3
	As	75	72	0.5110867P	42.83	1.18	0.3	3
	Rh	103	---	861566.1P	[1.000]	---	0.3	3
	Cd	111	103	0.009860151P	4.31	7.99	0.3	3
	In	115	---	1208622A	[1.000]	---	0.3	3
	Pb	208	72	20.75197A	96.4	1.03	0.3	3
GSS-1(d)	Cr	53	72	1.395075P	149.5	1.66	0.3	3
	Ni	60	72	0.3865449P	19.39	1.6	0.3	3
	Cu	63	72	1.279008P	26.55	2.08	0.3	3
	Zn	66	72	4.555682A	316.2	1.4	0.3	3
	Ge	72	---	285468.3P	[1.000]	---	0.3	3
	As	75	72	0.3677151P	48.53	0.88	0.3	3
	Rh	103	---	1689086A	[1.000]	---	0.3	3
	Cd	111	72	0.04488992P	3.05	2.42	0.3	3

GSS-1(e)	In	115	---	2141532A	[1.000]	---	0.3	3
	Pb	208	72	15.07822A	144.2	0.84	0.3	3
	Cr	53	72	1.567618P	130.3	1.96	0.3	3
	Ni	60	72	0.4314035P	18.36	3.41	0.3	3
	Cu	63	72	1.44839P	25.08	2.48	0.3	3
	Zn	66	72	5.124125A	322.2	1.26	0.3	3
	Ge	72	---	257222.9P	[1.000]	---	0.3	3
	As	75	72	0.4227348P	37.34	1.19	0.3	3
	Rh	103	---	1450864A	[1.000]	---	0.3	3
	Cd	111	72	0.0483758P	2.914	2.81	0.3	3
GSS-1(f)	In	115	---	1201871A	[1.000]	---	0.3	3
	Pb	208	72	17.36652A	99.89	3.21	0.3	3
	Cr	53	72	0.8907699P	117.3	3.35	0.3	3
	Ni	60	72	0.3515646P	20.9	2.88	0.3	3
	Cu	63	72	0.8941855P	20.42	3.7	0.3	3
	Zn	66	72	4.125449A	337.1	3.36	0.3	3
	Ge	72	---	670699.8P	[1.000]	---	0.3	3
	As	75	72	0.304971P	39.26	2.81	0.3	3
	Rh	103	---	4134823A	[1.000]	---	0.3	3
	Cd	111	103	0.005669929P	3.623	2.69	0.3	3
Blank-1(a)	In	115	---	5019341A	[1.000]	---	0.3	3
	Pb	208	72	9.729826A	100	3.1	0.3	3
	Cr	53	72	0.8216197P	0.1138	1.59	0.3	3
	Ni	60	72	0.03163745P	0.001883	2.2	0.3	3
	Cu	63	72	0.3303213P	0.007334	1.76	0.3	3
	Zn	66	103	0.01713481P	0.01253	2.65	0.3	3
	Ge	72	---	204125.7P	[1.000]	---	0.3	3
	As	75	72	0.2058558P	0.02428	1.34	0.3	3
	Rh	103	---	1860969A	[1.000]	---	0.3	3
	Cd	111	103	3.256904E-4P	0.00007019	1.2	0.3	3
Blank-1(b)	In	115	---	2252042A	[1.000]	---	0.3	3
	Pb	208	72	0.2876512P	0.002933	4.39	0.3	3
	Cr	53	72	0.8216197P	0.1155	1.62	0.3	3
	Ni	60	72	0.03163745P	0.001742	2.37	0.3	3
	Cu	63	72	0.3303213P	0.00744	1.94	0.3	3
	Zn	66	72	0.1561875P	0.01145	2.53	0.3	3
	Ge	72	---	204125.7P	[1.000]	---	0.3	3
	As	75	72	0.2058558P	0.02519	1.34	0.3	3
	Rh	103	---	1860969A	[1.000]	---	0.3	3
	Cd	111	103	3.256904E-4P	0.0001028	1.03	0.3	3
Blank-1(c)	In	115	---	2252042A	[1.000]	---	0.3	3
	Pb	208	72	0.2876512P	0.004138	4.25	0.3	3
	Cr	53	72	0.7443076P	0.09796	5.85	0.3	3
	Ni	60	72	0.02055587P	0.001269	4.56	0.3	3

