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Evaluation and Prediction of Water Quality in the Yangtze River Based on Fuzzy Comprehensive Evaluation Method

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ABSTRACT

Due to the increasingly serious water pollution of the Yangtze river, the discharge of waste water increases year by year, the water pollution problem is very serious, environmental protection is imminent. In this paper, we study the water quality assessment and prediction, based on the analysis of the conditions and data, the fuzzy comprehensive evaluation method to make quantitative analysis, the quality of the water in the Yangtze river and one dimensional water quality model to calculate two kinds of the main sources of pollutants, finally using the linear regression equation to predict the amount of sewage after ten years, and made the solution.

Keywords: Equation of linear regression; One dimensional water quality prediction model; Fuzzy comprehensive evaluation

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1. Introduction

The Yangtze river originates from the southwest side of the Geladon winter peak in the Tanggula mountains on the Qinghai-Tibet plateau, "the roof of the world". It is the mother river of the Chinese nation. With a total length of more than 6,300 kilometers, more than 800 kilometers longer than the Yellow River, it ranks the third in the world, second only to the Nile in Africa and the Amazon in South America. FeiWuShui in Yangtze river basin in 1995-2004 emissions increased significantly, and the Yangtze river basin of agricultural water rate is about 70%, every year, about 33 billion m³ after containing high nutrient matter agricultural water back into the Yangtze river water system, so the actual amount of FeiWuShui discharged into the Yangtze river waters each year should be point source emission and a 33 billion m³ after agricultural water, so that 2016 FeiWuShui emissions should be 68.3 billion m³ after, water pollution is very outstanding. The indicators that reflect the natural purification capacity of rivers are called degradation coefficients. In fact, the natural purification capacity of the main stream of the Yangtze river can be regarded as approximately uniform. According to the test, the degradation coefficient of the main pollutant permanganate index and ammonia nitrogen is usually between 0.1 and 0.5, for example, 0.2 (unit: 1/ day) can be considered. The main statistical data given in the report on water quality in the Yangtze river basin from 1995 to 2004. The future management of water resources in the Yangtze river needs to be further strengthened in three red lines, including water pollution control and water resources protection, which are consistent with the current goals of the river chief system and the "water pollution prevention and control action plan" (water 10) promoted by the state.

This paper makes a quantitative comprehensive evaluation on the water quality of the Yangtze river in the past two years and analyzes the pollution status of water quality in various

regions. It is concluded from the analysis that the main pollutant permanganate index and ammonia nitrogen pollution sources in the Yangtze river main stream are in which areas. In order to better control the Yangtze river basin, according to the main statistics of the past 10 years, the development trend of water pollution in the next 10 years of the Yangtze river is predicted and analyzed. According to the forecast analysis, at the same time each year over the next 10 years of Yangtze river main stream IV classes and class V water is controlled within 20%, the proportion of water and no worse V, how much is a year to deal with wastewater.

2. Model assumptions

- (1) The test data are reliable and representative.
- (2) Natural purification capacity of the main stream and tributaries of the Yangtze river. The water flow observed on the same tributary is uniform, and the detection range of each observation point is the same.
- (3) The amount of pollutants discharged into the water stream is only related to the natural purification of the water.
- (4) The water pollution of an observation station mainly comes from the local sewage and the upstream sewage.
- (5) The discharge of all waste water is untreated and all is straight.
- (6) The degradation coefficient of the main pollutant permanganate index and ammonia nitrogen was 0.2 (unit: 1/ day).

For hypothesis 2, the natural purification capacity of the trunk and tributaries of the Yangtze river is uniform, meaning that the degradation coefficient of pollutants by the trunk and tributaries is the same; A uniform flow of water from an observation station on the same tributary means the same flow of water on the same tributary.

3. Symbol descriptio

Symbol	Name
C_{ij}	The concentration of the ith index at the jth observation station
B_i	The standard value of the ith index
w_i	The weight of the ith index
q_j	Water flow at the jth observation station
$v(x_j)$	The water velocity in section j
L	The total flow of the Yangtze river
F	Total discharge of wastewater
P	The proportion of waste water in the total river water

4. The data analysis

According to the following figure and combining with this paper, this paper analyzes the regions

passed by the Yangtze river basin, and 17 observation sites are investigated and studied to analyze the water quality of the Yangtze river.

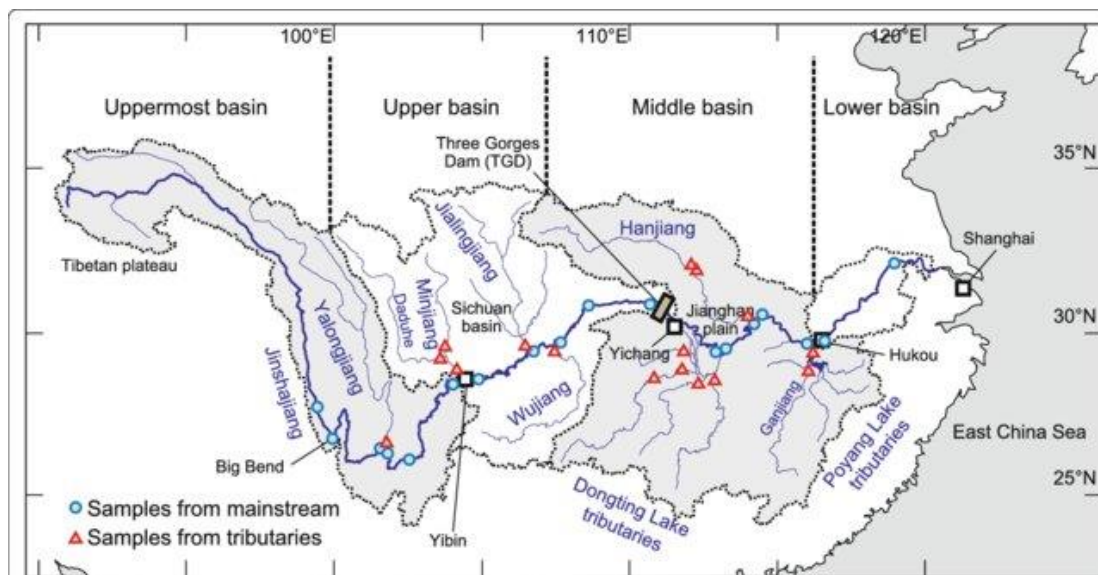


Fig.1 Map of the Yangtze River drainage basin

After processing the data in this paper, the proportion of all kinds of water in the total water

volume of the Yangtze river as shown in the table below was calculated by Excel.

