

Assessment of trace element toxicity in surface water of a fish breeding river in Bangladesh: A novel approach for ecological and health risk evaluation

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Table S1. Operating parameters employed for the determination of anion and cation by Ion chromatography

Parameters	Setting/value	
Brand	Anion	Cation
Eluent	30 mM sodium hydroxide (2.4g NaOH+2 L Deionized water)	6 Mm MSA (Methanesulfonic acid)
Flow Rate	1.5 mL/min	1 mL/min
Temperature	30 °C	30 °C
Detection	Suppressed Conductivity	Suppressed Conductivity
Suppressor	Anion Self-Regenerating Suppressor (ASRS [®] 300 4mm)	Cation Self-Regenerating Suppressor (CSRS [®] ULTRA II, 4mm) Auto [®] Suppression Recycle Mode
Applied Current	112 mA	18 mA
Inject Volume	25 µL	25 µL
Analysis time	10 min	18 min

Table S2. Definitions, symbols, units and values associated with equations used for health risk assessment.

Definitions	Symbols	Units	Values	References
Metal concentration	Cw	µg/L		
Body weight-adult	BWa	kg	70	Site-specific
Body weight-child	BWc	kg	15	USEPA (1991a)
Exposure duration	ED	years	26	USEPA (2011)
Exposure duration-child	EDc	years	6	USEPA (1991b)
Exposure duration-adult	EDa	years	20	USEPA (2020d)
Exposure frequency	EFres	days/year	350	USEPA (1991b)
Exposure time-adult	ETres-a	hours/event	0.71	USEPA (2011)
Exposure time-child	ETres-c	hours/event	0.54	USEPA (2011)
Resident events-adult	EVa	per day	1	USEPA (2004)
Resident events-child	EVc	per day	1	USEPA (2004)
Skin surface area-adult	SAa	cm ²	19652	USEPA (2014)
Skin surface area-child	SAc	cm ²	6365	USEPA (2014)
Resident water intake ratio-adult	IRWres-a	L/day	2.5	USEPA (2011)
Resident water intake ratio-child	IRWres-c	L/day	0.78	USEPA (2011)
			365 x ED = 9490	
Resident averaging time-adult	ATres-a	days	(non-carcinogenic)	USEPA (1989)
			365 x EDc = 2190	
Resident averaging time-child	ATres-c	days	(non-carcinogenic)	USEPA (1989)
Resident water ingestion rate	IFWres	L/kg	Age-adjusted	USEPA (2020d)
Resident water dermal contact factor	DFWres	cm ² -event/kg	Age-adjusted	USEPA (2020d)
Resident water exposure time	ETevent-res	hours/event	Age-adjusted	USEPA (2020d)

Life time	LT	years	70	USEPA (1989)
Averaging time	AT	days	$365 \times \text{LT} = 25550$ (carcinogenic)	USEPA (1989)

Table S3. Dermal permeability coefficient, reference dose, slope factor and gastrointestinal absorption coefficient for each element.

Elements	Dermal permeability constant (Kp; cm/h)	Oral reference dose (RfDo; mg/kg-day)	Oral slope factor (CSFo; mg/kg-day)	Gastrointestinal absorption(GIABS; unitless)
As	0.001 (USEPA, 2004)	0.0003 (USEPA, 2020e)	1.5 (USEPA, 2020e)	1 (USEPA, 2020e)
Co	0.0004 (USEPA, 2004)	0.0003 (USEPA, 2020e)		1 (USEPA, 2020e)
Cr	0.002 (USEPA, 2004)	0.003 (USEPA, 2020e)	0.5 (USEPA, 2020e)	0.025 (USEPA, 2020e)
Cu	0.001 (USEPA, 2004)	0.04 (USEPA, 2020e)		1 (USEPA, 2020e)
Fe	0.001 (USEPA, 2004)	0.7 (USEPA, 2020e)		1 (USEPA, 2020e)
Mn	0.001 (USEPA, 2004)	0.024 (USEPA, 2020e)		0.04 (USEPA, 2020e)
Pb	0.0001 (USEPA, 2004)	0.0014 (Saleem et al., 2019)	0.0085 (USEPA, 2020e)	1 (USEPA, 2020e)
Zn	0.0006 (USEPA, 2004)	0.3 (USEPA, 2020e)		1 (USEPA, 2020e)
Hg	0.001 (USEPA, 2004)	0.0002 (USEPA, 2020e)		1 (USEPA, 2020e)
Cd	0.0001 (USEPA, 2004)	0.001 (USDOE, 2011)		1 (USEPA, 2020e)

Table S4. Pearson correlation matrix of trace elements in surface water during wet season (the left lower part) and in dry season (the right upper part) in Halda River, Bangladesh.

