

Fate and Spatial–Temporal Variation of 23 Elements at 7 Wastewater Treatment Plants in Southeast City of China

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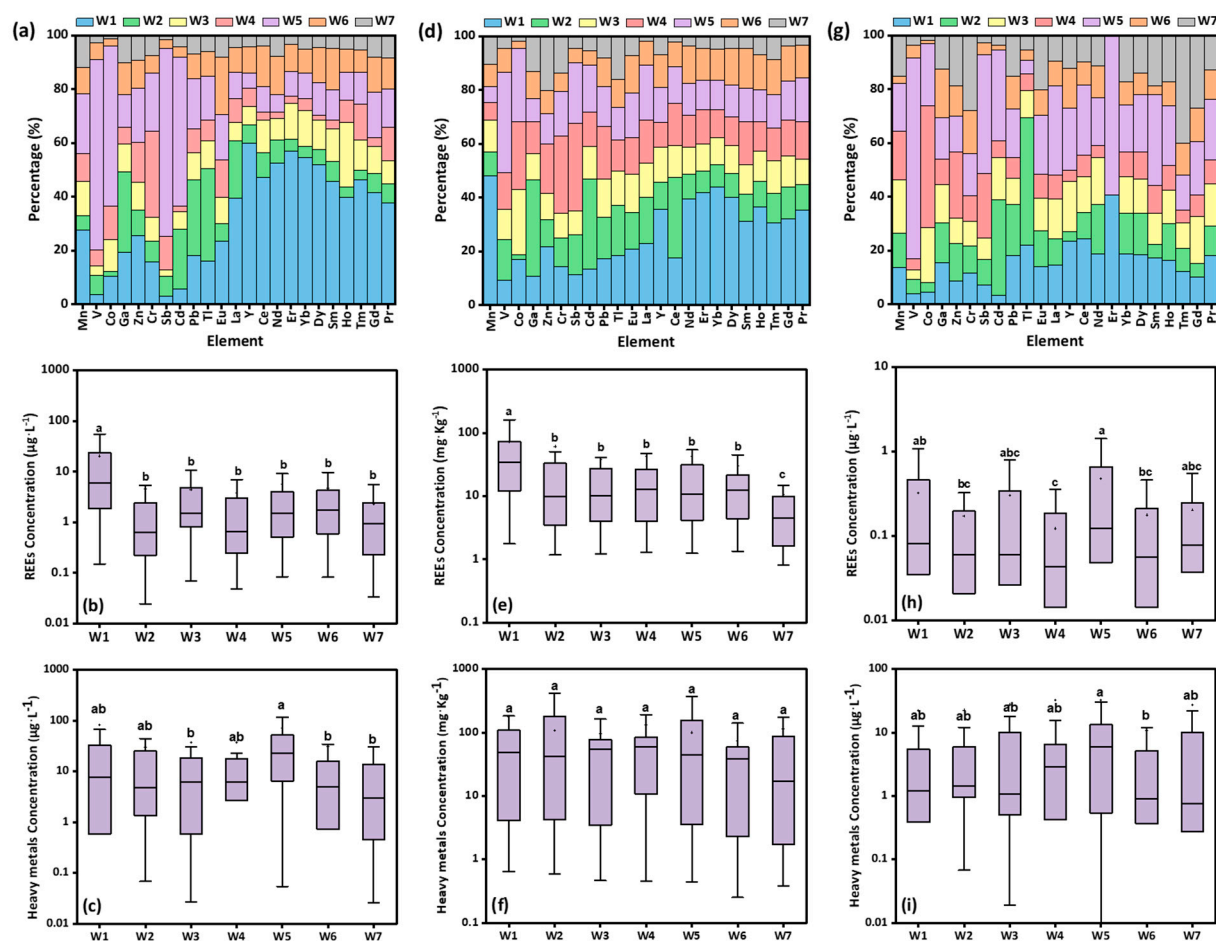


Figure S1. Relative percentage of inorganic elements in influent (a-c), sludge (d-f), and effluent (g-i) in 7 WWTPs. Different letters indicate statistically different (Kruskal-Wallis test; Dunn's test, $p < 0.05$).