Table 1: Water quality classification proportion of the Yangtze river

I	8%	37
II	58%	274
III	19%	91
IV	10%	46
V	2%	11
Bad V	4%	17

Of which I, II, III water quality for water quality; IV V, substandard V water quality is bad. By the picture above you can see in the overall quality of the Yangtze river, II class of water quality than most, followed by III kind of water quality, water quality in the majority.

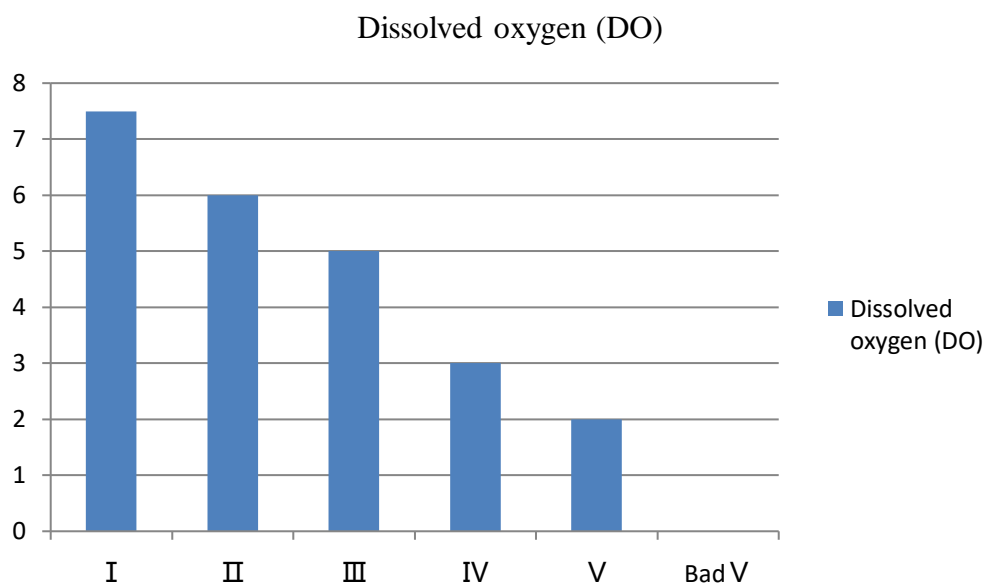


Fig.2: Dissolved oxygen content in various water quality

Table 2: Table of relevant information for 7 regions

Observation sites		Panzhihua, sichuan	Chongqing Zhu Tuo	Hubei yichang	Hunan yueyang	Jiangxi jiujiang	Anqing anhui	Nanjing, jiangsu
Distance between stations		0	950	1728	2123	2623	2787	3251
2004.04	Flow	3690	13800	21000	25600	28100	29500	29800
	Velocity	3.7	2.1	0.9	0.9	1	1.1	1.2
2004.05	Flow	3720	13100	19800	20500	29800	34000	34500
	Velocity	3.7	1.9	0.8	0.9	1.1	1.1	1.2
2004.06	Flow	4010	14200	20300	22600	29500	32100	33100
	Velocity	3.9	2.1	1.2	1.3	1.5	1.5	1.6
2004.07	Flow	4660	16400	22700	24100	27000	31900	32100
	Velocity	4.1	2.3	1.4	1.5	1.5	1.6	1.7
2004.08	Flow	3740	10600	24000	25900	32100	33400	35100
	Velocity	3.8	2.1	1.4	1.4	1.5	1.7	1.7
2004.09	Flow	6280	47600	53500	53800	72800	74200	81000
	Velocity	5.1	4.8	1.7	1.9	2.1	3.4	3.4
2004.1	Flow	3260	16200	19100	22300	24800	31000	38400
	Velocity	3.1	2.3	1.5	1.6	1.6	1.7	1.9
2004.11	Flow	1500	8170	10600	12000	14600	17000	19600
	Velocity	2.7	1.9	0.7	0.8	0.9	0.9	1
2004.12	Flow	951	6550	7400	10700	13200	14100	14900
	Velocity	3.1	1.5	0.7	0.8	0.8	0.8	0.9

2005.01	Flow	712	4020	4570	8190	10900	12300	14400
	Velocity	2.1	1.5	0.5	0.6	0.7	0.7	0.8
2005.02	Flow	612	3603	4510	7980	10300	13700	15100
	Velocity	2	1	0.4	0.6	0.7	0.7	0.8
2005.03	Flow	623	4740	5180	7040	14300	21400	21500
	Velocity	1.9	0.9	0.4	0.6	0.8	0.8	0.9
2005.04	Flow	642	3650	5400	7240	15100	20200	22100
	Velocity	2.1	1.2	0.4	0.5	0.7	0.8	0.8

It can be seen from the above table that the corresponding data of water flow and water velocity in the above 7 regions are from April 2004 to April 2005.

Based on the analysis of water quality, the water quality of the Yangtze river basin from 1995 to 2004 is shown in the table below.

