

Supplementary Materials

Effect of nitrogen and phosphorus distribution in overlying water and sediment of major rivers in Changchun Urban on water quality

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Table S1. Summary for the measurement results of ammonia nitrogen (NH₃-N), total nitrogen (TN) and total phosphorus (TP) in standard solutions

Standard solution	Concentration (mg/L)	Linear equation	R
NH ₃ -N	0.000, 0.250, 0.500, 0.750, 1.000, 1.250, 1.500	$y=1.923x-0.004$	0.9999
TN	0.000, 0.500, 1.000, 1.500, 2.000, 2.500, 3.000	$y=3.901x-0.072$	0.9993
TP	0.000, 0.100, 0.200, 0.300, 0.400, 0.500, 0.600	$y=0.676x-0.006$	0.9997

R: correlation coefficient.

Table S2. Measurement results of certified reference material GBW07309

GBW07309	N	P
C_1 (mg/g)	0.422	0.685
C_2 (mg/g)	0.435	0.676
C_3 (mg/g)	0.419	0.692
C_4 (mg/g)	0.425	0.690
C_5 (mg/g)	0.413	0.683
\bar{C}_i (mg/g)	0.423	0.685
C_s (mg/g)	0.440	0.670
$\Delta \lg C$ (%)	1.73	0.97
RSD (%)	4.75	2.71
DL (mg/L)	0.013	0.007

C_1 , C_2 , C_3 and C_4 : the 1st, 2nd, 3rd and 4th measured value, respectively; \bar{C}_i : the average value of four measurements; C_s : national standard value; $\Delta \lg C$: logarithmic deviation; $\Delta \lg C = |\lg \bar{C}_i - \lg C_s|$; RSD: relative standard deviation; $\text{RSD} = \frac{\sqrt{\frac{\sum_{i=1}^n (C_i - C_s)^2}{n-1}}}{C_s} \times 100\%$, where $n=5$ was the number of parallel experiments; DL: detection limit.

Table S3. Content of ammonia nitrogen (NH₃-N), total nitrogen (TN) and total phosphorus (TP) in overlying water and sediment of six rivers in Changchun Urban

Sample	Water			Sediment			River
	NH ₃ -N (mg/L)	TN (mg/L)	TP (mg/L)	NH ₃ -N (mg/g)	TN (mg/L)	TP (mg/g)	
1	0.10	1.02	0.05	1.48	3.97	58.93	Chuan Lake
2	0.89	1.46	0.05	1.96	4.69	55.32	
3	11.31	15.21	2.84	1.49	3.51	81.96	
4	0.80	1.07	0.08	1.60	3.71	70.00	
5	0.12	0.88	0.05	0.52	4.34	17.38	
6	0.53	1.11	0.06	1.24	3.26	45.51	
7	13.96	30.80	3.47	0.98	4.27	63.45	
8	0.46	1.18	0.07	1.56	3.24	60.06	
9	0.70	5.30	0.07	2.63	3.82	52.83	
10	2.73	11.17	0.06	2.49	2.61	27.32	
11	8.21	17.81	0.29	2.42	2.58	28.67	
12	0.34	1.21	0.05	1.17	3.21	44.33	
13	4.39	9.55	0.64	1.58	3.70	47.57	
1	11.21	16.65	0.12	0.41	2.07	38.83	Jingshui River
2	19.54	20.05	0.24	1.72	3.61	65.93	
3	10.24	10.51	0.29	2.46	4.23	99.35	
4	1.90	5.48	0.15	1.61	2.63	91.90	
5	2.35	7.45	0.18	1.14	2.00	56.67	
6	2.35	9.08	0.2	0.69	1.76	37.03	
7	10.61	11.53	0.2	1.34	2.65	64.95	
8	10.83	12.00	0.28	1.69	3.69	74.74	
9	10.84	15.16	0.13	1.19	3.87	63.45	
10	7.93	10.37	0.26	2.14	4.13	94.38	
1	0.16	1.36	0.17	0.31	1.43	15.12	West Lake
2	5.98	9.97	0.16	0.43	2.08	22.35	
3	6.05	10.22	0.13	0.28	1.76	32.28	
4	0.85	1.90	0.14	0.25	1.16	47.41	
5	3.61	7.42	0.28	0.25	1.60	79.71	
6	7.84	12.67	0.29	3.46	4.68	88.96	
7	10.38	14.20	0.14	3.51	3.92	152.87	
8	11.27	14.82	0.12	0.75	2.19	138.87	
9	12.01	14.96	0.13	4.10	4.49	138.64	
10	6.27	8.80	0.13	3.56	3.71	121.03	
1	1.46	10.51	0.22	0.29	5.25	48.54	Xinkai River
2	1.33	9.44	0.16	0.24	6.50	68.87	
3	0.98	7.45	0.16	0.24	6.08	59.16	
4	8.54	13.35	2.97	0.25	3.18	40.86	

