Supplementary Materials

Integrating water quality index (WQI) and multivariate statistics for regional surface water quality evaluation: key parameter identification and human health risk assessment

Huoqian Luo [1], Xizhi Nong [2,*], Huajie Xia [3], Huabin Liu [1], Lingshuang Zhong [3], Yao Feng [4], Wenjuan Zhou [1], and Yu Lu [5,*]

[1] Fujian Polytechnic of Water Conservancy and Electric Power, Sanming 366000, China; gis03028@163.com (L.H.); 13559877658@163.com (L.H.); giszwjer@163.com (Z.W.)

[2] College of Civil Engineering and Architecture, Guangxi University, Nanning 530004, China; nongxizhi@gxu.edu.cn (N.X.)

[3] Ningde City Water Resources and River Affairs Center, Sanming 366000, China; ndshzb@163.com (X.H.); 17605937293@163.com (Z.L.)

[4] Ningde Hywison Big Data Technology Co., Ltd., Sanming 366000, China; feuky@163.com (F.Y.)

[5] Guangxi Transportation Science and Technology Group Co., Ltd., Nanning 530004, China; wmwiz-ard@163.com (Y.L.)

* Correspondence: nongxizhi@gxu.edu.cn; wmwizard@163.com

Table S1

The location of the water quality monitoring stations for Nanning City.

Sites/Stations	Code	longitude	latitude
Baima	BM	107° 57' 08"	23° 02' 28"
Dingdang	DD	107° 58' 48"	23° 03' 42"
Duan	DA	108° 10' 48"	23° 51' 35"
Laokou	LK	108° 07' 35"	22° 47' 01"
Lianshan	LS	108° 19' 47"	22° 35' 21"
Liujing	LJ	108° 49' 41"	22° 52' 22"
Nanan	NA	109° 25' 18"	22° 48' 07"
Shangzhong	SZ	108° 01' 27"	22° 48' 17"
Yanjiang	YJ	107° 38' 26"	23° 16' 17"

Table S2

The normalization factors of the water quality indicators.

water quality indicators	Normalization factor (Ci)										
	100	**90**	**80**	**70**	**60**	**50**	**40**	**30**	**20**	**10**	**0**
T	21/16	22/15	24/14	26/12	28/10	30/5	32/0	36/−2	40/−4	45/−6	>45/<−6
pH	7	7-8	7-8.5	7-9	6.5-7	6-9.5	5-10	4-11	3-12	2-13	1-14
DO	≥7.5	>7	>6.5	>6	>5	>4	>3.5	>3	>2	≥1	<1
TP	<0.01	<0.02	<0.05	<0.1	<0.15	<0.2	<0.25	<0.3	<0.35	≤0.4	>100
COD_{Mn}	<1	<2	<3	<4	<6	<8	<10	<12	<14	≤15	>15
COD	<5	<10	<20	<30	<40	<50	<60	<80	<100	<150	>150
BOD_5	<0.5	<2	<3	<4	<5	<6	<8	<10	<12	<15	>15
NH_3-N	<0.01	<0.05	<0.1	<0.2	<0.3	<0.4	<0.5	<0.75	<1	≤1.25	>1.25
Cu	<5	<10	<20	<40	<50	<75	<100	<200	<500	<1000	>1000
Zn	<20	<50	<100	<400	<700	<1000	<1250	<1500	<1750	<2000	>2000
F^-	<0.17	<0.34	<0.51	<0.68	<0.84	<1	<1.13	<1.26	<1.39	<1.5	>1.5
Se	<0.001	<0.002	<0.004	<0.006	<0.008	<0.01	<0.012	<0.014	<0.016	<0.02	>0.02
As	<0.005	<0.01	<0.02	<0.03	<0.04	<0.05	<0.062	<0.074	<0.086	<0.1	>0.1
Hg	<0.01	<0.02	<0.04	<0.05	<0.075	<0.1	<0.25	<0.5	<0.75	<1	>1
Cd	<0.5	<1	<1.5	<2	<2.5	<3	<4	<5	<7.5	<10	>10
Cr	<5	<10	<15	<20	<25	<30	<40	<50	<75	<100	>100
Pb	<2.5	<5	<7.5	<10	<20	<30	<40	<50	<75	<100	>100

Table S3

Parameter selections of the WQI (lg(WQI+1)) models using the multiple stepwise linear regression based on the training data set (8 : 2; n=59).