Table 3: Water quality in the Yangtze river basin from 1995 to 2004

Years	Total discharge of the Yangtze river	Total discharge of wastewater	Drinking water ratio	Non-potable water ratio
1	9205	174	93.1	6.9
2	9513	179	85.3	14.7
3	9171.26	183	80.7	19.3
4	13127	189	88.4	11.6
5	9513	207	80.2	19.8
6	9924	234	74	26
7	8892.8	220.5	73.7	26.3
8	10210	256	76.7	23.3
9	9980	270	77.5	22.5
10	9405	285	68	32

Data analysis, the results of prediction of the Yangtze river every year over the next 10 years within 20%, the proportion of water and no worse V under the premise of analysis of related data IV classes and class V water is controlled

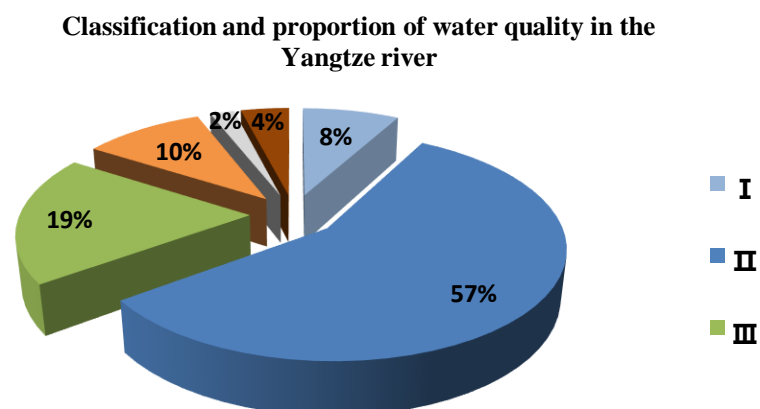


Fig.3: Water quality classification and proportion of the Yangtze river

Table 4: Contents of relevant indexes of various kinds of water

Divide class	I	II	III	IV	V	Bad V
Dissolved oxygen (DO)	7.5	6	5	3	2	0
Permanganate index (CODMn) ≤	2	4	6	10	15	∞
Ammonia nitrogen (NH ₃ -N) ≤	0.15	0.5	1	1.5	2	∞
PH (Dimensionless)	6---9					

5. Establishment and solution of water quality analysis

5.1 Model establishment

Fuzzy comprehensive evaluation index system is established based on data analysis:

$$V = \{v_1(I), v_2(II), v_3(III), v_4(IV), v_5(V), v_6(\text{Bad V})\}$$

(2) Determine the factor subset of the evaluation:

$$U = \{u_1(DO), u_2(CODMn), u_3(NH_3 - N), u_4(PH)\}$$

(3) Determine the weight of each evaluation factor:

After analyzing the range of four kinds of weights, this paper obtains three kinds of methods of

(1) Determine the evaluation criteria set of the evaluation:

It can be seen from the title that the classification of water quality is mainly divided into six grades, that is, the comment set is:

Since the evaluation of water quality is only related to four indicators, the factor set is:

taking superscalar multiples.

In the case of COdMn and nh3-n, the exceeding multiple is:

$$I_i = \frac{C_i}{B_i}$$

In the case of DO, the excess multiple is:

$$I_i = \frac{B_i}{C_i}$$

When it comes to PH, since this index has no dimension, when it is defined, 7.5, the midpoint

of the normal interval, is taken as the standard:

$$I_i = \frac{|C_i - B_i|}{B_i}$$

After normalization, the weight of each

evaluation index can be obtained

$$w_i = \frac{I_i}{\sum_{i=1}^4 I_i}$$

Thus, the weight set of each index can be

obtained as

$$W = \{w_1, w_2, w_3, w_4\}$$

(4) Determine the single factor fuzzy evaluation

matrix:

The fuzzy evaluation matrix of single factor R is composed of the membership degree of single

factor r_{ij} , which represents the membership evaluation level. namely:
degree of the i th evaluation factor to the j th

$$R = \begin{bmatrix} r_{11}, r_{12}, \dots, r_{16} \\ r_{21}, r_{22}, \dots, r_{26} \\ \vdots \\ r_{41}, r_{42}, \dots, r_{46} \end{bmatrix}$$

For example, the membership function of dissolved oxygen is as follows:

$$\begin{aligned} r_{11} &= \begin{cases} 0 & c < 6 \\ (c-6)/1.5 & 6 \leq c \leq 7.5 \\ 1 & c > 7.5 \end{cases} & r_{12} &= \begin{cases} c-5 & 5 < c < 6 \\ (7.5-c)/1.5 & 6 \leq c \leq 7.5 \\ 1 & c > 7.5, c < 5 \end{cases} \\ r_{13} &= \begin{cases} 6-c & 5 < c < 6 \\ (c-3)/2 & 3 \leq c \leq 5 \\ 0 & c > 6, c < 3 \end{cases} & r_{14} &= \begin{cases} (5-c)/2 & 3 < c < 5 \\ c-2 & 2 \leq c \leq 3 \\ 0 & c > 5, c < 2 \end{cases} \\ r_{15} &= \begin{cases} 1 & c < 2 \\ 3-c & 2 \leq c \leq 3 \\ 0 & c > 3 \end{cases} & r_{16} &= \begin{cases} 1 & c=0 \\ (2-c)/2 & 0 \leq c \leq 2 \\ 0 & c > 2 \end{cases} \end{aligned}$$

(5) Fuzzy comprehensive evaluation set: evaluation set of water quality can be obtained
After determining the single factor fuzzy as
evaluation matrix R and weight set W , the fuzzy

$$B = W \times R = [b_1, b_2, \dots, b_6]$$

Among them:

$$b_j = \max \{b_1, b_2, \dots, b_6\}$$

It is required to use differential equations to river. Through consulting the data, the one-dimensional water quality model in the fluid is
represent the process of pollutant concentration downstream along the whole Yangtze obtained in this paper:

$$\frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2} - v \frac{\partial C}{\partial x} - kC$$

Where, C is the concentration distribution of pollutants in water, t is the time, D is the diffusion coefficient, x is the length of river reach, v is the flow velocity, and k is the degradation coefficient of fluid. For this problem, the Yangtze river studied in this paper is relatively stable, the diffusion effect can be ignored, and the concentration changes with time are known, so the model can be simplified as follows

$$v \frac{dC}{dx} + kC = 0$$

The following model can be constructed in this (1) Pollutant mass conservation equation
paper

$$C_{i+1} q_{i+1} = \Delta m_{i+1}(n) + C_i(x_{i+1}) q_i$$

Where n represents the number of measurements, the month (2) Influence of degradation coefficient on pollutant concentration

$$v(x) \times \frac{dC_i(x)}{dx} = -k \times C_i(x)$$

(3) Pollutant accumulation

$$\sum_{n=1}^{12} \Delta m_{i+1}(n)$$

The discharge amount of the seven main drainage sections is screened out in order, and the largest ones are obtained, indicating that the discharge amount of these sections is very large.