Blank-1(d)	Cu	63	72	0.3841288P	0.008827	0.79	0.3	3
	Zn	66	72	0.1084283P	0.009099	5.52	0.3	3
	Ge	72	---	546400.8P	[1.000]	---	0.3	3
	As	75	72	0.1470554P	0.02034	6.47	0.3	3
	Rh	103	---	3882557A	[1.000]	---	0.3	3
	Cd	111	72	0.002934154P	0.0003153	8.75	0.3	3
	In	115	---	4497101A	[1.000]	---	0.3	3
	Pb	208	72	0.1570679P	0.002927	2.01	0.3	3
	Cr	53	72	0.3858697P	0.05115	5.32	0.3	3
	Ni	60	72	0.01691905P	0.001024	3.65	0.3	3
	Cu	63	72	1.390290P	0.03787	3.42	0.3	3
	Zn	66	72	0.1702965P	0.01526	3.81	0.3	3
	Ge	72	---	541436.2P	[1.000]	---	0.3	3
	As	75	72	0.08443311P	0.01158	4.77	0.3	3
	Rh	103	---	4119793A	[1.000]	---	0.3	3
Blank-1(e)	Cd	111	72	9.985797E-4P	0.0001329	1.66	0.3	3
	In	115	---	4730208A	[1.000]	---	0.3	3
	Pb	208	72	0.07445747P	0.002185	1.2	0.3	3
	Cr	53	72	0.4623221P	0.0689	4.67	0.3	3
	Ni	60	72	0.08591155P	0.00593	5.77	0.3	3
	Cu	63	72	0.1742320P	0.004016	1.77	0.3	3
	Zn	66	72	0.1441002P	0.01248	4.28	0.3	3
	Ge	72	---	202087.6P	[1.000]	---	0.3	3
	As	75	72	0.09747890P	0.0179	5.14	0.3	3
	Rh	103	---	1725410A	[1.000]	---	0.3	3
	Cd	111	72	6.36600E-4P	0.00005514	1.01	0.3	3
	In	115	---	2187218A	[1.000]	---	0.3	3
	Pb	208	72	0.1168152P	0.001861	2.61	0.3	3
	Cr	53	103	0.03282658P	0.03506	1.16	0.3	3
	Ni	60	103	0.002728192P	0.001337	1.49	0.3	3
Blank-1(f)	Cu	63	103	0.01515849P	0.001197	1.71	0.3	3
	Zn	66	103	0.01313438P	0.007839	0.56	0.3	3
	Ge	72	---	464003.8P	[1.000]	---	0.3	3
	As	75	103	0.009878991P	0.01081	2.55	0.3	3
	Rh	103	---	3577919A	[1.000]	---	0.3	3
	Cd	111	103	7.76226E-05	0.0006056	0.81	0.3	3
	In	115	---	4250361A	[1.000]	---	0.3	3
	Pb	208	103	0.01166926P	0.001204	1.66	0.3	3

Table S2. Vegetation indices derived from Landsat 8 OLI image.

Vegetation index	Calculation formula	Reference
CI	$b6/b7$	[28]
CAI	$b4/b3$	[29]
SAVI	$(b5-b4)(1+L)/(b5+b4+L)$, where $L=0.5$	[30]
NDVI	$(b5-b4)/(b5+b4)$	[31]

Table S3 Studies on farming practices for soil heavy metals.

Study area	Heavy metals	Data acquisition	The influence of farming practices	Reference
Ghaziabad, India	Ni, Cu, Cr, Pb, Cd, Zn, Fe and Mn	Two different soil sites were selected: wastewater irrigated soil, and ground water irrigated soil	Irrigation of soils with wastewater contributes to the deposition of toxic metals in agriculturally important and other crops, which eventually causes toxicity to humans and grazing animals via food chain.	[85]
Hunan province, China	Pb, Cd, Cr, As, Hg and Cu	Pot experiment: five silicon fertilizer treatments	The regulation of soil pH, EC and available-K were part of the approaches for silicon fertilizer to promote growth of pakchoi vegetable under the pressure of heavy metals and had a significant influence on bacterial community structure.	[86]
A farm from Al Shati province which is located in the southern west part of Libya	Cr, Cu, Cd, Mn, Zn, Ni, Fe and Pb	A total of six samples were collected each from urea and diammonium phosphate fertilizers and four samples from irrigation water	Chemical fertilizers such as NPK which are added as a source of nitrogen, phosphorous and potassium may contain some HMs (Cd, As, Cr, Ni, and Pb) as impurities. Application of excessive amounts of chemical fertilizers and poultry manures can also increase levels of HMs such as Cd, Cu, Zn and Pb in soils and subsequently in plants.	[87]
A farmland in Dongfang City, Hainan Province, China	Cd, Cr and Pb	Pot incubation experiments and field plot experiment: seaweed organic fertilizer	In the field experiment, combined amendments (seaweed organic fertilizer-apatite-biochar) improved soil quality, enhanced nutrient concentrations, reduced soil Cd and Cr bioavailability, reduced plant Cd, Pb, and Cr uptake, and enhanced maize production.	[88]
A 36 m ² piece of agricultural land near Kermanshah's wastewater treatment facility	Fe, Mn, Cu, Zn, As, Pb, Cd, Ni and Cr	Three kinds of irrigation sources	Overuse of fertilizers can increase metals like Cd, Pb, and Zn in the soil, and agricultural products are grown. Since various industrial wastewater in treated and untreated (containing high levels of As and Pb) were used to irrigate the cultivation site, the metals mentioned can be transferred to the soil and contaminate the soil.	[89]