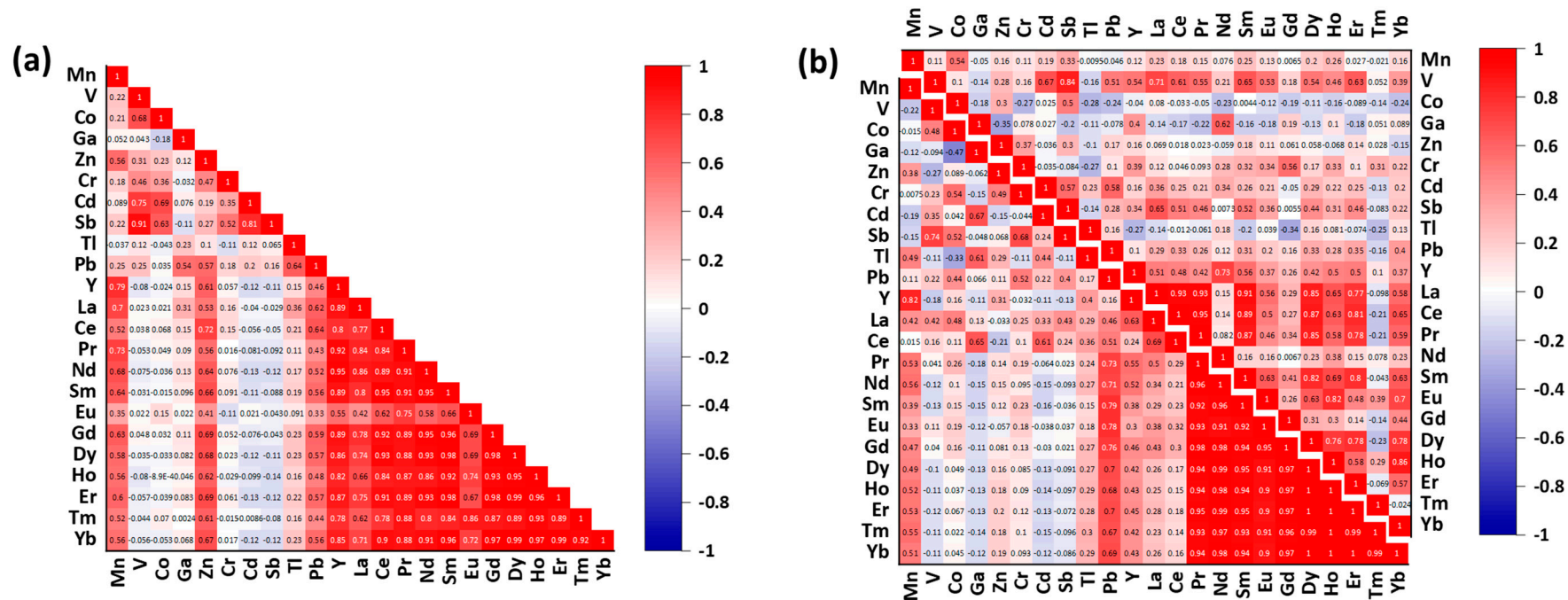


Figure S2. Correlation analysis among elements in influent (a), effluent (upper triangular) and sludge (lower triangular) (b).

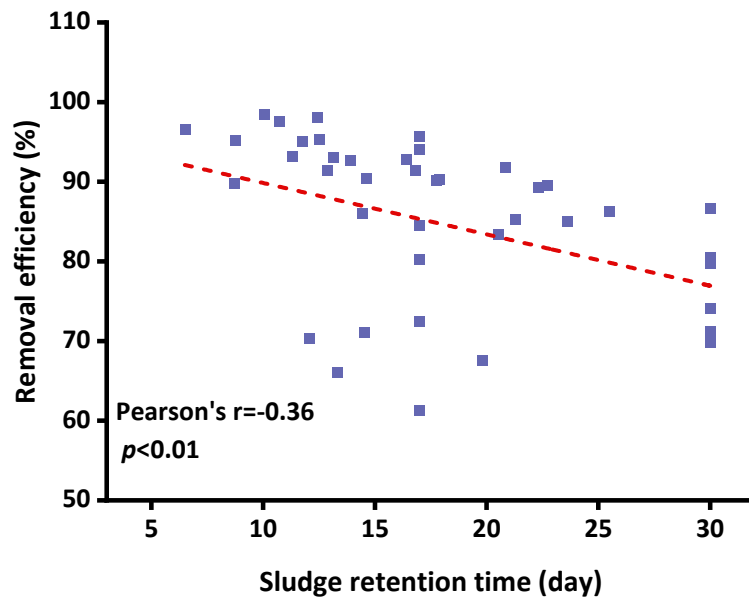


Figure S3. Relationship of sludge retention time and elemental removal efficiency in seven WWTPs.