5.2 Model solution

Table 5: Averages of indicators by region

	DO	CODMn	NH3-N	pH*
Panzhihua, sichuan	9.154286	2.432143	0.182857	8.256071
Chongqing Zhu Tuo	8.930357	2.096429	0.331786	7.911786
Nanjinguan, yichang, hubei	8.505357	2.875	0.264286	7.750714
Chenglingji, yueyang, hunan	8.683214	3.785714	0.33	7.816786
Jiangxi jiujiang hexi water plant	7.753571	2.428571	0.160357	7.424286
Anqing river estuary, anhui province	7.455357	2.575	0.228929	7.443214
Linshan, nanjing, jiangsu	7.491071	2.092857	0.127857	7.65
Minjiang river bridge, leshan, sichuan	5.558571	5.242857	0.924286	7.495714
Sichuan yibin cool ginger ditch	8.976071	2.735714	0.430357	8.075714
Second bridge of tuojiang river, luzhou, sichuan	6.865	3.339286	0.811786	7.677857
Hujialing, danjiangkou, hubei	9.291071	1.953571	0.092143	7.877143
Changsha, hunan	7.11	2.485714	0.916429	7.076786
Yueyang building, yueyang, hunan	8.315	4.192857	0.385714	7.728571
Wuhan, hubei province	7.421429	3.325	0.1975	7.9475
Chucha, nanchang, jiangxi	5.698214	2.323929	4.633214	7.110357
Toadstone, jiujiang, jiangxi	7.910357	3.742857	0.286429	7.619286
Sanjiangying, yangzhou, jiangsu	8.137857	3.021429	0.287143	7.681786

Each B_i has its different forms of expression, can according to the water quality can be divided into water and the drinking water in this paper, it is known that in the first III class boundary limit value as the reference standard of the results will be closer. For PH value of B_i , this article with 7.5 as the reference standard can be.

In this paper, a series of results w_i were obtained without considering other conditions in the calculation of the weight set W_i . When the

results were put into the solution formula, it was found that the results obtained in the classification and data analysis were quite different from each other. After checking the data, it was judged that the coefficient of PH weighting was too high, and there was only one case of abnormal PH pollution in the appendix. Therefore, when recalculating the coefficient, this paper multiplies the coefficient of PH index by 0.2 to achieve the most perfect evaluation.

The average values in table 5 represent the

indicators measured in each region, i.e C_i .

Table 6: Comprehensive judgment of the water pool situation in this area over the past two years

Region	The largest category obtained by weighting	I	II	III	IV	V	Bad V
Panzhihua, sichuan	II	- 0.123 45	0.088 885	0.017 958	0.019 474	0	0
Chongqing Zhu Tuo	II	- 0.485 38	0.166 587	0.0111 1	0	0	0
Nanjinguan, yichang, hubei	II	- 0.685 92	0.234 395	0	0	0	0
Chenglingji, yueyang, hunan	II	- 1.565 06	0.486 411	0.0011 26	0	0	0
Jiangxi jiujiang hexi water plant	II	0.069 321	0.076 587	0	0	0	0
Anqing river estuary, anhui province	II	- 0.300 59	0.146 77	0	0	0	0
Linshan, nanjing, jiangsu	I	0.982 272	0.017 728	0	0	0	0
Minjiang river bridge, leshan, sichuan	III	0.018 561	0.354 241	0.627 197	0	0	0
Sichuan yibin cool ginger ditch	II	- 1.283 97	0.347 767	0.024 398	0	0	0
Second bridge of tuojiang river, luzhou, sichuan	II	- 1.662 89	0.597 966	0	0	0	0
Hujialing, danjiangkou, hubei	I	0.952 412	0.035 351	0.012 237	0	0	0
Changsha, hunan	I	0.407 987	0.216 576	0.375 438	0	0	0
Yueyang building, yueyang, hunan	II	- 2.028 12	0.531 6	0.039 462	0	0	0
Wuhan, hubei province	II	- 0.538 46	0.301 435	0.000 722	0	0	0
Chucha, nanchang, jiangxi	Bad V	0.054 589	0.1192 53	0.046 95	0	0	0.779 209
Toadstone, jiujiang, jiangxi	II	- 1.245 74	0.424 658	0	0	0	0
Sanjiangying, yangzhou, jiangsu	II	- 0.844 57	0.267 205	0	0	0	0

It can be seen from the above table that the indicators is quite different, so it can clearly show weight of each region in several categories of the water quality category of each region.

Table 7: Permanganate index and the main sources of ammonia nitrogen pollution

	CODMn	NH3-H
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Panzhuhua, sichuan	21136.31	1198.659
Chongqing Zhu Tuo	56562.81	4454.936
Hubei yichang	11660.68	1027.455
Hunan yueyang	14614	1615.31
Jiangxi jiujiang	17163.19	1438.563
Anqing in anhui	45321.12	3933.124
Nanjing, jiangsu province	8222.338	371.1414

According to the above table, we can know the total amount of new pollutants in the main river reach corresponding to the monitoring station for more than a year, among which the permanganate index (CODMn) and ammonia nitrogen (nh3-n) in zhutuo, chongqing and

anjing, anhui are far higher than similar indexes in other regions.

According to the hypothesis, we can know the possible sources of these two pollutants in these two areas, and the specific river reaches may be panzhuhua in sichuan to zhutuo in chongqing and jiujiang in jiangxi to anqing in anhui.

