Supplement materials

Text 1: Analysis condition of ICP-MS and AFS

The analysis condition of ICP-MS was: the RF generator power was 1350 W, the velocity of flow of plasma gas was 16.0 L·min^{-1}, the velocity of flow carrier gas was 1.12 L·min^{-1}, the residence time was 30 ms. The pore diameter of skimmer was 0.80 mm.

Hg concentrations in the aqueous were analyzed by hydride generation atomic fluorescence spectrometry (HG-AFS) using a Millennium Excalibur system (PSA 10.055. PS Analytical Ltd, UK). The filtrated solution was transferred and reduced by KI–ascorbic acid solution (0.06 mol·L^{-1} KI and 0.01 mol·L^{-1} ascorbic acid) in 3 mol·L^{-1} HCl. The samples were made to a certain volume with ultrapure water and left for half an hour at room temperature. The Hg concentrations were then analyzed.

Text S2: Generally speaking, fuzzy comprehensive assessment (FCA) includes five main stages [1]

1) Establish assessment parameters set *U* as the environmental assessment parameters that were representative of water quality.

$$U = \left(u_1, u_2, \ldots, u_n\right), \qquad (1)$$

where *n* is the number of selected parameters (u_i).

2) Establish assessment criterion set *V* of five water quality classes was derived according to GB/T 14848-93 standards.

$$V = \left(v_1, v_2, \ldots, v_m\right), \qquad (2)$$

m is the number of water qulity criterion classes (v_i). In this stduy, *V* is established based on GB/T 14848-93 standards. Water quality is classified into five levels: Class I, excellent; Class II, good; Class III, ordinary; Class IV, poor; Class V, bad.

3) Establish the membership function and fuzzy matrix

Membership degree which indicates the degree of the parameters belonging to the fuzzy set is calculated by a set of formulas below.

$$u_1(x) = \begin{cases} 1 & x \le v_1 \\ (v_2 - x)/(v_2 - v_1) & v_1 < x < v_2 \\ 0 & x \ge v_2 \end{cases}, \qquad (3)$$

$$u_2(x) = \begin{cases} 0 & x \le v_1 \ or \ x \ge v_3 \\ (x - v_1)/(v_2 - v_1) & v_1 < x < v_2 \\ (v_3 - x)/(v_3 - v_2) & v_2 \le x < v_3 \end{cases}, \qquad (4)$$

$$u_3(x)=\begin{cases}0 & x\le v_2 \ or \ x\ge v_4\\ (x-v_2)/(v_3-v_2) & v_2<x<v_3\\ (v_4-x)/(v_4-v_3) & v_3\le x<v_4\end{cases}, \tag{5}$$

$$u_4(x)=\begin{cases}0 & x\le v_3 \ or \ x\ge v_5\\ (x-v_3)/(v_4-v_3) & v_3<x<v_4\\ (v_5-x)/(v_5-v_4) & v_4\le x<v_5\end{cases}, \tag{6}$$

$$u_5(x)=\begin{cases}0 & x\le v_4\\ (x-v_4)/(v_5-v_4) & v_4<x<v_5\\ 1 & x\ge v_5\end{cases}, \tag{7}$$

The membership degree of each parameter is obtained from the membership function above. The membership of all parameters establishes the fuzzy matrix *R*:

$$R=\begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} & r_{15}\\ r_{21} & r_{22} & r_{23} & r_{24} & r_{25}\\ \vdots & \vdots & \vdots & \vdots & \vdots\\ r_{n1} & r_{n2} & r_{n3} & r_{n4} & r_{n5}\end{bmatrix}, \tag{8}$$

n is the number of assessment parameters.

4) Establish the weight set *B*

Different pollutants have their own impacts on water quality, then different weight is assigned to each pollutant. Here the weights of all parameters are calculated using the formula below:

$$W_i = a_i \Big/ \sum_{i=1}^{n} a_i , \tag{9}$$

$$a_i = x_i / s_i , \tag{10}$$

where s_i is the average of the ith assessment criterion at each level, and x_i is the real value of ith assessment parameter (a_i).

5) Comprehensive assessment

The assessment result is obtained using the fuzzy algorithm of $B\cdot R=\left(b_1,b_2,b_3,b_4,b_5\right)$, and the assessed subject should be put into the category with the maximum of $b_j(j=1,2,3,4,5)$.