5	16.09	24.90	5.52	3.63	10.26	64.12	
6	9.50	18.31	2.98	3.65	9.92	50.12	
7	3.58	8.72	0.44	0.19	2.87	77.45	
8	4.07	7.20	0.33	0.29	3.90	104.09	
9	4.31	7.57	0.53	0.35	3.71	48.54	
10	3.88	10.77	0.6	0.18	5.57	29.80	
11	3.38	10.54	0.51	0.20	7.07	48.09	
12	3.13	8.15	0.45	0.52	6.50	70.90	
13	3.09	7.29	0.69	1.10	4.73	60.96	
14	2.44	6.60	0.79	2.29	5.39	67.29	
15	3.58	9.92	0.70	1.94	6.55	89.42	
16	4.97	11.95	1.25	1.36	5.09	84.67	
17	4.39	11.50	1.72	9.95	13.03	100.03	
18	3.78	11.55	1.98	9.97	10.44	126.00	
19	3.63	11.40	2.14	1.80	6.84	113.13	
20	4.08	11.55	2.06	12.35	13.13	86.93	
21	4.02	11.25	2.85	13.72	16.72	87.61	
22	4.34	11.20	2.29	3.55	10.12	73.38	
23	4.79	10.85	1.10	1.50	3.67	54.41	
24	4.85	10.20	0.92	9.67	10.84	61.87	
25	4.62	10.15	0.49	9.91	14.99	68.64	
26	2.56	7.64	0.45	0.66	2.44	77.45	
27	1.52	6.64	0.71	1.15	7.55	59.61	
28	3.84	9.75	1.03	1.69	4.36	67.74	
29	3.73	12.43	0.70	1.03	3.96	71.58	
1	1.17	7.53	0.09	1.55	3.55	78.58	
2	2.19	8.95	0.08	2.72	7.87	58.25	
3	2.23	10.37	0.10	3.71	9.20	97.09	
4	2.29	6.79	0.12	3.51	9.26	115.61	
5	1.34	6.10	0.12	1.06	5.30	89.64	Yitong River
6	1.84	7.95	0.10	2.51	9.09	87.84	
7	1.29	9.68	0.10	1.25	5.98	71.12	
8	2.11	8.22	0.09	4.00	10.47	104.55	
9	2.37	7.52	0.11	2.23	5.14	69.32	
10	1.55	8.72	0.09	1.84	5.08	69.32	
1	1.07	8.78	0.08	2.48	7.12	84.22	Yongchun River
2	1.42	5.25	0.05	2.94	4.06	87.84	
3	0.41	5.71	0.07	3.13	5.93	118.1	
4	0.96	6.58	0.07	2.85	6.60	96.72	
5	2.07	8.32	0.06	2.29	4.07	53.96	
6	0.06	9.24	0.10	2.67	4.01	114.48	
7	0.24	7.47	0.09	2.90	6.13	116.29	

8	0.15	8.36	0.09	2.79	3.52	115.39
9	1.57	8.55	0.07	2.39	4.70	69.09
10	0.69	6.14	0.07	2.99	4.34	107.41

Table S4. Other physicochemical properties of overlying water and sediment in six rivers of Changchun Urban

