NATIONAL UNIVERSITY OF MONGOLIA
SCHOOL OF ENGINEERING AND APPLIED SCIENCES

Contamination and health risk assessment of the heavy metal in street dust of Erdenet city, Mongolia

Batdelger Byambaa
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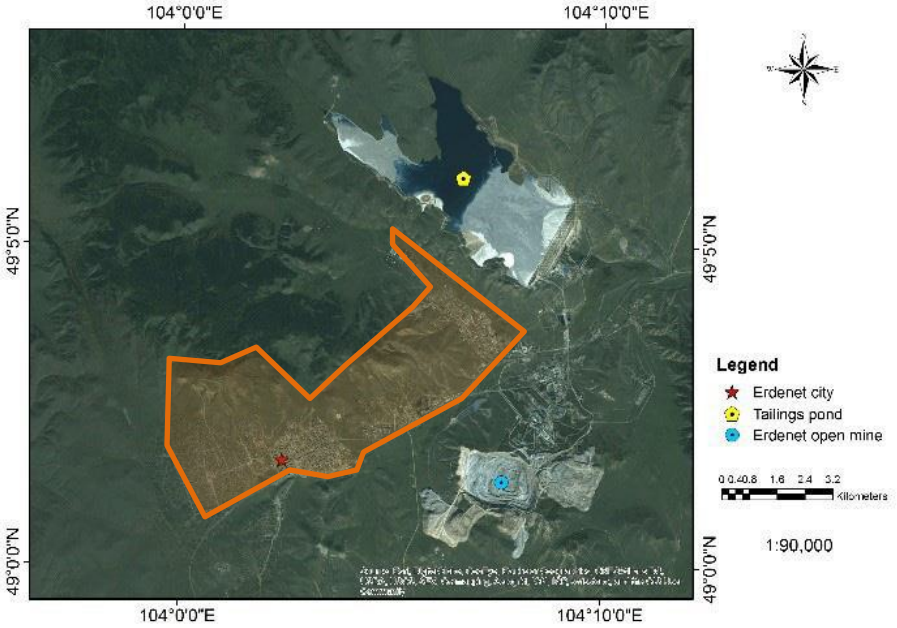
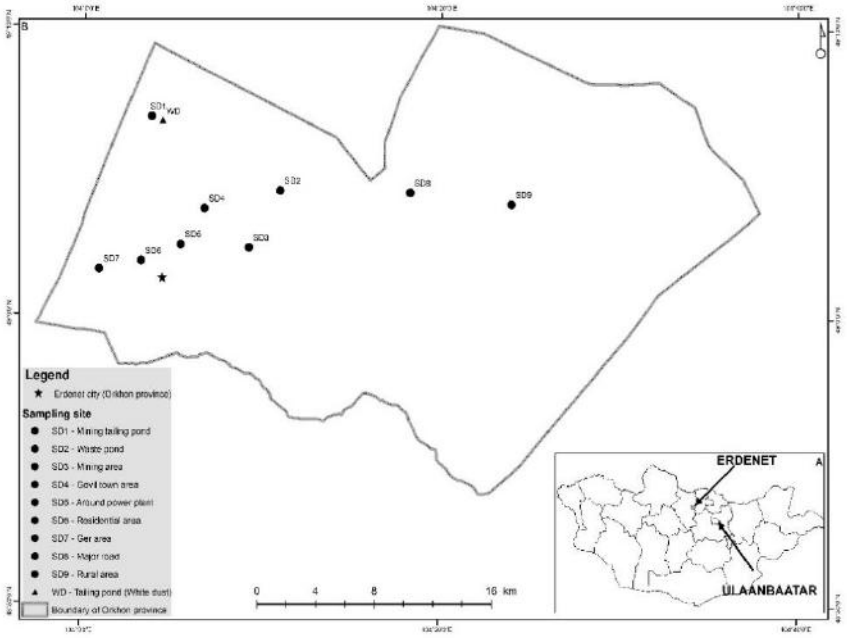
Study area and Previous study

