Supplementary Materials

Table S1. Basic concentration of metals in the Earth's crust [36].

Metal	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb
Concentration (mg/kg)	47200	850	95	45	90	68	0.3	20

Table S2. Toxic-response factor values of toxic metals by Hakanson [51].

Metal	Fe	Mn	Zn	Cu	Cd	Pb	Ni	Cr
Toxic-response factor	1	1	1	5	30	5	5	2

Table S3. Physicochemical parameters of the water of Lake Gusinoe basin.

Site	Temperature (°C)				pH				Turbidity, NTU				Mineralization (mg/L)				DO (mg/L)			
	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut	Win	Spr	Sum	Aut
WHO	25-30				6.5-8.5				5				600				>5.0			
MAC	—				6.5-8.5				—				1000				>4-6			
Tsagan-gol	—	12.2	13.0	14.0	—	7.7	7.32	7.61	—	1.59	4.88	1.2	—	107.8	74.5	112.8	—	9.6	8.62	9.84
Tsagan-gol mouth	0.1	11.5	17.9	20.4	7.31	8.16	7.49	8.71	4.28	4.32	3.18	4.14	611.5	329.1	98.2	117.3	3.92	9.81	4.35	13.57
Zagustai	—	8.7	16.3	16.6	—	7.48	7.57	8.14	—	4.98	4.05	9.91	—	162.7	320.8	882.7	—	7.99	6.61	11.57
Tel	—	3.4	12.6	11.8	—	7.32	7.56	7.73	—	31.5	13.2	6.73	—	58.6	90.0	95.6	—	10.16	9.0	10.69
Bayan-gol	0.2	11.5	20.0	12.3	8.25	8.1	7.43	7.61	1.58	1.61	1.48	1.63	396.2	331.8	341.5	387.2	13.53	9.67	4.51	5.56
GRES water intake	0.5	5.6	14.0	15.5	8.31	8.26	8.24	8.47	1.42	2.0	1.11	1.34	379.2	353.6	335.0	334.9	12.59	10.92	8.88	9.89
GRES discharge	12.0	14.9	22.3	22.0	8.25	8.26	8.3	8.6	2.27	3.26	1.89	1.8	377.6	356.0	324.2	341.4	11.01	9.86	8.71	10.48
8	0.1	10.9	20.0	18.5	8.04	8.36	8.45	8.86	0.98	3.86	3.21	10.7	387.6	352.1	323.9	312.1	13.77	10.71	8.78	15.21
9	0.1	9.4	20.1	17.0	8.27	8.19	8.39	8.44	0.67	7.88	1.78	2.72	391.6	362.6	328.2	338.5	13.64	10.22	8.91	11.12
10	0.1	9.2	19.7	18.5	8.27	8.3	8.36	8.55	1.07	5.38	7.54	3.75	391.2	353.8	330.3	328.6	13.38	11.0	8.78	13.86
11	0.1	7.2	19.7	17.6	8.24	8.28	8.53	8.56	0.41	2.47	1.65	7.37	377.8	351.5	331.4	328.3	13.85	11.69	11.69	12.7
12	0.1	10.5	23.0	17.5	8.25	7.73	8.48	8.86	1.16	6.67	5.19	2.92	387.1	270.0	335.2	342.1	13.54	7.35	10.87	12.92
13	0.1	6.2	22.6	14.6	8.18	8.15	8.63	8.31	1.06	2.81	2.51	4.4	386.2	355.9	333.1	331.6	14.02	10.81	10.7	9.14
14	0.1	7.4	22.2	13.6	8.29	8.15	8.31	8.09	1.49	9.43	1.96	16.8	393.1	335.1	334.3	348.1	14.24	10.69	8.68	9.84
15	0.1	8.5	20.7	13.2	8.22	8.18	8.41	8.08	2.2	8.13	2.0	15.9	396.2	332.2	326.9	337.0	14.25	10.17	8.28	9.8
16	0.1	7.9	20.2	12.5	8.11	8.17	8.3	8.33	1.16	1.31	1.03	1.98	375.3	342.1	336.4	334.7	13.19	10.32	8.57	10.06
17	0.1	8.6	20.0	12.9	8.2	8.25	8.37	8.4	0.56	1.85	1.02	1.29	383.4	348.8	329.5	341.2	13.48	9.68	8.38	10.2
18	0.1	6.9	19.6	13.2	8.2	8.19	8.03	8.21	0.93	1.96	1.18	1.34	383.4	325.8	331.4	329.3	13.30	10.86	9.0	10.65

Note: WHO - World Health Organization 2004 [75]; MAC - Russian National Standard [76]

Table S4. HMs concentrations in the surface waters of Lake Gusinoe and its tributaries.