Table S1. Performance of each WWTP during the sampling days.

WWTPs	Treatment process	Performance parameters	Jun 03	Jun 05	Jun 08	Jan 04	Jan 06	Jan 08
W1	primary sedimentation, oxidation ditches, secondary sedimentation, UV disinfection	Daily process capacity ($\times 10^4 \text{ m}^3 \cdot \text{d}^{-1}$)	11.4	10.6	12.0	6.1	7.2	6.6
		Daily activated sludge production (t)	248.4	256.7	240.2	265.2	252.6	249.0
		Daily excess sludge production (t)	20.6	24.9	26.9	20.7	22.7	18.3
W2	primary sedimentation, oxidation ditches, secondary sedimentation, UV disinfection	Daily process capacity ($\times 10^4 \text{ m}^3 \cdot \text{d}^{-1}$)	9.1	8.8	9.4	9.5	9.4	9.4
		Daily activated sludge production (t)	111.3	106.6	108.0	128.9	144.6	139.6
		Daily excess sludge production (t)	7.7	7.2	8.5	11.2	12.2	14.7
W3	primary sedimentation, A ² /O or oxidation ditches, secondary sedimentation, UV disinfection	Daily process capacity ($\times 10^4 \text{ m}^3 \cdot \text{d}^{-1}$)	9.2	9.8	9.8	9.2	9.0	8.5
		Daily activated sludge production (t)	457.1	455.4	438.8	546.2	555.8	556.8
		Daily excess sludge production (t)	16.3	17.4	11.8	18.1	19.5	16.4
W4	primary sedimentation, A ² /O, secondary sedimentation, chemical disinfection	Daily process capacity ($\times 10^4 \text{ m}^3 \cdot \text{d}^{-1}$)	8.4	8.3	9.1	9.8	10.1	10.0
		Daily activated sludge production (t)	295.3	295.3	295.3	452.2	381.2	385.5
		Daily excess sludge production (t)	170.6	172.6	184.0	163.3	157.2	179.4
W5	primary sedimentation, A ² /O, secondary sedimentation, UV disinfection	Daily process capacity ($\times 10^4 \text{ m}^3 \cdot \text{d}^{-1}$)	11.2	11.3	11.5	13.8	13.9	13.7
		Daily activated sludge production (t)	699.7	691.3	668.7	1215.9	1065.0	1091.6
		Daily excess sludge production (t)	20.3	23.6	23.1	23.5	30.3	35.4
W6	primary sedimentation, oxidation ditches, secondary sedimentation, UV disinfection	Daily process capacity ($\times 10^4 \text{ m}^3 \cdot \text{d}^{-1}$)	24.1	23.3	23.7	23.9	24.5	25.7
		Daily activated sludge production (t)	602.7	574.6	568.9	640.9	606.3	538.8
		Daily excess sludge production (t)	59.1	50.1	51.8	40.1	62.2	38.3
W7	primary sedimentation, biological aerated filters (BAF), UV disinfection	Daily process capacity ($\times 10^4 \text{ m}^3 \cdot \text{d}^{-1}$)	22.9	22.9	24.4	28.4	29.3	27.1
		Daily activated sludge production (t)	ND	ND	ND	ND	ND	ND
		Daily excess sludge production (t)	ND	ND	ND	ND	ND	ND

ND: no excess sludge was discharged during sampling day.

Table S2. Elemental recoveries and analytical standard deviations in aqueous and sludge (n =3).