Metals	Cd	Cr	Mn	Fe	Co	Cu	Zn	As	Pb	Hg
Cd	1	0.045	0.610*	0.227	-0.378	0.086	0.063	-0.066	0.102	-0.168
Cr	0.523*	1	0.064	-0.437	-0.08	-0.174	0.382	-0.214	-0.155	-0.181
Mn	0.344	0.198	1	0.059	-0.352	-0.085	-0.031	-0.061	-0.022	-0.033
Fe	0.366	-0.135	-0.32	1	-0.086	0.07	-0.468	0.132	0.634*	-0.046
Co	0.054	-0.294	-0.082	0.533*	1	0.29	0.337	-0.199	0.042	-0.088
Cu	0.072	-0.162	.693**	-0.226	-0.141	1	0.707**	0.079	-0.122	0.507*
Zn	-0.053	-0.03	-0.073	0.352	0.428	0.185	1	-0.347	-0.251	0.247
As	-0.19	-0.322	-0.247	0.188	-0.274	0.246	0.063	1	-0.435	0.136
Pb	-0.245	-0.114	0.076	-0.224	-0.071	0.101	-0.015	0.567*	1	-0.245
Hg	-0.22	-0.648	0.016	0.346	0.18	0.368	0.134	0.656*	0.45	1

** . Correlation is significant at the 0.01 level (1-tailed).

* . Correlation is significant at the 0.05 level (1-tailed).

Table S5. Trace element evaluation index (TEI) of studied metal in Halda river, Bangladesh (summer and winter season).

Sites	Cd	Cr	Mn	Fe	Co	Cu	Zn	As	Pb	Hg	TEI	Risk level
Wet season												
SW1	11.87	0.047	0.013	1.511	1.277	1.429	0.024	27.67	2.633	1.378	47.85	High
SW2	1.800	0.029	0.015	0.843	0.087	1.896	0.018	52.50	1.967	1.089	60.24	High
SW3	2.078	0.098	0.017	1.050	0.097	1.931	0.024	76.17	2.567	0.578	84.61	High
SW4	2.089	0.117	0.013	1.040	0.118	0.929	0.019	49.00	4.567	0.994	58.89	High
SW5	16.56	0.098	0.013	1.091	0.089	1.210	0.023	8.233	0.800	0.856	28.97	High
SW6	16.28	0.094	0.011	1.268	0.125	0.860	0.015	45.33	1.700	0.450	66.13	High
SW7	23.33	0.105	0.096	1.271	0.092	2.882	0.020	50.50	3.200	1.222	82.72	High
SW8	1.722	0.069	0.010	1.779	0.077	1.926	0.022	316.8	3.133	1.439	327.0	High
SW9	1.622	0.038	0.014	1.343	0.110	2.278	0.020	276.8	3.500	1.594	287.4	High
SW10	26.44	0.097	0.007	1.017	0.117	1.517	0.021	173.5	1.900	1.089	205.7	High
SW11	22.11	0.099	0.015	1.396	0.111	1.814	0.021	271.0	5.167	1.244	303.0	High
SW12	1.733	0.024	0.012	1.490	0.119	1.303	0.020	264.3	5.167	1.456	275.7	High
Dry season												
SW1	13.33	1.133	0.093	2.563	0.733	0.068	0.100	31.00	40.00	0.500	89.53	High
SW2	12.22	1.133	0.400	1.599	0.600	0.078	0.163	59.17	2.000	0.333	77.70	High
SW3	8.778	1.293	0.120	1.374	1.113	0.027	0.152	66.17	2.667	0.444	82.14	High
SW4	16.67	3.333	0.533	1.578	0.800	0.035	0.197	52.33	2.667	0.500	78.64	High
SW5	8.889	0.933	0.113	2.294	1.200	0.047	0.067	6.567	20.00	0.444	40.55	High
SW6	18.89	1.067	0.707	1.887	1.200	0.075	0.138	19.00	26.67	0.356	69.98	High
SW7	8.889	0.840	0.133	1.647	1.400	0.150	0.207	4.767	4.333	0.994	23.36	High

SW8	17.78	0.373	0.840	2.338	0.467	0.040	0.024	216.8	5.667	0.889	245.2	High
SW9	19.00	1.040	0.100	1.846	0.533	0.007	0.044	210.2	4.333	0.456	237.5	High
SW10	23.56	0.907	0.377	2.233	1.213	0.250	0.233	114.0	6.667	0.433	149.9	High
SW11	6.667	1.067	0.093	2.087	1.467	0.015	0.057	247.7	6.800	0.222	266.1	High
SW12	6.667	1.200	0.087	1.841	1.000	0.240	0.190	262.3	3.000	1.056	277.6	High

References

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