Site	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb
WHO	300	100	4000	2000	50	70	3	10	300	100	4000	2000	50	70	3	10
MAC	100	10	10	1	20	10	5	6	100	10	10	1	20	10	5	6
	In winter								**In spring**							
Tsagan-gol	—	—	—	—	—	—	—	—	33.8	19.4	5.1	0.4	1.6	—	0.1	0.1
Tsagan-gol mouth	14.9	51.5	5.3	1.1	6.0	0.1	0.1	0.1	22.1	17.0	1.3	0.8	2.5	0.1	0.1	0.1
Zagustai	—	—	—	—	—	—	—	—	147.5	11.4	7.6	1.5	18.0	0.5	0.1	0.1
Tel	—	—	—	—	—	—	—	—	244.8	7.9	4.8	1.2	1.8	0.8	0.1	0.1
Bayan-gol	1.2	1.7	0.6	1.2	3.2	0.1	0	0	12.6	11.9	0.8	0.8	3.0	0.3	0.1	0.1
GRES water intake	5.7	4.1	5.1	1.2	3.0	0.1	0.1	0.1	78.0	1.5	4.6	1.3	3.2	0.1	0.1	0.1
GRES discharge	22.2	6.9	5.6	2.8	3.0	0.1	0.1	0.1	12.3	1.3	5.0	2.2	2.8	0.1	0.1	0.1
Mean±SD	11.00±9.39	16.05±23.73	4.15±2.38	1.58±0.82	3.80±1.47	0.10±0.00	0.08±0.05	0.08±0.05	78.73±87.86	10.06±7.01	4.17±2.36	1.17±0.59	4.70±5.89	0.32±0.29	0.10±0.00	0.10±0.00
8	5.4	2.3	1.7	1.1	2.9	0.1	0.1	0.1	13.5	72	1	0.7	2.5	0.2	0.1	0.1
9	7	11.2	1.2	1.1	2.3	0.1	0.1	0.1	10.5	3.8	5.7	1	2.9	0.5	0.1	0.1
10	7.6	6.6	0.2	1.1	2.4	0.1	0.1	0.1	9.8	2	1	0.7	2.9	0.1	0.1	0.1
11	51	5.1	0.5	1.1	3.2	0.1	0.1	0.1	10.8	2.8	4.3	1.2	2.6	0.1	0.1	0.1
12	7.8	5.3	1.7	0.9	2.7	0.1	0.1	0.1	3.6	25.1	2	0.8	2.1	0.6	0.1	0.1
13	11.9	3.9	1.6	1.2	3.6	0.1	0.1	0.1	12.8	1.8	1.5	1.1	2.9	0.1	0.1	0.1
14	10.8	7.1	6.4	2.1	3.2	0.1	0.1	0.1	11.5	5.3	3.2	1.2	2.5	0.2	0.1	0.1
15	10.4	1.8	0.5	1.5	3.6	0.1	0.1	0.1	7.7	3.8	1.1	0.7	2.5	0.1	0.1	0.1
16	7.1	4.2	0.8	1.2	3.3	0.1	0.1	0.1	9.8	4.2	0.9	0.7	2.4	0.1	0.1	0.1
17	10.5	2.3	3.6	1.3	2.6	0.1	0.1	0.1	10.9	4	2.5	1.1	2.7	0.1	0.1	0.1
18	45.7	37.4	5.2	1.3	3.8	0.1	0.1	0.1	11.5	2.4	1.8	1.1	2.8	0.1	0.1	0.1
Mean±SD	15.93±16.20	7.93±10.14	2.13±2.05	1.26±0.32	3.05±0.51	0.10±0.00	0.10±0.00	0.10±0.00	10.22±2.69	11.56±21.11	2.27±1.55	0.94±0.22	2.62±0.25	0.20±0.18	0.10±0.00	0.10±0.00

Table S4 (continued).