5.3 Results analysis

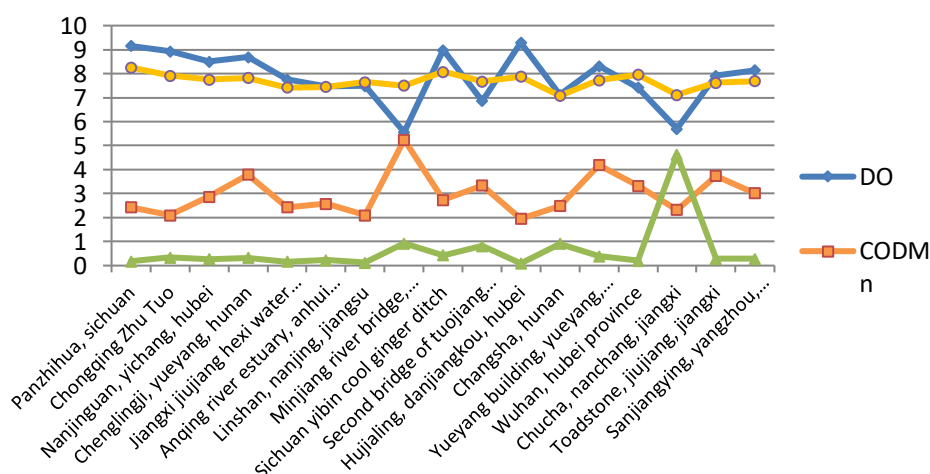


Fig.4: Average of indicators by region

As can be seen from the figure above, the dissolved oxygen index in leshan of sichuan province and nanchang of jiangxi province decreased rapidly, and the permanganate index in leshan of sichuan province also rose, indicating that the sewage discharge in leshan of sichuan province was not under much control and the pollution discharge was mainly

permanganate. However, the ammonia nitrogen index in nanchang, jiangxi province exceeded the standard, indicating that the ammonia nitrogen emission in this area is very high and the overall water pollution is very serious. The overall water quality in nanchang, jiangxi province is poor and needs to be improved.

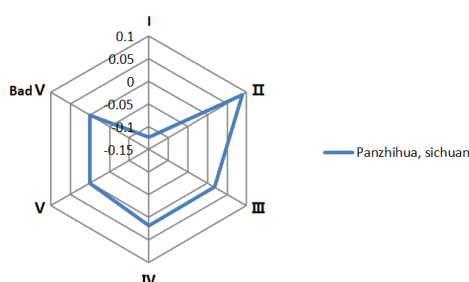


Fig.5: Weight of water quality in panzhihua, sichuan

It can be seen from this figure that the overall water quality can be clearly identified as belonging to which category, but other categories also have a certain proportion of

weight, indicating that some indicators meet the standard of this type, but to a lesser degree, it is not easy to affect the judgment.

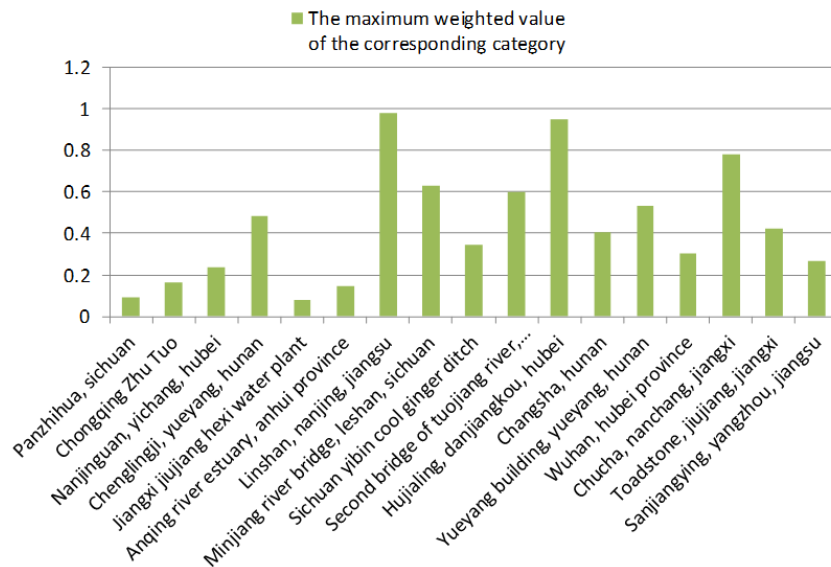


Fig.6: Weighted category maxima in each region

From Fig.6, we can find that the maximum weighted value of linshan in nanjing, jiangsu province and hujialing in danjiangkou, hubei province is approximately one, indicating that the corresponding category has a very high

credibility, while cities such as panzhihua in sichuan province do not belong to this category. According to the horizontal comparison of each category, we can know which areas have stable water quality.

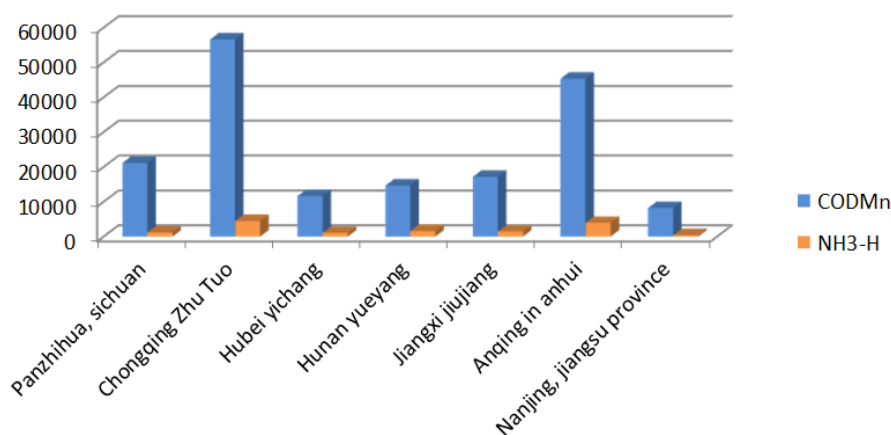


Fig.7: Pollutant content in various areas

As can be seen from the figure above, except for yichang in hubei province and nanjing in jiangsu province, the content of the two pollutants is relatively low, while the content in other areas is

relatively low. Continuous analysis of several major observation stations reveals that the most likely source of pollution is located near zhutuo, chongqing, in the section between panzhihua,

sichuan province and zhutuo, chongqing, and near anqing, anhui province, from jiujiang, jiangxi province to anqing, anhui province. Control of these two pollutants should be conducted as close to the upstream of the two sites as possible.