Sample	DO (mg/L)	Eh (mV)	T (°C)	COD (mg/L)	pH _w	OM (%)	pH _s	River
1	13.60	141.50	7.20	8.50	8.40	0.08	8.52	Chuan Lake
2	11.25	153.00	6.60	10.00	8.31	0.12	7.95	
3	5.49	181.50	5.40	59.00	8.04	0.09	7.52	
4	7.89	165.50	5.90	29.50	8.36	0.12	7.86	
5	13.10	141.50	7.00	15.00	8.54	0.08	8.08	
6	11.43	151.71	6.40	16.86	8.41	0.10	8.02	
7	2.57	179.50	4.45	82.00	8.19	0.06	7.28	
8	17.17	153.00	5.65	8.00	8.26	0.08	8.07	
9	15.45	149.50	6.15	10.00	8.30	0.09	8.13	
10	10.19	163.00	8.70	22.50	8.50	0.07	8.22	
11	10.35	172.00	7.30	43.67	8.39	0.08	8.32	
12	15.93	145.33	6.43	10.33	8.37	0.08	8.26	
13	10.38	161.62	6.24	32.31	8.34	0.09	7.96	
1	9.67	162.00	8.35	49.50	8.04	0.07	7.89	Jingshui River
2	13.05	153.50	4.70	90.00	7.86	0.10	7.72	
3	15.72	100.50	4.85	65.50	8.05	0.12	7.28	
4	16.67	45.50	4.95	35.00	8.22	0.11	7.61	
5	17.44	66.00	5.85	66.50	8.12	0.09	7.92	
6	13.11	129.50	9.40	56.50	8.12	0.07	7.75	
7	14.27	109.50	6.35	60.50	8.07	0.09	7.69	
8	13.88	170.50	8.45	67.50	8.06	0.11	7.42	
9	11.50	92.00	4.75	47.50	8.03	0.09	7.75	
10	18.21	107.00	4.90	77.50	8.06	0.12	7.58	
1	10.96	267.50	6.50	23.50	7.60	0.04	7.74	West Lake
2	9.56	261.50	10.95	16.00	7.41	0.05	7.50	
3	10.34	227.00	12.10	14.50	7.94	0.06	7.77	
4	11.03	149.00	7.05	16.50	8.43	0.06	7.80	
5	10.58	121.00	6.80	27.50	8.09	0.05	7.86	
6	10.02	135.00	10.65	32.50	8.03	0.04	7.83	
7	8.46	132.50	12.70	29.50	7.93	0.04	7.57	
8	8.32	130.50	12.30	26.50	7.90	0.03	7.93	
9	8.31	127.50	12.60	24.00	7.86	0.05	7.96	
10	9.72	199.50	9.75	27.50	7.67	0.06	7.83	
1	15.87	170.90	6.00	21.50	8.39	0.05	7.60	Xinkai River
2	13.45	168.35	5.75	19.50	8.13	0.04	7.53	
3	12.80	146.50	5.80	33.50	8.16	0.04	7.82	
4	11.37	122.65	6.60	463.50	9.16	0.04	8.55	
5	9.99	105.00	6.65	816.50	9.79	0.05	8.57	