Site	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb
WHO	300	100	4000	2000	50	70	3	10	300	100	4000	2000	50	70	3	10
MAC	100	10	10	1	20	10	5	6	100	10	10	1	20	10	5	6
	In summer								**In autumn**							
Tsagan-gol	44.1	12.8	1.7	0.8	0.9	0.2	0.1	0.1	23.1	14.9	0.1	0.7	0.6	0.1	0.1	0.1
Tsagan-gol mouth	69	3.1	5.5	0.6	1.0	0.5	0.1	0.1	17.6	3.7	0.1	0.7	0.9	0.1	0.1	0.3
Zagustai	130.9	25.8	2.6	0.2	1.5	0.1	0.1	0.1	13.3	57.5	8.6	0.8	4.8	0.2	0.1	0.1
Tel	202.7	20.7	3.1	0.3	1.5	0.7	0.1	0.1	179.9	32.6	6.5	1.0	1.2	0.3	0.1	0.1
Bayan-gol	117.3	7.8	7.4	0.6	1.7	0.1	0.1	0.1	42.1	12.5	1.2	0.9	1.7	0.1	0.1	0.1
GRES water intake	15.2	2.2	33.9	0.7	2.2	0.1	0.1	0.1	4.2	3.1	6.8	1.4	1.3	0.1	—	—
GRES discharge	6.9	2.2	21.2	1.4	1.4	0.3	0.1	0.1	5.3	2.8	5.5	1.9	1.4	0.5	0.1	0.1
Mean±SD	83.73±70.58	10.66±9.51	10.10±12.18	0.66±0.39	1.46±0.44	0.29±0.23	0.10±0.00	0.10±0.00	40.79±62.66	18.16±20.29	4.11±3.55	1.06±0.44	1.70±1.41	0.20±0.15	0.10±0.00	0.13±0.08
8	17.3	2.1	2.4	0.2	1.9	1.1	0.1	0.1	14.6	2.9	1.1	0.8	1.4	0.2	0.1	2
9	12.9	2	5.4	0.5	1.7	0.4	0.1	0.1	7.3	5.8	2.3	1.4	1.1	0.1	0.1	0.1
10	10.6	2.3	2.1	0.7	1.9	0.1	0.1	0.1	4.6	2.9	0.1	1.1	1.5	0.1	0.1	0.1
11	9.7	2.1	2.6	0.7	1.3	0.1	0.1	0.1	3.3	2.6	1.9	1.2	1.2	0.1	0.1	0.1
12	8.3	2.3	1.6	0.2	1.3	0.2	0.1	0.2	2.9	2.6	0.5	1.3	1.2	0.1	0.1	0.5
13	13.1	2.1	1.9	0.6	1.6	0.2	0.3	0.1	5.1	1.8	0.1	1.3	1.4	0.5	0.1	0.1
14	8.7	1.6	1.4	0.7	1.1	0.3	0.1	0.1	7.5	2.2	7.3	0.9	1.5	0.1	0.1	0.1
15	11.8	1.5	1.8	0.5	1.3	0.1	0.1	0.1	7.4	2.4	1	1.1	1.4	0.1	0.1	0.1
16	5.4	1.4	5.6	0.8	2	0.1	0.1	0.1	10.5	2.1	0.8	0.9	1.4	0.1	0.1	0.1
17	17.5	1.7	1.4	0.7	1.3	0.2	0.1	0.1	8.4	3.2	3.5	1.1	1.3	0.1	0.1	0.1
18	7.2	1.6	1.6	0.8	1.7	0.1	0.2	0.1	4.5	2.1	0.5	1.2	1.4	0.1	0.1	0.1
Mean±SD	11.14±3.88	1.88±0.33	2.53±1.52	0.58±0.21	1.55±0.31	0.26±0.29	0.13±0.06	0.11±0.03	6.92±3.44	2.78±1.08	1.74±2.11	1.12±0.19	1.35±0.13	0.15±0.12	0.10±0.00	0.31±0.57

Table S5. Enrichment factor for HMs in BSs collected in the Lake Gusinoe basin, Russia.

