Supporting Information:

Assessment of phosphorus recovery from swine wastewater in Beijing, China

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1 Phosphorus amount in swine wastewater from 1980-2014 in Beijing

Table 1 Calculation coefficient

Phosphorus discharge coefficient (kg/head/breeding cycle)	
Solid	Liquid
23.89	2.66

Table 2 Calculation of pig breeding amount and P contained in swine wastewater

Year	Pig breeding Amount (104 heads)	Total P (ton)	P in Swine Wastewater (ton)
1980	220.10	58436.55	11687.31
1981	216.80	57560.40	11512.08
1982	212.40	56392.20	11278.44
1983	225.00	59737.50	11947.50
1984	219.40	58250.70	11650.14
1985	209.30	55569.15	11113.83
1986	196.50	52170.75	10434.15
1987	185.80	49329.90	9865.98
1988	187.00	49648.50	9929.70
1989	229.10	60826.05	12165.21
1990	281.00	74605.50	14921.10
1991	337.20	89526.60	17905.32
1992	373.30	99111.15	19822.23
1993	382.90	101659.95	20331.99
1994	398.90	105907.95	21181.59
1995	340.20	90323.10	18064.62
1996	355.30	94332.15	18866.43
1997	353.50	93854.25	18770.85
1998	374.80	99509.40	19901.88
1999	400.90	106438.95	21287.79
2000	415.61	110344.46	22068.89

2001	453.10	120298.05	24059.61
2002	483.20	128289.60	25657.92
2003	466.97	123980.54	24796.11
2004	460.50	122262.75	24452.55
2005	448.70	119129.90	23825.97
2006	382.80	101633.40	20326.68
2007	288.60	76623.30	15324.66
2008	292.70	77711.85	15542.37
2009	314.00	83367.00	16673.40
2010	311.80	82782.90	16556.58
2011	312.20	82889.10	16577.82
2012	306.10	81269.55	16253.91
2013	314.90	83605.95	16721.19
2014	305.80	81189.90	16237.98

Total P = L2×23.89×104/1000+ L2×2.66×104/1000=265.5×L2 (ton)

P in Swine Wastewater = 0.2×Total P (ton)

L2: the second line

2 The information of four estimation models

The G.M. (1.1) model is the basic and most important grey prediction model, which has been utilized in a wide variety of fields. The effectiveness of the G.M. (1.1) model of dealing with small samples is one of its most important advantages over the other prediction models, and it was reported that the accuracy of the G.M. (1.1) model can be very high with very small samples. Linear fit model is an approach for modeling the relationship between a scalar dependent variableand one or more explanatory variables. The case of one explanatory variable is called simple linear regression. For more than one explanatory variable, the process is called multiple linear regression. Annual growth model is the change in the value of a measurement over the period of a year. Logistic model measures the relationship between the categorical dependent variable and one or more independent variables by estimating probabilities using a logistic function, which is the cumulative logistic distribution.

2.1 The Average Growth Model

$$B = A \times (1 + \mathrm{m})^{\mathrm{n}} \qquad \text{eq(1)}$$

$$\mathrm{m} = \sqrt[\mathrm{n}]{\frac{B}{A}} - 1 \qquad \text{eq(2)}$$

B: pig breeding amount in the last year; A: pig breeding amount in the first year; m: the average growth rate; n: total year.

The value of m was first calculated using the pig breeding amount data in the year 2010 and in the first year 1980 by eq(2), which means B is 311.80, A is 220.10, n is 31, so the value is 0.011298.Therefore, the pig breeding amount in the following year could be calculated by eq(1). After calculation, the pig breeding amount in 2030 was predicted to be 483.24×104 heads.

2.2 The Linear Fit model

The linear fit model is based on the linear regression shown as:

$$Y=a+b*X \qquad \text{eq(3)}$$

Table 3 Parameters of pig breeding amount in Beijing of Linear Fit model

Parameter	Value
R-Square	0.45
a	-13840.96
B	7.10

2.3 The Logistic Model

The origin basic function of the logistic model is based on:

$$Y = \frac{a}{1+e^{-k*(X-Xc)}} \qquad \text{eq(4)}$$

Table 4 Parameters of pig breeding amount in Beijing of Logistic Model

Parameter	Value
R-Square	0.57
a	404.00
Xc	1982.84
k	0.16

2.4 The G.M. (1.1) Grey Model

Table 5 Calculation procedure of G.M.(1.1) Grey Model

Year	original numerical arrays	AGO
1980	220.10	220.10
1981	216.80	436.90
1982	212.40	649.30
1983	225.00	874.30
1984	219.40	1093.70
1985	209.30	1303.00
1986	196.50	1499.50
1987	185.80	1685.30
1988	187.00	1872.30
1989	229.10	2101.40
1990	281.00	2382.40
1991	337.20	2719.60
1992	373.30	3092.90
1993	382.90	3475.80
1994	398.90	3874.70
1995	340.20	4214.90
1996	355.30	4570.20
1997	353.50	4923.70
1998	374.80	5298.50
1999	400.90	5699.40

2000	415.61	6115.01
2001	453.10	6568.11
2002	483.20	7051.31
2003	466.97	7518.28
2004	460.50	7978.78
2005	448.70	8427.48
2006	382.80	8810.28
2007	288.60	9098.88
2008	292.70	9391.58
2009	314.00	9705.58
2010	311.80	10017.38

AGO: Accumulated Generation One-time

PBA: Pig Breeding Amount

After calculation, the formula to predict AGO is:

$$L_3 = 12710 * e^{0.019*(L_1-1980)} - 12490.72$$

L1 and L3 means the first and the third line separately.