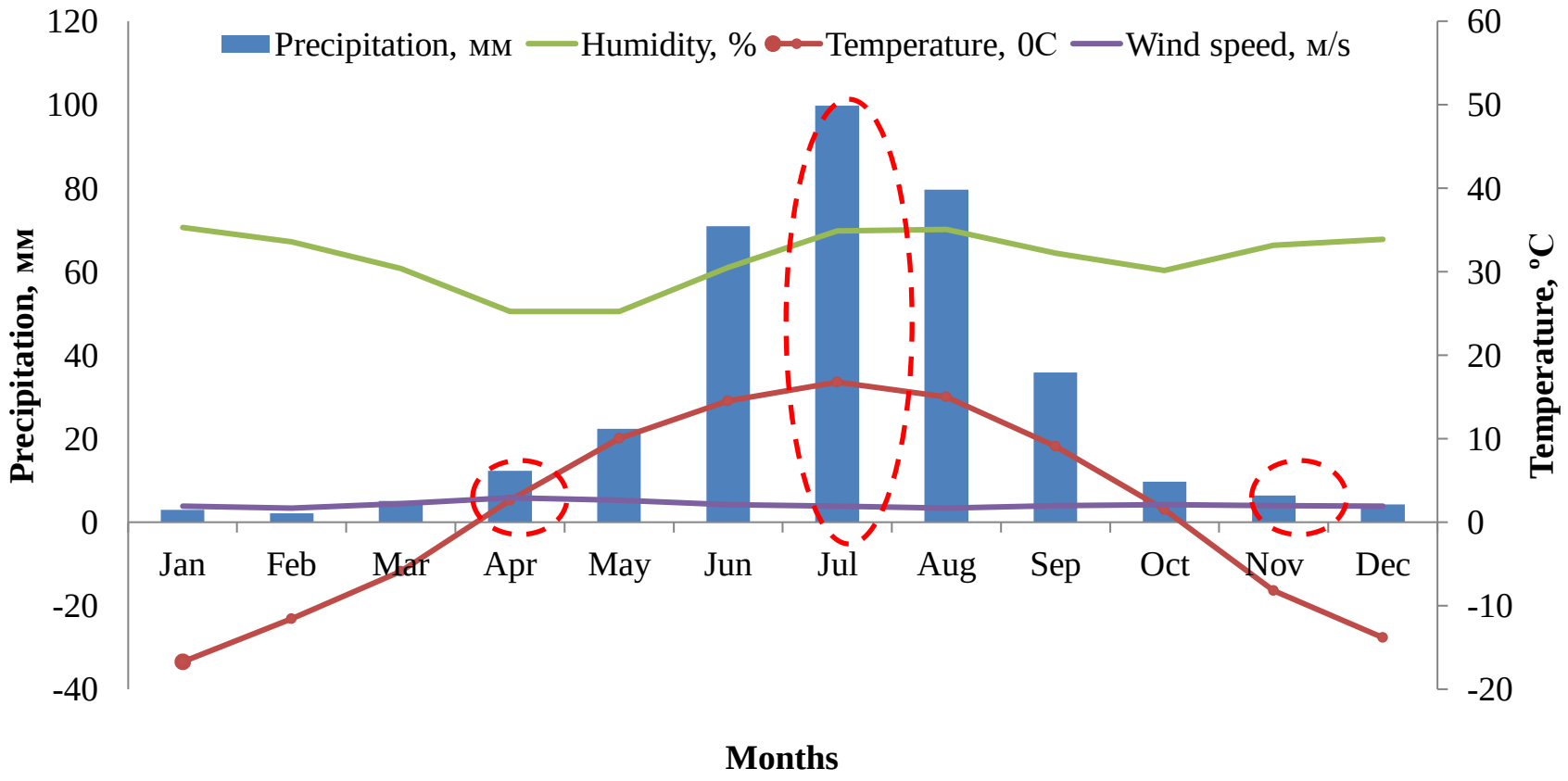




Source; Photo A,B,C by Erdenet info news and Photo D is our study

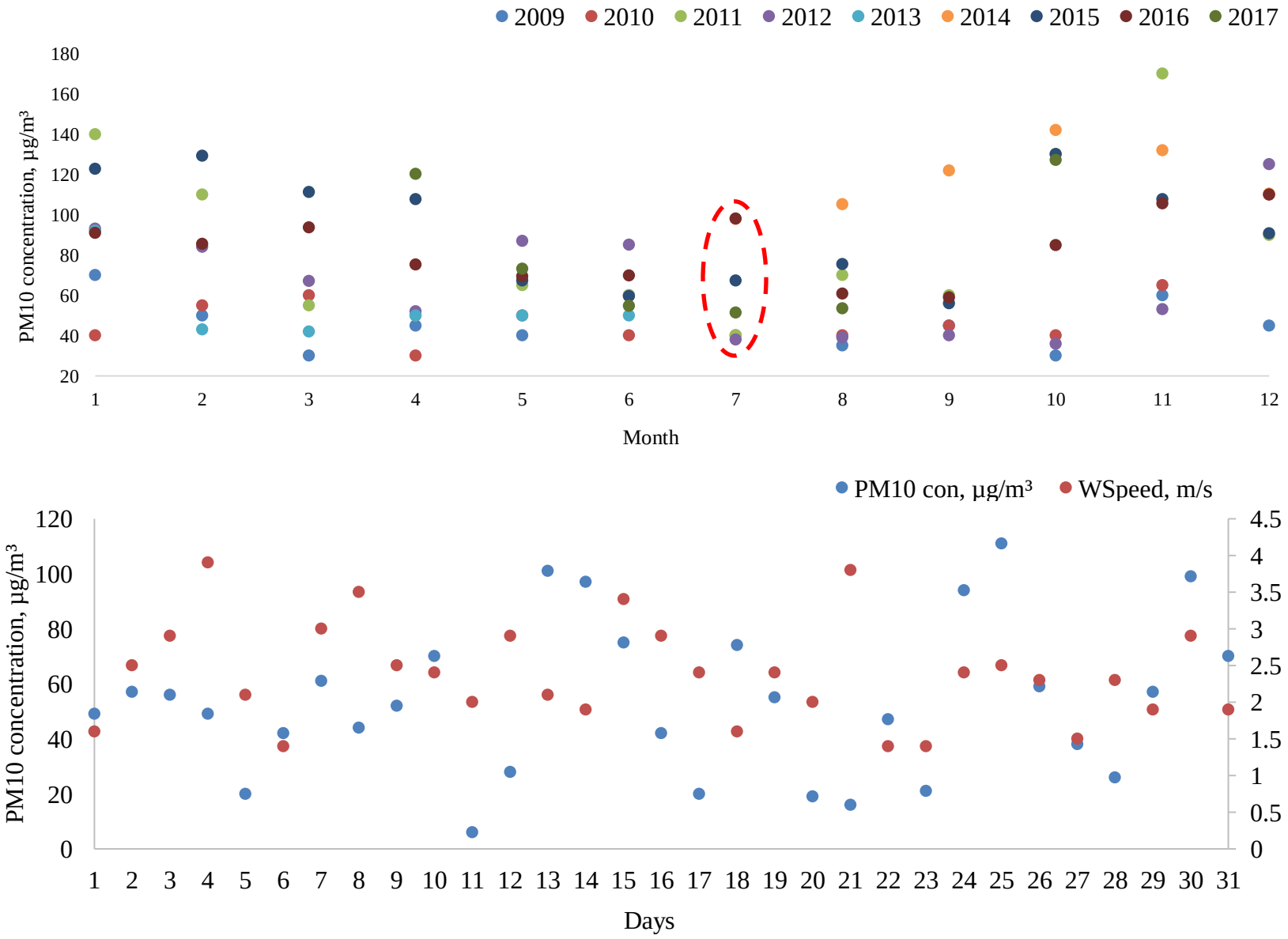
Previous study	Study field	Study Objective	Result and mean pollution	Conclusions	Discussion
Battogtokh. B et al 2014	Soil, stream sediment, tailing pond's wet deposition	Heavy metals concentration, Pollution index and pollution source's distance	Cu and Mo	Water, soil quality and potential human health risk	Health assessment
Ziadat A. H, et al 2015	Tree bark, lichens and street dust	The possibility to use bioindicators to heavy metal analysis	Cu	Mining activity effect on Environmental	

Previous study and Meteorological condition



Source: Previous study, 2015 and Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE)