Table S1 Sampling site information

sampling site as red circles in Fig. 1				pollution site as black triangle in Fig. 1	
No.	coordinate	well depth/m	use of state	No.	coordinate
1	N25°46.284′; E113°09.597′	below 1.0	non-use from 2008	1	N25°42.917′; E113°10.970′
2	N25°47.582′; E113°08.856′	1.0	non-use from 2006	2	N25°43.298′; E113°9.623′
3	N25°47.762′; E113°08.648′	1.0	non-use from 2006	3	N25°43.161′; E113°09.997′
4	N25°48.115′; E113°10.405′	1.2	being used	4	N25°43.906′; E113°10.547′
5	N25°49.005′; E113°09.225′	1.7	being used	5	N25°44.108′; E113°10.339′
6	N25°49.402′; E113°09.041′	2.5	being used	6	N25°46.303′; E113°09.646′
7	N25°49.495′; E113°8.547′	1.5	being used	7	N25°46.354′; E113°10.349′
8	N25°49.548′; E113°09.551′	1.5	being used	8	N25°46.354′; E113°10.349′
9	N25°49.571′; E113°09.223′	2.0	being used	9	N25°47.718′; E113°09.743′
10	N25°49.604′; E113°08.615′	1.7	being used	10	N25°47.888′; E113°9.169′
11	N25°49.812′; E113°08.599′	1.5	being used	11	N25°48.028′; E113°09.676′
12	N25°49.877′; E113°08.784′	1.0	non-use from 2005	12	N25°48.054′; E113°09.781′
13	N25°50.554′; E113°08.849′	1.2	non-use from 2003	13	N25°48.054′; E113°09.781′
14	N25°51.913′; E113°9.595′	below 1.0	being used	14	N25°48.046′; E113°09.630′
15	N25°52.087′; E113°09.194′	–	non-use	15	N25°49.970′; E113°08.457′
16	N25°52.289′; E113°09.191′	1.5	being used	16	N25°50.463′; E113°08.519′
17	N25°52.908′; E113°09.662′	1.0	being used	17	N25°50.949′; E113°8.762′
18	N25°52.942′; E113°09.461′	below 1.0	being used	18	N25°51.379′; E113°08.928′
19	N25°53.170′; E113°08.758′	10.0	being used		
20	N25°53.657′; E113°08.816′	1.0	non-use from 2003		

Table S2 Limit of detection (LOD), SF and RfD for each heavy metal

heavy metal	LOD/(ng·L^{-1})	SF/(kg·d·mg^{-1})	RfD /(mg·(kg d)$^{-1}$)
Cr	0.2	0. 5	0.003
Mn	0.2	–	0.024
Fe	30	–	0.7
Ni	0.3	–	0.02
Cu	1.0	–	0.04
Zn	2.0	–	0.3
As	0.1	1.5	0.0003
Cd	0.01	6.1	0.0005
Ba	0.2	–	0.2
Hg	0.005	–	0.00016
Pb	0.1	0.0085	0.0014

Table S3 Origin data of heavy metal in 20 well

season	sampling site No.	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Ba	Hg	Pb
dry season	1	0.55	1.46	78.43	0.64	1.48	53.85	0.99	0.06	92.39	0.02	1.25
	2	0.72	3.46	70.93	0.68	2.06	57.02	0.30	0.05	60.74	0.02	2.23
	3	0.64	21.04	108.09	1.05	7.78	53.83	3.81	0.09	120.94	0.03	0.39
	4	0.62	35.78	101.61	0.58	2.12	58.15	1.21	0.05	65.79	0.01	0.76
	5	0.48	2.46	93.38	0.69	1.34	46.40	0.53	0.03	76.12	0.01	1.62
	6	0.53	1.33	82.34	0.72	4.51	73.74	0.32	0.03	103.94	0.01	4.03
	7	2.45	30.30	518.87	3.09	9.93	208.47	16.09	0.67	209.86	0.82	1.77
	8	0.55	1.41	76.19	0.78	1.70	70.57	0.25	0.03	105.76	0.14	2.03
	9	0.45	6.44	91.70	0.96	2.70	116.87	0.79	0.04	93.39	0.09	1.56
	10	0.52	5.68	93.40	1.14	2.37	100.95	1.04	0.07	112.16	0.07	3.95
	11	0.37	723.04	97.79	1.00	1.55	62.72	0.39	0.45	94.54	0.05	0.41
	12	0.41	232.94	101.57	1.49	1.47	43.22	0.43	0.16	128.56	0.06	0.52
	13	0.40	6.81	62.56	0.86	1.52	66.60	0.26	0.03	91.88	0.04	1.57
	14	0.44	6.53	67.03	1.06	1.24	61.84	0.24	0.03	93.35	0.02	3.65
	15	0.46	5.94	66.74	0.95	1.81	61.00	2.91	0.04	115.46	0.03	2.43
	16	0.45	6.65	93.79	0.72	1.37	53.91	0.82	0.03	89.64	0.05	1.82
	17	0.37	2.20	61.29	1.04	1.59	76.31	0.46	0.03	80.63	0.01	2.20
	18	0.52	5.08	70.99	0.96	1.58	51.06	0.54	0.03	103.56	0.01	1.44
	19	0.72	12.47	154.97	6.76	3.98	86.41	2.79	0.16	91.18	0.04	2.06
	20	0.43	5.87	93.44	0.95	1.65	59.75	3.04	0.05	103.36	0.05	0.38
	distribution	log-normal	log-normal	log-normal	log-normal	log-normal	log-normal	log-normal	log-normal	log-normal	log-normal	normal
wet season	1	0.79	1.25	74.47	0.54	1.31	37.45	0.59	0.07	104.54	0.02	0.79
	2	0.89	4.66	74.78	1.29	2.01	34.67	0.46	0.06	109.94	0.02	1.27
	3	0.83	46.27	150.1	0.96	4.70	54.34	16.07	0.22	115.94	0.1	0.28