Elements	Liquor			Sludge		
	Recovery (%)	RSD (%)	DL($\mu\text{g}\cdot\text{L}^{-1}$)	Recovery (%)	RSD (%)	DL ($\text{mg}\cdot\text{Kg}^{-1}$)
Mn	116.08	3.15	3.93×10^{-2}	70.92	0.08	1.21×10^1
V	114.78	1.63	9.20×10^{-1}	76.29	1.25	2.63×10^1
Co	107.76	1.11	7.27×10^{-2}	73.26	0.45	3.53
Ga	109.67	1.39	7.11×10^{-2}	68.87	7.66	3.43
Cr	108.56	3.51	3.52	92.02	3.77	1.35×10^2
Zn	107.05	4.83	1.44×10^{-1}	86.96	0.89	5.07×10^2
Cd	100.38	1.19	3.81×10^{-1}	91.55	2.70	4.44
Sb	114.77	2.05	4.40×10^{-2}	82.45	7.40	6.57
Tl	106.84	2.32	4.00×10^{-3}	71.53	3.12	1.80
Pb	99.19	2.28	8.29×10^{-3}	97.55	0.43	1.66×10^1
Y	115.76	0.94	2.13×10^{-3}	64.53	6.38	1.33
La	111.73	1.11	3.32×10^{-3}	112.58	5.59	1.10
Ce	112.75	1.18	2.87×10^{-3}	112.99	5.51	4.71
Pr	113.06	1.24	3.69×10^{-3}	122.43	4.76	5.11
Nd	114.08	0.71	1.10×10^{-2}	126.65	2.39	4.38
Sm	114.97	0.99	1.84×10^{-2}	118.55	5.84	2.75
Eu	124.16	0.84	3.03×10^{-3}	100.03	0.73	1.32
Gd	113.37	0.89	2.81×10^{-3}	120.03	1.72	2.73
Dy	114.79	0.73	6.40×10^{-3}	107.78	4.13	3.40
Ho	115.59	0.66	1.54×10^{-3}	97.04	3.81	4.92×10^{-1}
Er	114.75	0.81	5.75×10^{-3}	93.77	4.23	6.44
Tm	115.88	0.68	1.13×10^{-3}	98.20	3.80	3.50×10^{-1}
Yb	113.95	0.70	2.67×10^{-3}	95.40	4.27	4.06

Table S3. Median concentrations of target elements, unit: $\mu\text{g}\cdot\text{L}^{-1}$.

Country	Zn	Cr	Cd	Pb	Reference
Influent					
Southeast City, China	142	22.0	0.29	7.50	This work
Chongqing, China	109.1	-	1.22	18.2	[1]
Shanghai, China	358	46.0	0.12	2.00	[2]
Ostrava	181	2.76	1.00	5.00	[3]
Norway	119.1	2.96	0.19	3.17	[4]
Italy	833	5.80	0.60	13.3	[5]
Effluent					
Southeast City, China	72.4	7.91	0.146	0.991	This work
GB 18918-2002	1000	100	10	100	[6]
Sludge					
Southeast City, China	309	296	1.65	56.9	This work
48 cities, China	1058	93.1	2.01	72.3	[7]

Table S4. Median value of removal efficiency of target elements, unit: $\mu\text{g}\cdot\text{L}^{-1}$.

Element	W1	W2	W3	W4	W 5	W6	W7
Pb	87.71	89.97	90.80	92.46	90.89	85.88	76.19
V	86.50	84.36	81.72	84.35	79.06	90.50	82.21
Cr	82.62	55.92	63.00	87.25	78.96	54.07	-15.49
Ga	69.92	83.34	65.40	63.30	62.75	60.07	60.23
Cd	83.10	48.20	18.80	15.84	79.79	81.94	74.47
Zn	85.00	20.25	59.60	23.28	69.64	48.66	7.72
Tl	3.73	25.76	21.43	42.02	76.49	73.85	44.96
Sb	-11.97	45.18	-44.76	31.27	75.14	34.00	39.84
Co	77.30	-21.23	-31.11	-135.61	75.30	59.38	6.63
Mn	66.82	-83.47	-5.87	-28.10	34.45	81.98	-3.90
Y	97.51	95.66	86.31	97.03	75.37	92.63	79.72
La	99.09	98.95	95.58	98.29	93.68	98.09	95.22
Ce	98.46	56.35	96.33	79.42	94.62	98.24	94.57
Pr	98.80	95.92	95.16	98.07	95.79	98.26	97.19
Nd	97.79	80.44	81.91	87.01	86.24	93.34	88.13
Sm	98.89	98.82	96.93	96.31	94.54	99.54	91.11
Eu	95.99	79.46	88.08	94.60	90.76	96.43	79.59
Gd	97.78	93.75	86.73	83.65	86.34	88.68	64.12
Dy	98.81	89.22	96.45	88.65	93.57	98.33	87.72
Ho	98.07	80.50	97.75	96.70	91.89	97.19	84.76
Er	99.39	100.00	100.00	100.00	96.62	100.00	100.00
Tm	96.61	68.13	87.58	95.95	88.03	86.18	43.63
Yb	97.99	76.71	95.50	92.08	87.75	96.98	81.24
Total	96.61 ^a	80.43 ^{ab}	86.72 ^{ab}	87.24 ^{ab}	90.27 ^{ab}	90.49 ^{ab}	79.59 ^b

Note: a and b: different letters are statistically different (Kruskal–Wallis test; Dunn's test, $p < 0.05$).

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