Site	Enrichment factor (EF)							Avr	Enrichment degree
	Mn	Zn	Cu	Cr	Ni	Cd	Pb		
Tsagan-gol	1.17	1.26	0.41	0.62	0.30	1.07	0.02	0.69	No enrichment
Tsagan-gol mouth	0.91	0.78	0.18	0.39	0.21	4.05	0.27	0.97	No enrichment
Zagustai	3.70	1.36	0.43	0.38	0.22	1.86	0.65	1.23	No enrichment
Tel	1.94	1.20	0.50	0.50	0.14	8.17	0.61	1.86	No enrichment
Bayan-gol	2.10	1.43	0.49	0.63	0.17	1.40	0.18	0.92	No enrichment
GRES discharge	0.98	1.80	1.95	0.58	0.44	2.89	0.79	1.35	No enrichment
8	1.64	3.40	1.04	1.08	0.39	1.82	0.70	1.44	No enrichment
9	0.91	1.75	1.69	0.69	0.51	0.99	0.77	1.04	No enrichment
10	2.11	2.15	1.08	0.58	0.23	1.57	0.53	1.18	No enrichment
11	1.51	2.57	1.08	0.29	0.66	0.83	0.38	1.04	No enrichment
12	0.64	0.64	0.18	0.13	0.38	5.24	1.04	1.18	No enrichment
13	1.21	0.60	0.55	0.18	0.08	2.44	0.58	0.81	No enrichment
14	0.73	0.65	0.19	0.22	0.12	0.54	0.83	0.47	No enrichment
15	2.57	3.27	0.19	0.17	0.33	0.41	0.67	1.09	No enrichment
16	3.53	4.90	2.78	1.72	1.00	2.93	2.75	2.80	Moderate enrichment
17	3.82	4.41	3.78	1.43	0.92	3.67	2.51	2.93	Moderate enrichment
18	4.44	5.75	3.56	2.13	1.34	6.69	3.61	3.93	Moderate enrichment
Average	1.99	2.23	1.18	0.69	0.44	2.74	0.99	1.47	

Table S6. Contamination factor (C_f) and contamination degree (C_d) for HMs in BSs collected in the Lake Gusinoe basin, Russia.

Site	Contamination factor (C_f)								Degree of contamination (C_d)	Contamination level
	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb		
Tsagan-gol	0.27	0.31	0.34	0.11	0.17	0.08	0.29	0.00	1.58	Low contamination
Tsagan-gol mouth	0.22	0.24	0.21	0.05	0.10	0.06	1.09	0.07	2.05	Low contamination
Zagustai	0.46	1.00	0.36	0.11	0.10	0.06	0.50	0.18	2.77	Low contamination
Tel	0.40	0.52	0.32	0.13	0.13	0.04	2.20	0.16	3.91	Low contamination
Bayan-gol	0.36	0.57	0.39	0.13	0.17	0.05	0.38	0.05	2.08	Low contamination
GRES discharge	0.30	0.26	0.48	0.52	0.16	0.12	0.78	0.21	2.84	Low contamination
8	0.70	0.44	0.92	0.28	0.29	0.10	0.49	0.19	2.25	Low contamination
9	0.28	0.25	0.47	0.45	0.19	0.14	0.27	0.21	6.42	Moderate contamination
10	0.32	0.57	0.58	0.29	0.16	0.06	0.42	0.14	1.02	Low contamination
11	0.25	0.41	0.69	0.29	0.08	0.18	0.22	0.10	3.41	Low contamination
12	0.13	0.17	0.17	0.05	0.04	0.10	1.41	0.28	6.41	Moderate contamination
13	0.16	0.33	0.16	0.15	0.05	0.02	0.66	0.16	2.91	Low contamination
14	0.14	0.20	0.18	0.05	0.06	0.03	0.14	0.22	2.54	Low contamination
15	0.86	0.69	0.88	0.05	0.05	0.09	0.11	0.18	2.35	Low contamination
16	1.14	0.95	1.32	0.75	0.46	0.27	0.79	0.74	2.22	Low contamination
17	0.90	1.03	1.19	1.02	0.38	0.25	0.99	0.68	8.52	Moderate contamination
18	1.11	1.19	1.55	0.96	0.57	0.36	1.80	0.97	1.68	Low contamination
Average	0.47	0.54	0.60	0.32	0.19	0.12	0.74	0.27	3.23	Low contamination

Table S7. Geoaccumulation index (I_{geo}) of HMs in sediments collected from the Gusinoe Lake basin, Russia.