6. Establishment and solution of wastewater treatment problem

6.1 Model establishment

In view of the prediction problem, this paper first evaluates the main data as the total discharge,

$$\begin{cases} L_x = ax + b \\ F_x = cx + d \\ Q_{xk} = ex + f \end{cases}$$

After fitting with MATLAB, this paper can find that the fitting of expressions of L_x and Q_{xk} is not ideal,

$$\begin{cases} L_x = ax^b \\ Q_{xk} = ex^f \end{cases}$$

The predicted data introduce a new variable, which represents the ratio of total discharge to total discharge. And part of central drinking water quality is subdivided into light polluted water (IV classes and class V) and heavy polluted water (bad V class). The linear relationship between the top ten young polluted water and the heavily polluted water was calculated and the predicted results were.

(1) linear model of lightly polluted water:

Since the proportion of lightly polluted water shows no obvious trend in the course of ten years and fluctuates, the linear regression model is assumed to be $P_1 = a + b \cos \omega x + c \sin \omega x$

2) linear model of heavily polluted water:

Since there are only two significant Numbers in the first ten years of heavily polluted water, this

total discharge and water quality of the Yangtze river. The water quality can be divided into potable water and non-potable water. Since it is a problem of prediction, linear regression is first considered in this paper, then

The expression of total discharge L_x , total discharge of waste water F_x and water quality of the Yangtze river Q_{xk} is

so another expression is adopted in this paper

paper directly selects the function of first order, namely $P_2 = cx + d$

In order to meet the Yangtze river IV classes and class V control within 20%, the proportion of water and no worse V the water that is P must at the same time satisfy the two conditions. Through analysis, it can be known that the smaller the value of P , the smaller the proportion of sewage and the less pollution. Therefore, this paper needs to obtain a smaller value of P , namely $P = \min \{P_1, P_2\}$

If you multiply the P here by the predicted L_x year by year, the absolute value of the difference with F_x is the amount of sewage that needs to be treated every year for the next 10 years.

6.2 Model solution

The following table is calculated by Excel:

Table 8: water quality forecast for the next 10 years

Year	Total discharge of wastewater	Total discharge of the Yangtze river	Non-potable water ratio	Drinking water ratio
------	-------------------------------	--------------------------------------	-------------------------	----------------------

2005	290.46	10006.7	27.67293	72.32707
2006	303.32	10017.86	28.34256	71.65744
2007	316.18	10028.14	28.95308	71.04692
2008	329.04	10037.66	29.5137	70.4863
2009	341.9	10046.54	30.03165	69.96835
2010	354.76	10054.85	30.51271	69.48729
2011	367.62	10062.66	30.96159	69.03841
2012	380.48	10070.03	31.38214	68.61786
2013	393.34	10077.01	31.7776	68.2224
2014	406.2	10083.63	32.15065	67.84935

According to the above table, it can be intuitively increase gradually, while only the ratio of known that the changes of several main drinking water decreases. observation indicators over the years all The results of several linear regression equations are as follows

$$\begin{cases} a = 9704, b = 0.012181 \\ c = 12.86, d = 149 \\ e = 93.46, f = -0.1069 \end{cases}$$

The fitting condition is ideal and the error is small. Calculated by Excel in the next decade for Yangtze river trunk stream IV every year the proportion of classes and class V water control within 20%, and there is no worse V the water, so need to deal with the sewage each year shown in the table below:

Table 9: water quality ratios for the next 10 years

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
IVand V	9.6	0.8	13.3	0	12.8	25.4	26.5	22.5	6.1	23.5
Bad V	0	0	0	0	0	0	5.8	8.7	0	9
Proportion of sewage	0.01890 3	0.01881 6	0.01995 4	0.01439 8	0.0217 6	0.02357 9	0.02479 5	0.02507 3	0.02705 4	0.03030 3

Table 10: maximum sewage capacity and its capacity to treat over the next ten years with the change of years

Year	Can withstand the highest volume of sewage	The amount of sewage that needs to be treated
2005	224.7506	65.70944
2006	225.0012	78.31879
2007	225.232	90.94797
2008	225.446	103.594
2009	225.6453	116.2547
2010	225.8319	128.9281
2011	226.0074	141.6126
2012	226.1729	154.3071

2013	226.3296	167.0104
2014	226.4784	179.7216

As can be seen from the above table, the volume of wastewater that needs to be treated is expected to increase due to the higher and higher discharge of wastewater when no measures are taken. And when meet no worse

V water corresponding light polluted water (IV classes and class V water) is 19.989%, conform to the topic. Therefore, the corresponding ratio of 2.246% is consistent with the situation.

6.3 Results analysis

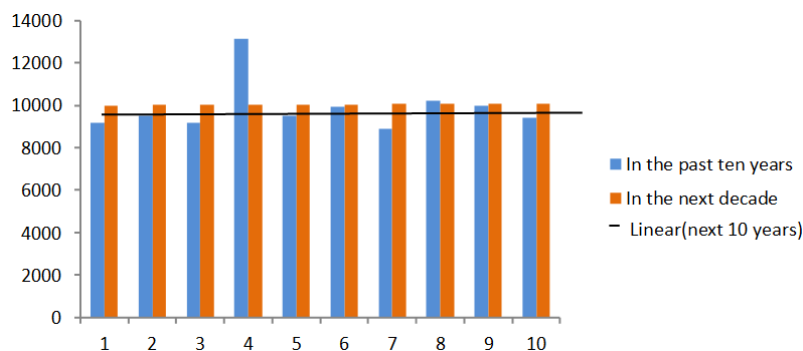


Fig.8: Comparison of the total flow of the Yangtze river in the first ten years and the last ten years

It can be seen from the figure above that the total flow of the Yangtze river was the largest in 1998, which is consistent with the historical situation. Under other circumstances, the total flow of the

Yangtze river remained basically stable. It can be found that the total flow in the next decade was slightly higher than that in the previous decade, but the error was relatively small.