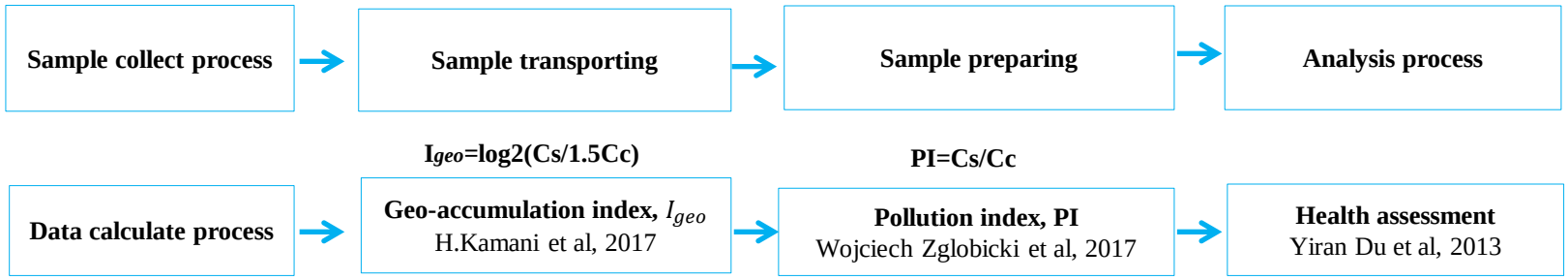
Dust event (Background information)



Source: Previous study, 2015 and Information and Research Institute of Meteorology, Hydrology and Environment (IRIMHE)

This study goal and method

- To determine the content of heavy metal in the street dust of around Erdenet city
- To investigate the health assessment of the heavy metal in the dust following with USEPA method



$$D_{ing}=C_s \times (I_{ing}R \times EF \times ED)/(BW \times AT) \times 10^{-6}$$

$$D_{inh}=C_s \times (I_{inh}R \times EF \times ED)/PEF \times BW \times AT$$

$$D_{dermal}=C_s \times (SL \times SA \times ABS \times EF \times ED)/(BW \times AT) \times 10^{-6}$$

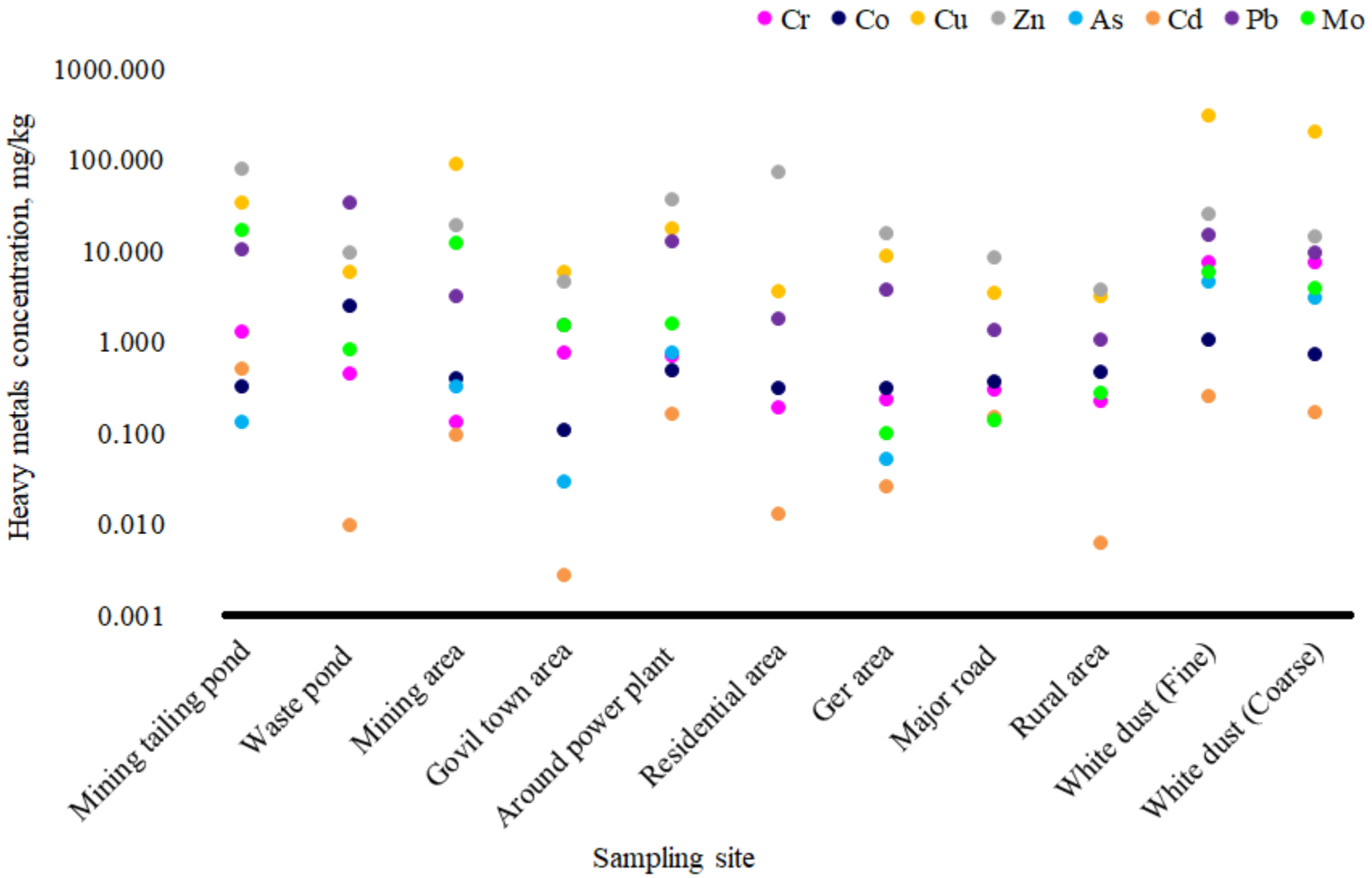
$$LADD = C_s \times CR \times EF \times ED/PEF \times BW \times AT$$