Site	Geoaccumulation index (I_{geo})								Pollution degree
	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb	
Tsagan-gol	−2.48	−2.26	−2.14	−3.75	−3.16	−4.22	−2.38	−8.33	Unpolluted
Tsagan-gol mouth	−2.76	−2.62	−2.83	−4.94	−3.85	−4.74	−0.46	−4.34	Unpolluted
Zagustai	−1.71	−0.59	−2.04	−3.71	−3.88	−4.64	−1.58	−3.09	Unpolluted
Tel	−1.91	−1.52	−2.22	−3.48	−3.49	−5.36	0.55	−3.20	Unpolluted
Bayan-gol	−2.06	−1.41	−1.96	−3.51	−3.15	−5.00	−1.99	−4.94	Unpolluted
GRES discharge	−2.33	−2.50	−1.63	−1.52	−3.26	−3.66	−0.95	−2.81	Unpolluted
8	−1.09	−1.77	−0.71	−2.43	−2.36	−3.85	−1.62	−2.99	Unpolluted
9	−2.40	−2.61	−1.67	−1.72	−3.01	−3.45	−2.49	−2.85	Unpolluted
10	−2.23	−1.40	−1.37	−2.37	−3.25	−4.61	−1.83	−3.41	Unpolluted
11	−2.60	−1.89	−1.12	−2.36	−4.26	−3.08	−2.75	−3.88	Unpolluted
12	−3.57	−3.11	−3.13	−4.98	−5.42	−3.86	−0.09	−2.42	Unpolluted
13	−3.26	−2.20	−3.22	−3.33	−4.95	−6.07	−1.19	−3.27	Unpolluted
14	−3.41	−2.94	−3.10	−4.90	−4.69	−5.59	−3.38	−2.74	Unpolluted
15	−0.81	−1.12	−0.77	−4.85	−5.05	−4.06	−3.75	−3.06	Unpolluted
16	−0.40	−0.66	−0.19	−1.00	−1.70	−2.48	−0.93	−1.02	Unpolluted
17	−0.74	−0.54	−0.34	−0.56	−1.96	−2.60	−0.60	−1.15	Unpolluted
18	−0.43	−0.33	0.04	−0.64	−1.39	−2.05	0.26	−0.63	Unpolluted
Average	−2.01	−1.73	−1.67	−2.94	−3.46	−4.08	−1.48	−3.18	

Table S8. Ecological risk factors (E_r) and potential ecological risk indices (RI) for HMs in BSs collected in the Lake Gusinoe basin, Russia.

Site	Ecological risk factor (E_r)								Potential ecological risk index (RI)	Risk degree
	Fe	Mn	Zn	Cu	Cr	Ni	Cd	Pb		
Tsagan-gol	0.27	0.31	0.34	0.56	0.34	0.40	8.67	0.02	10.91	Low risk
Tsagan-gol mouth	0.22	0.24	0.21	0.24	0.21	0.28	32.67	0.37	34.45	Low risk
Zagustai	0.46	1.00	0.36	0.57	0.20	0.30	15.00	0.88	18.78	Low risk
Tel	0.40	0.52	0.32	0.67	0.27	0.18	66.00	0.82	69.18	Low risk
Bayan-gol	0.36	0.57	0.39	0.66	0.34	0.23	11.33	0.24	14.12	Low risk
GRES discharge	0.30	0.26	0.48	2.62	0.31	0.59	23.33	1.07	28.97	Low risk
8	0.70	0.44	0.92	1.40	0.58	0.52	14.67	0.95	20.18	Low risk
9	0.28	0.25	0.47	2.27	0.37	0.69	8.00	1.04	13.37	Low risk
10	0.32	0.57	0.58	1.46	0.31	0.31	12.67	0.71	16.92	Low risk
11	0.25	0.41	0.69	1.46	0.16	0.89	6.67	0.51	11.02	Low risk
12	0.13	0.17	0.17	0.24	0.07	0.52	42.33	1.40	45.02	Low risk
13	0.16	0.33	0.16	0.74	0.10	0.11	19.67	0.78	22.04	Low risk
14	0.14	0.20	0.18	0.25	0.12	0.16	4.33	1.12	6.49	Low risk
15	0.86	0.69	0.88	0.26	0.09	0.45	3.33	0.90	7.46	Low risk
16	1.14	0.95	1.32	3.74	0.92	1.34	23.67	3.70	36.78	Low risk
17	0.90	1.03	1.19	5.09	0.77	1.24	29.67	3.38	43.25	Low risk
18	1.11	1.19	1.55	4.80	1.15	1.81	54.00	4.86	70.46	Low risk