6	8.68	136.15	5.50	415.50	8.97	0.16	8.15	
7	11.48	154.15	5.55	64.00	8.37	0.34	8.12	
8	13.47	146.45	5.75	41.00	8.31	0.26	8.17	
9	10.36	150.60	6.00	35.00	8.29	0.17	8.19	
10	9.40	150.00	6.35	35.00	8.29	0.14	8.05	
11	10.70	146.40	6.35	32.50	8.27	0.11	8.01	
12	11.63	149.05	6.65	32.50	8.28	0.14	8.09	
13	11.59	155.55	7.10	34.50	8.44	0.06	8.24	
14	10.90	153.65	7.50	40.00	8.44	0.03	9.17	
15	10.87	154.90	8.00	39.50	8.47	0.03	8.95	
16	11.03	160.20	9.35	28.50	8.52	0.04	7.87	
17	10.71	160.55	10.15	22.50	8.43	0.06	7.77	
18	10.35	162.90	10.75	23.50	8.45	0.06	7.96	
19	10.38	166.45	10.40	25.50	8.32	0.05	8.06	
20	10.69	168.40	9.15	26.50	8.25	0.06	7.89	
21	10.96	172.05	8.95	27.00	8.30	0.05	7.91	
22	11.35	182.05	9.00	28.50	8.29	0.05	7.85	
23	11.31	188.25	9.25	28.50	8.25	0.05	7.76	
24	11.29	189.30	8.90	25.00	8.22	0.04	7.91	
25	11.19	188.65	8.50	23.00	8.22	0.05	7.99	
26	10.97	173.70	7.75	31.50	8.24	0.05	8.29	
27	11.07	167.60	5.35	32.00	8.30	0.05	8.30	
28	9.74	168.90	6.90	71.00	8.31	0.05	7.90	
29	13.16	160.00	8.05	72.00	8.41	0.06	7.73	
1	9.11	137.50	11.20	27.50	8.13	0.06	8.01	
2	8.75	108.00	11.80	27.00	8.14	0.08	7.96	
3	9.06	115.50	12.55	33.00	8.08	0.13	7.78	
4	9.21	74.00	13.15	32.50	8.05	0.16	7.72	
5	9.45	105.00	11.80	32.00	8.01	0.09	7.49	
6	9.11	108.00	12.10	30.40	8.08	0.11	7.79	Yitong River
7	9.30	146.50	11.20	32.50	8.04	0.06	7.55	
8	8.87	106.50	12.55	28.00	8.17	0.14	8.24	
9	9.10	75.50	12.40	31.50	8.02	0.11	7.45	
10	9.05	130.67	11.40	29.00	8.10	0.07	7.84	
1	9.39	117.50	14.00	46.00	9.36	0.07	7.96	
2	9.13	123.00	11.55	37.00	9.21	0.07	7.68	
3	10.24	160.50	11.25	43.00	8.57	0.09	7.99	
4	9.58	133.67	12.27	42.00	9.04	0.08	7.87	
5	8.28	80.00	14.30	40.00	10.00	0.06	7.65	Yongchun River
6	10.50	155.00	13.70	52.00	8.72	0.09	8.26	
7	10.37	157.75	12.48	47.50	8.64	0.09	8.12	
8	10.43	156.38	13.09	49.75	8.68	0.09	8.19	

9	8.84	98.75	14.15	43.00	9.68	0.07	7.80
10	9.91	147.08	11.76	42.50	8.80	0.08	7.93

DO: dissolved oxygen; Eh: oxidation-reduction potential; T: temperature; COD: Chemical oxygen demand; pH_w: pH value of overlying water; OM: organic matter in sediment; pH_s: pH value of sediment.

Table S5. Classification of samples based on five discriminant functions

Initial grouping		Prediction grouping						Total
		1	2	3	4	5	6	
Count	1	13	0	0	0	0	0	13
	2	0	10	0	0	0	0	10
	3	1	0	9	0	0	0	10
	4	2	0	0	27	0	0	29
	5	0	0	1	0	9	0	10
	6	0	0	0	0	0	10	10
Percentage (%)	1	100	0	0	0	0	0	100
	2	0	100	0	0	0	0	100
	3	10	0	90	0	0	0	100
	4	6.9	0	0	93.1	0	0	100
	5	0	0	10	0	90	0	100
	6	0	0	0	0	0	100	100

Note: 95.1% of the initial grouping cases were correctly classified.

Table S6. The eigenvalue of canonical discriminate function

Function	Eigenvalue	VC%	Cumulative VC %	Correlation
1	8.076 ^a	41.3	41.3	0.943
2	6.732 ^a	34.4	75.7	0.933
3	2.668 ^a	13.6	89.3	0.853
4	1.670 ^a	8.5	97.9	0.791
5	0.420 ^a	2.1	100	0.544

a: The first five discriminant functions are used in the analysis. VC: variance contribution

Table S7. Classification standard of ammonia nitrogen (NH₃-N), total nitrogen (TN) and total phosphorus (TP) for surface water in the environmental quality standard GB3838-2002 of the People's Republic of China

Classification	I	II	III	IV	V
NH ₃ -N (mg/L) ≤	0.15	0.5	1	1.5	2
TN (mg/L) ≤	0.2	0.5	1	1.5	2
TP (mg/L) ≤	0.02	0.1	0.2	0.3	0.4