$$HQ = LADD/RfD$$

$$HI = \sum_{i=1}^{3} HQ$$

Factor	Definition	Unit	Value		Reference
			Children	Adult	
C_s	Concentration of the contamination in dusts	mg/kg			This study
R_{ing}	Ingestion rate	mg/day	200	100	USEPA, 2001
EF	Exposure frequency	day/year	350	350	USEPA, 2001
ED	Exposure duration	years	6	24	
BW	Average body weight	kg	15	70	Xiufen Han et al, 2017
AT	Average time	days	365xED	365xED	
CF	Conversion factor	kg/time	$1x10^{-6}$		Yiran Du et al, 2013
R_{inh}	Inhalation rate	m^3/day	7.6	20	Xiufen Han et al, 2017
PEF	Particle emission factor	m^3/kg	$1.36x10^9$		USEPA, 2001
SA	Surface area of the skin that contacts the dust	cm^2	2800	5700	USEPA, 2001
SL	Skin adherence factor for dust	mg/cm^2	0.2	0.7	
ABS	Dermal absorption factor (Chemical specific)		0.03 for As, 0.001 for other metals		Li Kexin et al, 2015

Heavy metal concentrations



Heavy metal concentrations

Concentrations of the heavy metals, mg/kg

№	Sample names	Sample code	Cr	Co	Cu	Zn	As	Cd	Pb	Mo
1	Mining tailing pond	SD1	1.22	0.31	33.00	76.97	0.13	0.48	10.07	16.53
2	Waste pond	SD2	0.43	2.41	5.72	9.02	DL	0.01	32.18	0.81
3	Mining area	SD3	0.13	0.38	84.78	18.55	0.31	0.09	3.00	11.90
4	Govil town area	SD4	0.72	0.10	5.67	4.49	0.03	0.003	1.44	1.46
5	Around power plant	SD5	0.67	0.47	16.64	35.16	0.72	0.15	12.30	1.53
6	Residential area	SD6	0.18	0.29	3.44	71.82	DL	0.01	1.70	DL
7	Ger area	SD7	0.22	0.30	8.41	15.12	0.05	0.02	3.65	0.10
8	Major road	SD8	0.29	0.35	3.31	8.03	DL	0.15	1.27	0.13
9	Rural area	SD9	0.21	0.45	3.00	3.66	DL	0.01	1.01	0.26
10	White dust (Fine)	WD	7.23	1.03	291.45	24.82	4.36	0.24	14.56	5.55
11	White dust (Coarse)		7.30	0.70	195.42	13.66	2.88	0.16	9.32	3.71
12	Earth's upper crust	Cc	92	17.3	28	67	4.8	0.09	17	1.1

Fine<45 mic, Coarse>45 mic, SD-Street dust, WD-White dust, Cc- Earth's upper crust and DL-detection limit