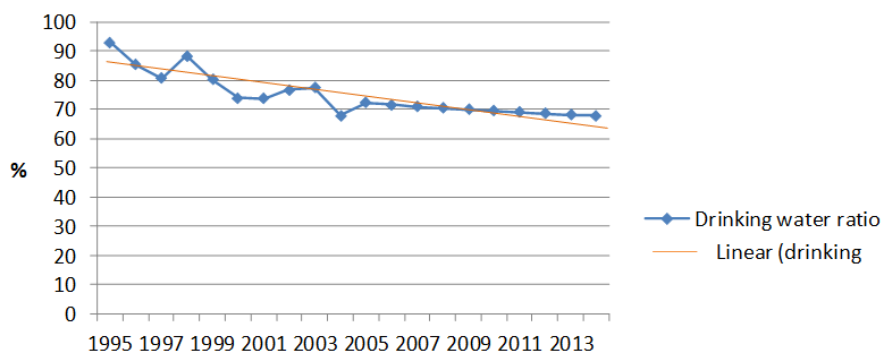


Fig.9: Drinking water ratio

By Fig.9 shows the proportion of water under the linear expression is showing a decrease, although in the first ten years once or twice, but because one year for flooding, pollutants residual amount and would have been natural

degradation rate is slightly higher than the normal years, therefore remove the special years, drinking water or present a steady decrease.

From 1995 to 2014

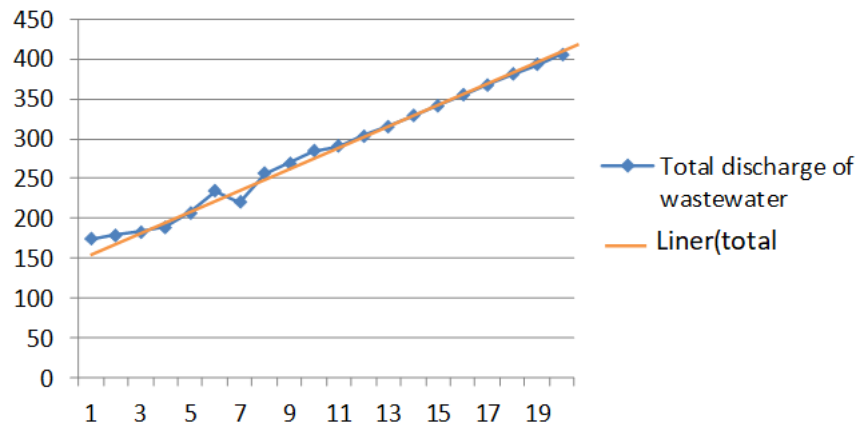


Fig.10: Change of total wastewater discharge over years

It can be seen from Fig.10 that the discharge of wastewater is increasing year by year, and the overall situation is very consistent with the linear increase, indicating that the proportion of drinking water may be smaller and smaller in the future if the discharge of wastewater is not limited.

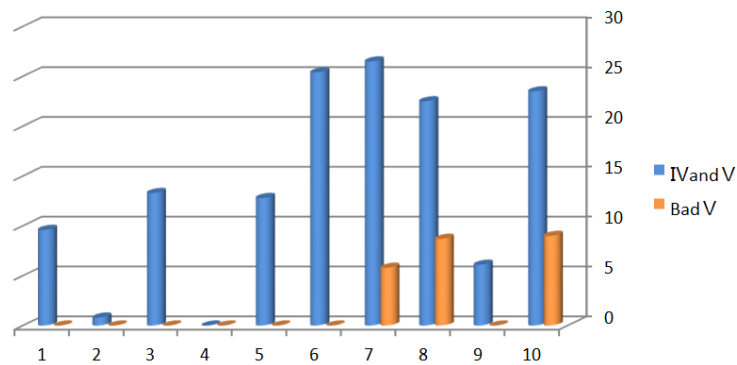


Fig.11: Water quality over the past decade

As can be seen from the figure above, in the past ten years, slightly polluted water exceeded the standard by 40%, while severely polluted water exceeded the standard by 30%, both of which were in a relatively high state, so it is urgent to improve.

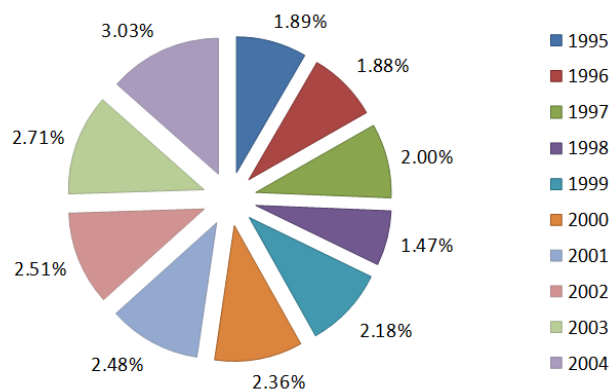


Fig.12: The annual proportion of sewage in the Yangtze river has changed with the years in the past ten years

As can be seen from the figure above, the proportion of sewage increases year by year, with only a slight change in the first four years. Therefore, if the sewage problem is not solved,

it will become increasingly serious. Therefore, this problem has become very obvious and serious. this set of data shows that the sewage treatment

