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Comprehensive evaluation of water quality

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Abstract

In this paper, the water quality of the Yangtze River in 2014-2018 is analyzed, and the comprehensive evaluation is carried out according to the entropy method. Firstly, the four project evaluation indexes are quantified and processed into standardized data, and then the water quality data is analyzed. The weight of each index is determined according to the entropy method, so as to obtain the classification of the water quality of the Yangtze River, and the comprehensive score of the water quality index layer is obtained by using the programming solution modelThis paper evaluates the water resources of the Yangtze River and puts forward some suggestions on the protection of water resources.

Keywords

Entropy method, comprehensive evaluation method.

1. Questions raised

Water is the resource on which human beings rely for survival. To protect water resources is to protect ourselves. The protection and management of water resources in China should be the top priority.Experts appeal: "people oriented, build a civilized and harmonious society, improve the environment between man and nature, reduce pollution."At present, there is still a large market space for water quality monitoring industry. The traditional water quality monitoring is mainly based on laboratory instrument analysis and manual on-site sampling, which can not meet the needs of current water environment management.In contrast, online automatic water quality monitoring has come into people's view and become the main development direction of water quality monitoring industry.

2. Problem analysis

For the comprehensive evaluation of water quality, starting from the key indicators of water quality, the weights of the indicators are given, so as to carry out the comprehensive evaluation.For the indicators of water quality, this paper collected four data collected from seven observation stations in the Yangtze River Basin in each period from 2014 to 2018, divided the year into four quarters, and then analyzed the water quality of each quarter comprehensively.The data collected are in weekly units. We use the method of averaging to measure the water quality in a quarter.We have known the monitoring values of the contents of four indicators from seven observation stations in the main stream of the Yangtze River. Because the pH value is relatively stable, most of them are in the range of 7-9, so we only

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consider the influence of dissolved oxygen content, permanganate content and ammonia nitrogen content on water quality.

3. Modeling

3.1.1. Calculate the weight of each index

In information theory, entropy is a measure of uncertainty.The greater the amount of information, the smaller the uncertainty and entropy; the smaller the amount of information, the greater the uncertainty and entropy.According to the characteristics of entropy, we can judge the randomness and disorder degree of an event by calculating the entropy value, and we can also judge the randomness and disorder degree of an index by using the entropy value. The greater the dispersion degree of an index, the greater the impact of the index on the comprehensive evaluation.Degree of dispersion

Therefore, according to the variation degree of each index, the weight of each index can be calculated by using the tool of information entropy, which provides the basis for the comprehensive evaluation of multiple indexes.

$step1$:The value of the second indicator of the third monitoring station is recorded as:

Among them;

$step2$: Due to the different dimensions of each index, before calculating the weight of each index, the normalization is carried out

$$c_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}}$$

$step3$: Each index is quantified in the same degree, and the proportion of the second monitoring station in the index is calculated

$$P_{ij} = \frac{c_{ij}}{\sum_{j=1}^{n} c_{ij}} \quad (i = 1, 2, \ldots n, j = 1, 2, \ldots, m)$$

Where n is the number of monitoring stations and M is the number of indicators

$step4$: According to the definition of entropy, the entropy of the second index is calculated

$$e_j = -k \sum_{i=1}^{n} P_{ij} \ln(P_{ij})$$

among P_{ij} The probability of a certain value in the probability space is expressed, and the information entropy is calculated based on the above formula. If the probability of each sample point is more average, the disorder degree is greater, and the entropy is also greater.The entropy method uses this theory and method for reference. When the ratio difference is smaller, the calculated entropy value is larger, indicating that the amount of information is less.Suppose,.It can be concluded that: and when it is completely equal,. P_{ij}

$step5$: Calculate the weight of each index:

w_j Satisfaction is the weight of each index determined by entropy method.

$$w_j = \frac{(1-e_j)}{\sum_{j=1}^{m}(1-e_j)}$$

3.1.2. Calculation of comprehensive evaluation value

The standard values are defined to represent the standard values of class I, II and III water respectively.

Relatively poor definition

$$\begin{cases} d_{ij} = x_{ij} - I_2 \\ d_{ij} = I_2 - x_{ij} \end{cases}$$

In the formula, the first formula is used to describe the positive indicators, and the second formula is used to evaluate the negative indicators.

From the definition, the larger the value is, the better the class evaluation index of the monitoring station is, so the higher the satisfaction is.

For the sum of relative differences:

$$D_j = \sum_{i=1}^{n} d_{ij}$$

D_j The sum of the relative differences of the indicators in each monitoring station can express the impact of the indicators on water quality.

Define the comprehensive evaluation index of water quality

$$Q = \sum_{j=1}^{m} D_j \omega_j$$

Define measures:

$$Q_s = (I_2 - 0.95 I_1) \times n \times \varpi_j$$

Among them, it refers to the number of monitoring stations and the average weight of each year from 2014 to 2018.