Rudnick and Gao, 2003

№	City	Cr	Co	Cu	Zn	As	Cd	Pb	Mo	Reference
1	Erdenet, Mongolia	0.5	0.6	18.2	27.0	0.1	0.1	7.4	**3.6**	This study
2	Beijing, China	69.3		72.1	219.2		0.6	201.8		Yiran Du et al, 2013
3	Seoul, Korea			101			3	245		Chon et al, 1995
4	London, UK			155	680		3.5	1030		Schwar et al, 1988
5	New York, USA			355	1811		8	2582.5		Fergusson and Ryan, 1984
6	Istanbul, Turkey			208.5	520.8		2.3	211.9		Sezin et al, 2004
7	Tehran, Iran	38.16		286.14	694.79		0.43	81.28		H.Kaman et al, 2017
8	Earth's upper crust	92	17.3	28	67	4.8	0.09	17	1.1	Rudnick and Gao, 2003

Correlation analysis and comparison

	Cr	*Co*	*Cu*	*Zn*	*As*	*Cd*	*Pb*	*Mo*
Cr	1							
Co	-0.07	1						
Cu	-0.02	-0.14	1					
Zn	0.45	-0.23	0.12	1				
As	0.22	-0.13	0.40	0.15	1			
Cd	0.77	-0.21	0.31	0.62	0.26	1		
Pb	0.25	**0.93**	-0.09	-0.02	0.11	0.06	1	
Mo	0.54	-0.17	**0.76**	0.49	0.21	0.79	0.02	1

Geo-accumulation index and Pollution index

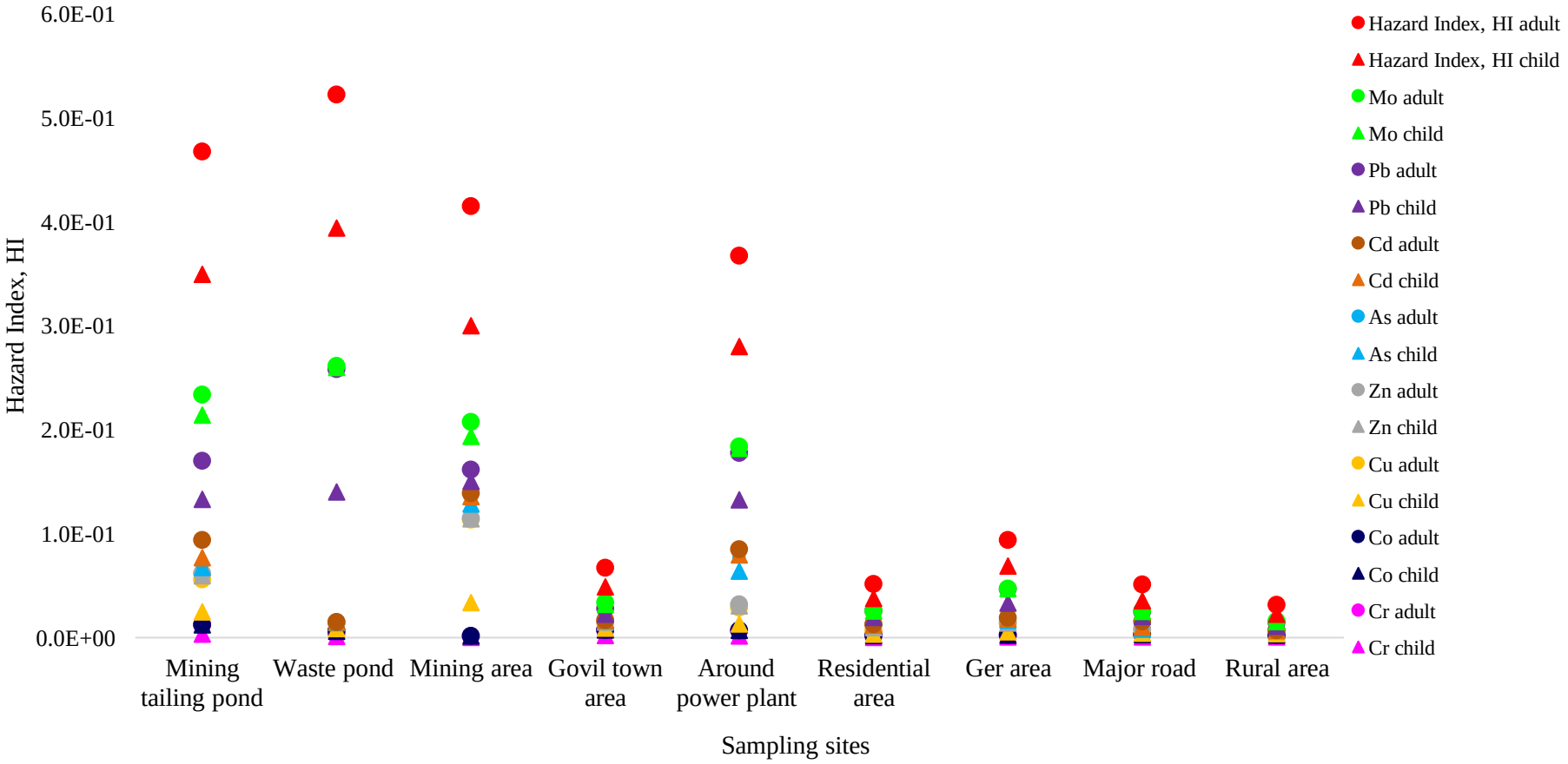
Igeo Value	Description	Class
Igeo ≤ 0	Uncontaminated	0
0 < Igeo ≤ 1	Uncontaminated to moderately contaminated	1
1 < Igeo ≤ 2	Moderately contaminated	2
2 < Igeo ≤ 3	Moderately to heavily contaminated	3
3 < Igeo ≤ 4	Heavily contaminated	4
4 < Igeo ≤ 5	Heavily to extremely contaminated	5
Igeo > 5	Extremely contaminated	6