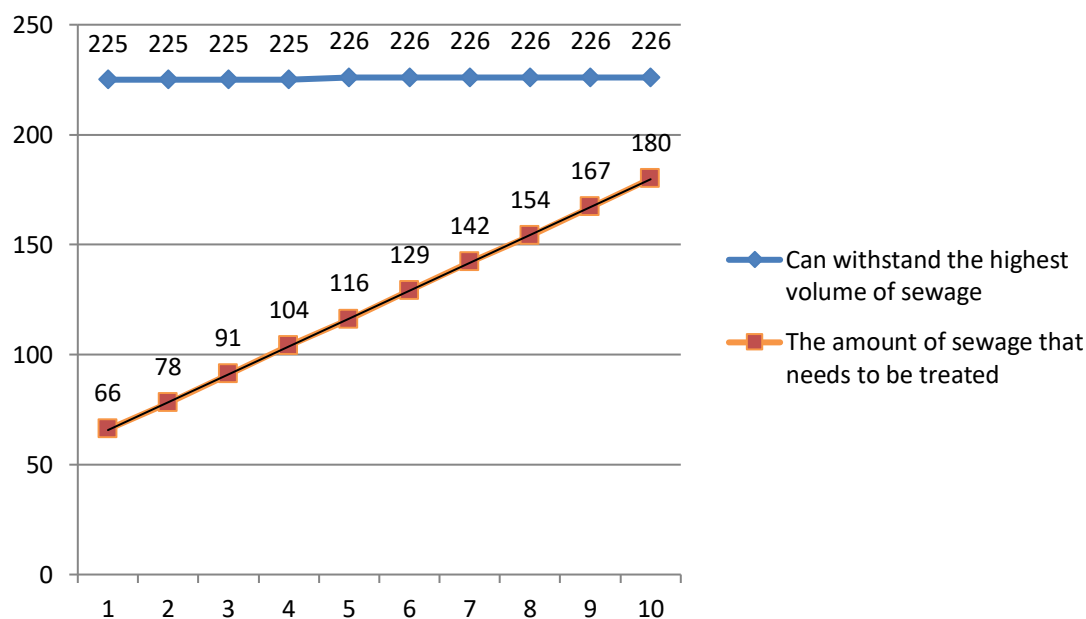


Fig.13: The maximum allowable amount of sewage in the Yangtze river and the amount of sewage to be treated varies with the years

It can be seen from the figure above that the maximum amount of sewage that can withstand is the threshold value simulated by the regression equation, which represents the maximum sewage discharge that can meet all conditions, so the excess sewage is waiting to be treated. Processing to the critical value is more likely to meet the requirements.

7. Model test

Since data are obtained by measurements, observations, and sometimes even complete guesswork, we need to consider the possibility of inaccuracies.

For the linear regression model in this paper, two conditions should be met when predicting the quantity of sewage, while the actual situation is that when one condition is met, the other condition will also be met basically. For example, in the case of problem 4, we calculated the maximum amount of wastewater when the two conditions were met to simulate the whole situation, and the result was that the proportion of lightly polluted water was less than 20% when

the heavily polluted water was equal to 0, which has a high probability.

Therefore, this result cannot fully reflect the accuracy of the prediction function of light pollution, so we need to conduct sensitivity analysis of the prediction equation of light pollution water.

When the tolerable proportion of lightly polluted water was adjusted to 19.5% and 19%, we substituted the corresponding P values into the model for calculation, and obtained that the corresponding P values were 0.02160 and 0.02073, respectively, less than the answer to the question 0.02246, which proved that the model was very sensitive to the factor change within 2%, that is, the model was valid and the results were highly executed.

8. Evaluation of model

8.1 Advantages of the model

(1) The judgment accuracy of membership function is very high, and the result obtained is very clear and precise.

(2) The one-dimensional water quality model established is in line with the objective reality,

and various factors are taken into account in the calculation process.

(3) The linear regression equations are fitted to a high degree with high confidence.

(4) The predicted data are highly representative, and the response about the concentration is obvious.

8.2 Disadvantages of the model:

1. about the bad V water prediction is not clear, only the approximate calculation method of average.

2. The model of dry period and wet period was not analyzed respectively, which wasted some data provided.

9. Model improvement and generalization

9.1 Model improvement

Aiming at the evaluation and optimization of the water quality of the Yangtze river, the membership model and one-dimensional water quality model are established in this paper, which can better simulate the judgment of the whole process or the whole category. But in view of the problem four linear regression equation model there is a certain error, because of light pollution water (IV, V) and prediction of polluting water (Bad V) has certain uncertainty.

In the past ten years, the proportion of lightly polluted water fluctuates a lot, and the scatter of heavily polluted water is relatively concentrated in the scatter diagram, which has some objective instability in terms of linearity. Therefore, we can introduce a new discrete stochastic prediction model:

Take the six types of water as a matrix $\Omega = \{I, II, III, IV, V, \text{Bad V}\}$; X is the random variable of water quality described, and the probability distribution state of X .

Such as: in 1995 (0.146, 0.595, 0.189, 0.027, 0.17, 0..Distribution in 025), as time changes, the distribution state of X will change, so that the changing process of various water proportions can be described as a random process X_t , t is time, the probability distribution

$P_{X_t} = (a_1, a_2, a_3, a_4, a_5, a_6)$ of X_t at time t is expressed in terms of P_{X_t} , because industrial pollution makes water quality status changes, each state change, we use a state transition matrix to describe the change of $P = (p_{ij})_{6 \times 6}$; (the probability of class AA water being converted to class AA water), so we get a discrete random prediction model:

$$X_{t+1} = X_t P$$

The data for the previous decade should also be treated in a consistent manner, with the exception of 1998, the year of the great flood.

9.2 Model promotion:

The models established for each problem have some universality. The membership model used for problem 1 can be used when the judgment conditions are fuzzy, and can achieve a higher accuracy under the condition of correct weighting. Moreover, because the process is quantitative analysis, the results are supported by data. Such models can be considered when classifying.

When analyzing water quality, we can use one-dimensional water quality model, which has summarized all types of pollution diffusion to a large extent. Although this study mainly focuses on stable river water, this method can achieve most of our requirements in still water or rivers.

The linear regression model can play an important role in the processing of data-type prediction. According to different linear models, various scatter conditions can be simulated and a high confidence result can be obtained.

Although this research is on the Yangtze river, the idea and model of this paper can be used for reference in any water quality problem. The closer to the reality, the more accuracy and confidence can be achieved, and the desired results can be given on the basis of reality.

10 Conclusion

In this paper, the water quality of the Yangtze river is quantitatively analyzed by using the fuzzy comprehensive evaluation method, and the main

sources of two pollutants are calculated by using the one-dimensional water quality model. The source of ammonia nitrogen ($\text{NH}_3\text{-N}$) pollution is Zhutuo, Chongqing, and Anqing, Anhui province. In the past ten years, the slightly polluted water exceeds the standard by 40%, and the heavily polluted water exceeds the standard by 30%, both of which are in a relatively high state, so it is urgent to improve. The linear regression equation is used to predict the quantity of sewage in ten years and the solution is made, which has a good guiding significance for the future treatment of the Yangtze river.



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