Therefore, the formula to predict the pig breeding amount in Beijing is shown as:

$$PBA_n = R_{n-1979}L_3 - R_{n-1980}L_3,$$

where R means row, L means line and n(n＞1980) is the value of year.

3 The information of the five rivers in Beijing

The location information of the five rivers in Beijing is shown in Fig.1 base on google earth. The parameters for the five rivers in Beijing is shown in Table 6.

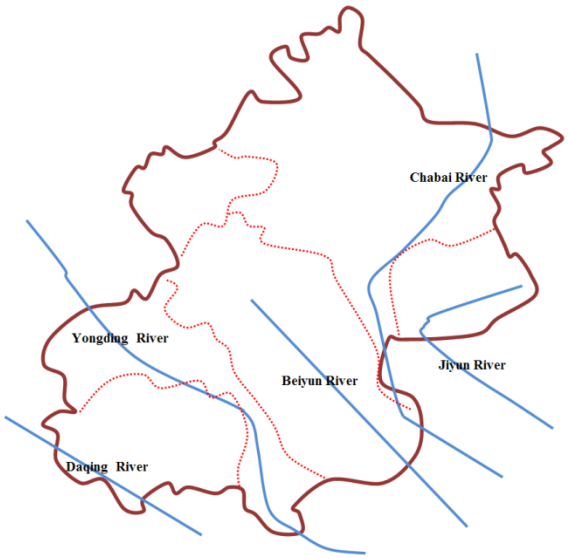

Fig.1 Location information of the five rivers in Beijing

Table 6 Parameters for the five rivers in Beijing

River	Qm (m3/s)	Length (km)
Jiyun River	1.44	30
Chaobai River	23.24	82

Beiyun River	10.74	70
Yongding River	11.16	124
Daqing River	2.92	35

4 The fundamental parameters of PRE models

The PRE models were established by JMP 10.0, a product of SAS. The fundamental parameters were collected from literature and shown in Table 7 and Table 8.

Table 7 The fundamental parameters of biological phosphorus removal model

pH	Anaerobic stage time/hour	Sludge retention time/day	PRE	Reference
8.15	2.00	11.00	0.978	[1]
8.24	2.00	11.00	0.975	
8.32	2.00	11.00	0.973	
8.35	2.00	11.00	0.948	
7.65	4.00	25.00	0.800	[2]
7.25	1.00	10.00	0.570	[3]
7.50	2.00	10.00	0.940	[4]
7.00	4.00	7.00	0.986	[5]
7.50	2.67	15.00	0.980	[6]

Table 8 The fundamental parameters of struvite crystallization model

Cp	Mg/P	pH	PRE	Reference
191.00	0.25	8.10	0.65	[7]
189.90	0.50	8.55	0.64	[8]
189.90	0.80	8.55	0.87	
189.90	1.00	8.55	0.93	
189.90	1.20	8.55	0.96	
189.90	1.00	8.43	0.87	
189.90	1.00	8.50	0.92	
189.90	1.00	8.65	0.93	
60.00	1.00	8.43	0.93	[9]
167.00	0.62	9.00	0.88	[10]
167.00	0.82	9.00	0.95	[9]
167.00	0.98	9.00	0.95	
167.00	1.39	9.00	0.97	
167.00	2.29	9.00	0.96	
142.60	0.5	9.00	0.86	[11]
145.00	0.36	8.00	0.55	[12]
145.00	0.62	8.00	0.69	
145.00	0.76	8.00	0.72	
145.00	0.89	8.00	0.86	
145.00	1.11	8.00	0.89	

65.36	1.00	7.27	0.15	
65.36	1.00	9.05	0.65	
65.36	1.00	9.1	0.66	[13]
65.36	1.00	9.2	0.68	
65.36	1.00	9.3	0.70	
60.00	1.40	8.9	0.68	
60.00	1.40	9.2	0.91	
60.00	1.40	9.5	0.94	
60.00	1.40	9.8	0.95	
60.00	1.40	10.10	0.95	
60.00	1.40	10.40	0.91	
60.00	1.40	10.70	0.85	
60.00	1.40	11.00	0.65	
60.00	1.00	9.80	0.86	
60.00	1.10	9.80	0.89	
60.00	1.20	9.80	0.94	
60.00	1.30	9.80	0.94	
60.00	1.40	9.80	0.95	[14]
60.00	1.50	9.80	0.95	
60.00	1.60	9.80	0.96	
60.00	1.70	9.80	0.96	
23.93	2.99	8.90	0.72	
23.93	2.99	9.20	0.92	
23.93	2.99	9.50	0.97	
23.93	2.99	9.80	0.96	
23.93	2.99	10.10	0.97	
23.93	2.99	10.40	0.93	
23.93	2.99	10.70	0.88	
23.93	2.99	11.00	0.68	
195.00	0.90	8.70	0.82	
195.00	0.90	8.40	0.81	[15]
195.00	0.90	8.10	0.72	
61.00	1.30	8.50	0.94	[16]
117.80	2.95	8.60	0.73	[17]
96.00	0.63	9.13	0.53	
96.00	0.63	9.06	0.52	
96.00	0.63	8.98	0.47	
96.00	1.00	9.13	0.73	
96.00	1.00	9.06	0.70	[18]
96.00	1.00	8.98	0.65	
96.00	1.20	9.13	0.78	
96.00	1.20	9.06	0.76	

96.00	1.20	8.98	0.74
96.00	1.40	9.13	0.86
96.00	1.40	9.06	0.84
96.00	1.40	8.98	0.81
96.00	1.60	9.13	0.89
96.00	1.60	9.06	0.87
96.00	1.60	8.98	0.83

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