PI	Pollution index, PI
PI < 1	Low
1 ≤ PI < 3	Moderate
3 ≤ PI < 6	Considerable
PI ≥ 6	Very high

Description statistics	Heavy metals							
	Cr	Co	Cu	Zn	As	Cd	Pb	Mo
Geo-accumulation index, Igeo								
min	-10.1	-8.0	-3.8	-4.8	-8.0	-5.7	-4.7	-4.1
max	-6.8	-3.4	1.0	-0.4	-3.3	1.8	0.3	3.3
mean	-8.6	-6.1	-2.2	-2.7	-5.8	-2.0	-2.8	-0.7
Pollution index, PI								
min	0.001	0.01	0.1	0.1	0.01	0.03	0.1	0.09
max	0.01	0.1	3.0	1.1	0.1	5.3	1.9	15.0
mean	0.005	0.03	0.7	0.4	0.1	1.1	0.4	3.7

№	Sample names	Sample code	Cr	Co	Cu	Zn	As	Cd	Pb	Mo	Total IP	Pollution index, PI
1	Mining tailing pond	SD1	0.0	0.0	1.2	1.1	0.0	5.3	0.6	15.0	23	Very high
2	Waste pond	SD2	0.0	0.1	0.2	0.1	0.0	0.1	1.9	0.7	3.2	Considerable
3	Mining area	SD3	0.0	0.0	3.0	0.3	0.1	1.0	0.2	10.8	15	Very high
4	Govil town area	SD4	0.0	0.0	0.2	0.1	0.0	0.0	0.1	1.3	2	Moderate
5	Around power plant	SD5	0.0	0.0	0.6	0.5	0.1	1.7	0.7	1.4	5	Considerable
6	Residential area	SD6	0.0	0.0	0.1	1.1	0.0	0.1	0.1	0.0	1.5	Moderate
7	Ger area	SD7	0.0	0.0	0.3	0.2	0.0	0.3	0.2	0.1	1.1	Moderate
8	Major road	SD8	0.0	0.0	0.1	0.1	0.0	1.6	0.1	0.1	2	Moderate
9	Rural area	SD9	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.2	0.6	Low
10	White dust (Fine)	WD	0	0	20	0	2	2	1	4	31	Very high
11	White dust (Coarse)		0	0	14	0	1	2	1	3	20	Very high