Measurement standard e, rationality analysis:

By comparing the difference and relative difference between the standard values of class I and class II water, we can generally judge the quality of water. We hope that the goal of water quality is class I and class II water. Therefore, it is reasonable to consider the difference between the standard values of class I and class II water.

Define degree coefficient:

$$e = \frac{\sum_{g=1}^{k}(Q_g - Q_s)}{\sum_{g=1}^{k}|Q_g - Q_s|}$$

Where, e -- the overall pollution degree of water quality in a certain period;

K is the total number of years;

Q_g --Is the comprehensive evaluation index of the year;

It can be seen from the expression that:

$e \in [-1,1]$,According to our model, it is reasonable to define the comprehensive evaluation of water quality as the following categories with the uniform distribution of E;

$e \in [-1, 0]$ According to the above model, class I and II water basically do not exist;

$e \in (0, \frac{1}{6}]$ Defined as' poor ';

$e \in (\frac{1}{6}, \frac{1}{3}]$ Defined as' poor ';

$e \in (\frac{1}{3}, \frac{1}{2}]$ It is defined as' middle ';

$e \in (\frac{1}{2}, \frac{2}{3}]$ It is defined as' better ';

$e \in (\frac{2}{3}, \frac{5}{6}]$ It is defined as' good ';

$e \in (\frac{5}{6}, 1]$ It is defined as' excellent ';

4. Model solving

4.1. Index weight

The weight of the impact of water quality indicators on water quality in each quarter of 2014-2018 is obtained by substituting the data into the model.

$$w_j = \frac{(1-e_j)}{\sum_{j=1}^{m}(1-e_j)}$$

The results are as follows:

2014year				2015year		
	dissolved oxygen	Amount of ammonia nitrogen	permanganate	dissolved oxygen	Amount of ammonia nitrogen	permanganate
first quarter	0.3249	0.3737	0.3014	0.3796	0.3654	0.255
Second quarter	0.322	0.3006	0.3774	0.3208	0.3936	0.2856
Third quarter	0.3568	0.366	0.2772	0.3369	0.3232	0.3399
Fourth quarter	0.3264	0.4715	0.2021	0.3398	0.3702	0.2901
2016year				2017year		
	dissolved oxygen	Amount of ammonia nitrogen	permanganate	dissolved oxygen	Amount of ammonia nitrogen	permanganate
first quarter	0.3286	0.3002	0.3712	0.3723	0.3374	0.2904

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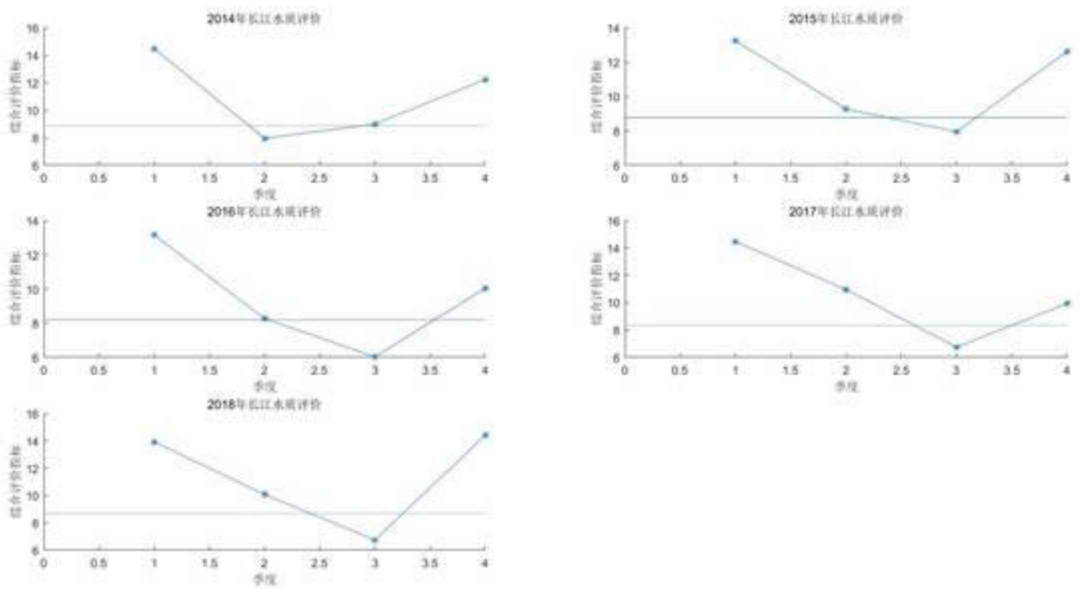
Second quarter	0.322	0.2672	0.4108	0.3470	0.3808	0.2722
Third quarter	0.376	0.3057	0.3184	0.3972	0.2609	0.342
Fourth quarter	0.3849	0.3681	0.247	0.3315	0.3045	0.3641