Model	Linear model	R^2	*P*
1	$1.787^{***}+0.098^{***}lg(DO+1)$	0.632	< 0.001
2	$1.561^{***}+0.078^{***}lg(DO+1)+0.136^{***}lg(COD_{Mn}+1)$	0.829	< 0.001
3	$1.546^{***}+0.080^{***}lg(DO+1)+0.096^{***}lg(COD_{Mn}+1)+0.046^{***}lg(NH_3\text{-}N+1)$	0.878	< 0.001
4	$1.416^{***}+0.089^{***}lg(DO+1)+0.092^{***}lg(COD_{Mn}+1)+0.046^{***}lg(NH_3\text{-}N+1)+0.061^{***}lg(Hg+1)$	0.918	< 0.001
5	$1.375^{***}+0.071^{***}lg(DO+1)+0.069^{***}lg(COD_{Mn}+1)+0.064^{***}lg(NH_3\text{-}N+1)+0.090^{***}lg(Hg+1)+0.018^{***}lg(WT+1)$	0.959	<0.001
6	$1.320^{***}+0.068^{***}lg(DO+1)+0.058^{***}lg(COD_{Mn}+1)+0.057^{***}lg(NH_3\text{-}N+1)+0.083^{***}lg(Hg+1)+0.018^{***}lg(WT+1)+0.054^{***}lg(COD+1)$	0.972	< 0.001
7	$1.126^{***}+0.071^{***}lg(DO+1)+0.059^{***}lg(COD_{Mn}+1)+0.058^{***}lg(NH_3\text{-}N+1)+0.078^{***}lg(Hg+1)+0.016^{***}lg(WT+1)+0.052^{***}lg(COD+1)+0.101^{***}lg(Se+1)$	0.985	< 0.001

Table S4

Parameter selections of the WQI (lg(WQI+1)) models using the multiple stepwise linear regression based on the training data set (7 : 3; n=52).

Model	Linear model	R^2	*P*
1	$1.775^{***}+0.105^{***}\lg(DO+1)$	0.544	< 0.001
2	$1.498^{***}+0.086^{***}\lg(DO+1)+0.160^{***}\lg(COD_{Mn}+1)$	0.762	< 0.001
3	$1.334^{***}+0.095^{***}\lg(DO+1)+0.155^{***}\lg(COD_{Mn}+1)+0.079^{***}\lg(Hg+1)$	0.831	< 0.001
4	$1.335^{***}+0.094^{***}\lg(DO+1)+0.112^{***}\lg(COD_{Mn}+1)+0.078^{***}\lg(Hg+1)+0.044^{***}\lg(NH_3\text{-}N+1)$	0.886	< 0.001
5	$1.345^{***}+0.072^{***}\lg(DO+1)+0.076^{***}\lg(COD_{Mn}+1)+0.097^{***}\lg(Hg+1)+0.063^{***}\lg(NH_3\text{-}N+1)+0.018^{***}\lg(WT+1)$	0.941	<0.001
6	$1.209^{***}+0.077^{***}\lg(DO+1)+0.071^{***}\lg(COD_{Mn}+1)+0.094^{***}\lg(Hg+1)+0.057^{***}\lg(NH_3\text{-}N+1)+0.016^{***}\lg(WT+1)+0.080^{***}\lg(BOD_5+1)$	0.965	< 0.001
7	$1.179^{***}+0.074^{***}\lg(DO+1)+0.055^{***}\lg(COD_{Mn}+1)+0.082^{***}\lg(Hg+1)+0.053^{***}\lg(NH_3\text{-}N+1)+0.017^{***}\lg(WT+1)+0.071^{***}\lg(BOD_5+1)+0.057^{***}\lg(COD+1)$	0.981	< 0.001

Table S5

Parameter selections of the WQI (lg(WQI+1)) models using the multiple stepwise linear regression based on the training data set (6 : 4; n=45).

Model	Linear model	R^2	*P*
1	$1.785^{***}+0.099^{***}lg(DO+1)$	0.570	< 0.001
2	$1.535^{***}+0.078^{***}lg(DO+1)+0.149^{***}lg(COD_{Mn}+1)$	0.814	< 0.001
3	$1.365^{***}+0.089^{***}lg(DO+1)+0.142^{***}lg(COD_{Mn}+1)+0.081^{***}lg(Hg+1)$	0.872	< 0.001
4	$1.379^{***}+0.087^{***}lg(DO+1)+0.103^{***}lg(COD_{Mn}+1)+0.074^{***}lg(Hg+1)+0.042^{***}lg(NH_3\text{-}N+1)$	0.908	< 0.001
5	$1.365^{***}+0.065^{***}lg(DO+1)+0.075^{***}lg(COD_{Mn}+1)+0.088^{***}lg(Hg+1)+0.067^{***}lg(NH_3\text{-}N+1)+0.020^{***}lg(WT+1)$	0.955	<0.001
6	$1.155^{***}+0.067^{***}lg(DO+1)+0.076^{***}lg(COD_{Mn}+1)+0.085^{***}lg(Hg+1)+0.068^{***}lg(NH_3\text{-}N+1)+0.017^{***}lg(WT+1)+0.107^{***}lg(Se+1)$	0.971	< 0.001
7	$1.047^{***}+0.070^{***}lg(DO+1)+0.074^{***}lg(COD_{Mn}+1)+0.086^{***}lg(Hg+1)+0.063^{***}lg(NH_3\text{-}N+1)+0.015^{***}lg(WT+1)+0.098^{***}lg(Se+1)+0.070^{***}lg(BOD_5+1)$	0.983	< 0.001