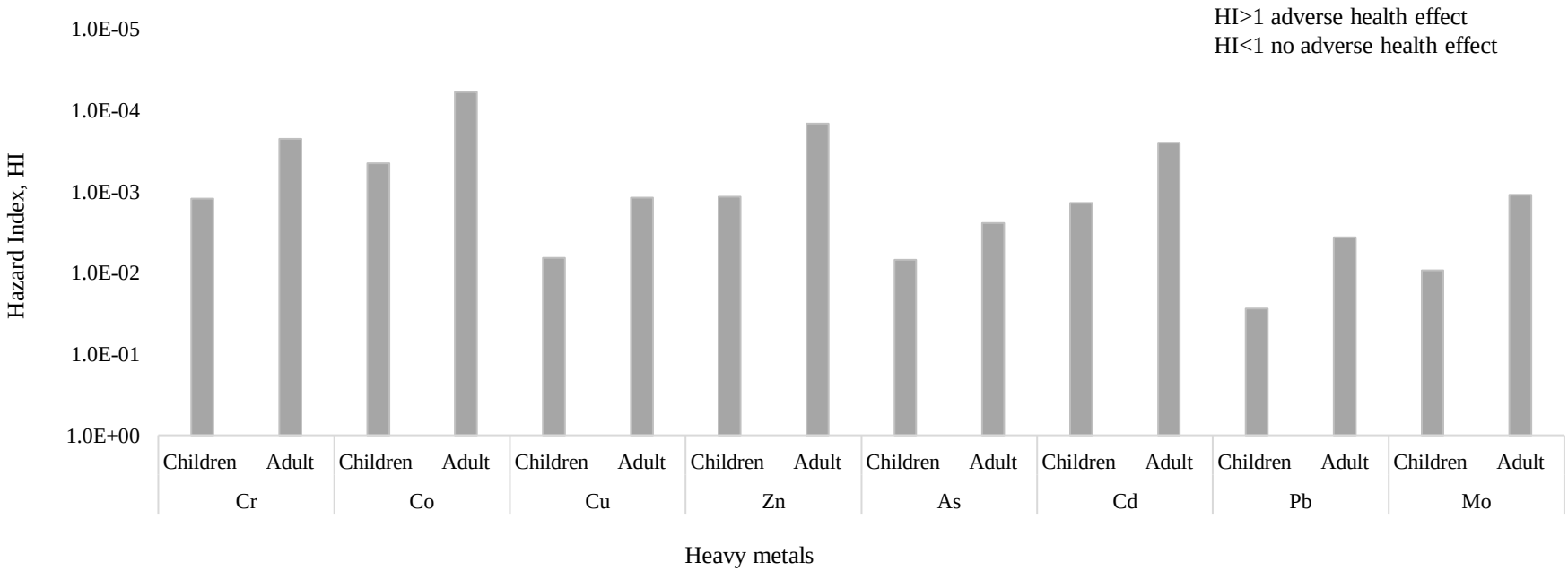
Health risk assessment



HI>1 adverse health effect
HI<1 no adverse health effect

Health risk assessment

Description statistics	The Hazard Index (HI) of the heavy metals							
	Cr	Co	Cu	Zn	As	Cd	Pb	Mo
Children								
min	3.47E-04	8.32E-05	1.09E-03	1.58E-04	0.00E+00	3.51E-05	3.77E-03	0.00E+00
max	3.33E-03	1.92E-03	3.09E-02	3.33E-03	3.69E-02	6.46E-03	1.20E-01	4.26E-02
mean	1.24E-03	4.50E-04	6.64E-03	1.17E-03	7.00E-03	1.39E-03	2.75E-02	9.37E-03
Adult								
min	6.35E-05	1.12E-05	1.97E-04	2.00E-05	0.00E+00	6.40E-06	5.02E-04	0.00E+00
max	6.10E-04	2.58E-04	5.58E-03	4.22E-04	1.29E-02	1.18E-03	1.59E-02	5.01E-03
mean	2.26E-04	6.04E-05	1.20E-03	1.48E-04	2.44E-03	2.53E-04	3.67E-03	1.10E-03



Conclusion

- The contaminated of Cu, Zn, Cd, and Mo in the tailings pond were higher than Earth's upper crust, and Pb in the waste pond and Cu in the mining area had high was caused from mining activity and different anthropogenic source.

- Street dust pollution as a source of heavy metals in the urban environment is an increasingly complicated problem in Erdenet city.

- The findings of health risk assessment show that to be the major way of exposure to heavy metals in the street dust causing greater health risks.

Thank you for attention