2018year			
	dissolved oxygen	Amount of ammonia nitrogen	permanganate
first quarter	0.307	0.4158	0.2772
Second quarter	0.2615	0.4463	0.2922
Third quarter	0.3398	0.2986	0.3616
Fourth quarter	0.4028	0.2979	0.2993

4.2. Water quality judgment

The abscissa represents the first four quarters of a year, and the ordinate represents the comprehensive evaluation index value. The part under the water quality standard indicates that the water quality is not up to standard, and the part on the standard indicates that the water quality is up to standard. It can be seen from the figure that the water quality is poor in the second three quarters, and the water quality of the Yangtze River is above the standard in the rest of the time.As shown in the figure below:



In the second and third quarters, the water quality was poor. We analyzed the reasons. Since the dry season of the year is from autumn to spring, due to less precipitation and slow flow rate, many substances slowly sink into the bottom of the river, the river renewal speed is slow, and many harmful substances are naturally relatively more.At the same time, the main causes of pollution in the Yangtze River Basin are phosphorus mining and phosphorus chemical industry pollution, large-scale use of chemical fertilizer in farmland, urban production and domestic sewage discharge, large-scale livestock and poultry breeding and water cage culture, rural garbage and domestic sewage discharge, etc.

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4.3. Water quality grade

From the degree coefficient:

$$e = \frac{\sum_{q=1}^{k} (Q_q - Q_z)}{\sum_{q=1}^{k} |Q_q - Q_z|}$$

The corresponding water quality grades are obtained from different e. the excellent degree of water quality in 2014-2018 is as follows:

2014	2015	2016	2017	2018
0.8092	0.8260	0.5267	0.7281	0.7244
excellent	excellent	Better	good	good

From the above table, it can be concluded that from 2014 to 2018, the water quality of the Yangtze River showed a downward trend, and the state should increase policy protection, cancel or relocate some factories, and strictly enforce the sewage discharge standards.Ammonia nitrogen, total phosphorus, chemical oxygen demand, pH value and permanganate index are the main factors affecting the water quality standard rate of the river water function area.

5. Suggestions on water quality protection

According to the data, due to the huge gap between the natural conditions and economic and social development in different areas of the Yangtze River, the hydrological characteristics, geophysical and chemical characteristics and the pollutants caused by human activities are different in each water area, so the main over standard items and the impact degree of each river section, Lake and reservoir are also different.In 2006, the main pollutants of the Yangtze River were cod, ammonia nitrogen, total phosphorus and total nitrogen, of which the contribution rates of COD and ammonia nitrogen in the point source were 54.2% and 55.9% respectively [1], indicating that COD and ammonia nitrogen were mainly caused by point source pollution, which was closely related to the large amount of industrial and domestic wastewater discharge. However, the contribution rates of total nitrogen and total phosphorus in the point source were only 21.4% and 24.5% respectively, indicating that when the pollution of the Yangtze River was caused by the point source pollution, it was closely related to the large amount of industrial and domestic wastewater dischargeNitrogen and phosphorus are mainly caused by non-point source pollution.

In recent years, the treatment capacity of urban waste water has been greatly improved, and the total amount of COD and ammonia nitrogen emissions has gradually decreased, but the treatment of nutrients such as total phosphorus has not kept up with the growth of fertilizer use. Not only the nutrients in non-point source continue to increase, but also the proportion in point source waste water emissions has increased. Therefore, the total phosphorus pollution is more and more serious.Since 2016, total phosphorus has become the main pollution factor of the Yangtze River, among which the upstream pollution is the most serious, the total phosphorus pollution is more serious in dry and normal water periods, the water quality fluidity is not strong in dry water period, the self purification capacity is reduced, and the pollution is lighter in wet water period.In recent years, the urban sewage treatment capacity of the Yangtze River Basin has doubled, but the vast majority of sewage treatment plants have not added phosphorus removal equipment, and the discharge of phosphorus has not decreased. After treatment, nitrogen and phosphorus in the middle water are still the main pollution sources of rivers, lakes and reservoirs.At present, agricultural pollution has not been effectively

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controlled, and the total amount of phosphorus and nitrogen entering the water body is still large, especially after phosphorus entering the water body, it is difficult to reduce.Due to the construction of cascade reservoirs, the fluidity of water body is greatly reduced, and nitrogen and phosphorus are easy to be retained and deposited, resulting in flooding.Quite a lot of urban rivers have built many sluices and dams in order to expand the water surface, which makes the water body a river in shape, but most of the time it presents the characteristics of lakes and reservoirs, which is easy to cause water eutrophication.Therefore, almost all water bodies in the Yangtze River are facing the problem of exceeding the standard of total phosphorus and other nutrients.

Of course, the single factor evaluation of water function area is relatively strict. As long as one of more than 20 indicators exceeds the standard, the water quality will exceed the standard.Therefore, in the application of evaluation results, it is necessary to consider comprehensively according to the actual requirements of water function.

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