4	0.79	17.10	113.2	0.77	4.25	34.68	10.38	0.22	117.84	0.04	0.70
5	0.76	4.48	82.58	0.91	1.41	40.08	0.76	0.03	107.84	0.02	2.44
6	0.77	0.95	68.31	1.01	2.74	26.46	0.21	0.02	107.24	0.02	1.02
7	0.78	42.93	128.6	1.00	1.70	23.94	3.99	0.05	101.64	0.01	1.24
8	0.88	4.03	85.64	1.18	1.63	32.72	2.87	0.23	111.94	0.02	0.77
9	0.80	5.62	79.63	2.62	2.88	30.20	0.33	0.02	116.14	0.03	0.30
10	0.85	3.64	83.12	5.89	2.94	50.09	0.50	0.07	131.94	0.05	0.71
11	0.67	1471.54	179.7	2.00	2.32	45.64	2.25	0.45	82.9	0.07	0.26
12	0.76	9.56	78.77	0.67	1.51	34.62	0.25	0.04	65.45	0.05	1.36
13	0.70	20.57	86.39	0.86	1.76	33.11	0.55	0.03	107.44	0.04	0.76
14	0.65	17.06	63.95	1.16	2.08	43.62	0.37	0.04	99.43	0.03	0.13
15	0.97	4.93	93.4	1.19	2.55	40.79	3.64	0.05	134.04	0.07	0.17
16	0.70	8.21	83.94	0.80	1.03	56.18	1.03	0.03	46.35	0.03	0.46
17	0.41	0.93	52.7	0.79	1.32	31.56	0.43	0.03	82.52	0.02	1.49
18	0.65	3.77	67.95	0.79	1.12	33.24	0.56	0.02	70.42	0.01	0.60
19	0.72	2.62	80.4	1.02	1.94	40.17	1.26	0.08	67.84	0.01	1.14
20	0.76	3.24	97.15	0.65	1.30	41.29	2.48	0.02	101.54	0.01	0.89
distribution	normal	log-normal	log-normal	log-normal	normal	normal	log-normal	log-normal	log-normal	log-normal	normal

Table S4 Frequency of quality of individual heavy metal in dry and wet seasons

season	index	Cr	Mn	Fe	Ni	Cu	Zn	As	Cd	Ba	Hg	Pb
dry season	I	1	0.9	0.9	1	1	1	0.95	0.95	0.3	0.95	1
	II	0	0	0.05	0	0	0	0.05	0.05	0.7	0.05	0
	III	0	0.05	0.05	0	0	0	0	0	0	0	0
	IV	0	0.05	0	0	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0	0	0	0	0
wet season	I	1	0.95	0.9	1	1	1	0.9	1	0.05	1	1
	II	0	0	0.1	0	0	0	0.1	0	0.95	0	0
	III	0	0	0	0	0	0	0	0	0	0	0
	IV	0	0.05	0	0	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0	0	0	0	0

References

1. Huang F, Wang X, Lou L, Zhou Z, Wu J. Spatial variation and source apportionment of water pollution in Qiantang River (China) using statistical techniques. Water Research, 2010, 44(5): 1562–1572