CHEMICAL ENGINEERING TRANSACTIONS
VOL. 55, 2016
A publication of AIDIC
The Italian Association of Chemical Engineering
Online at www.aidic.it/cet
Guest Editors: Tichun Wang, Hongyang Zhang, Lei Tian

ISBN 978-88-95608-46-4; **ISSN** 2283-9216
DOI: 10.3303/CET1655082

Analysis on Influencing Factors of Water Quality of Qingshui River System in Zhangjiakou City

Yi Luo[a], Xiaobo Liu*[a], Qiong Chen[a], Na Dong[b], Xiaoxia Wei[a], Aijiao Huang[a]

[a]Hebei University Of Architecture, Zhangjiakou 075000, China
[b]Zhangjiakou Kaibofeng Real Estate Development Co., Ltd, Zhangjiakou 075000, China
liuxiaobo1818@163.com

Taking the Zhangjiakou section of Qingshui river basin as the research object, the influencing factors of river basin water pollution were analyzed. Using the analytic hierarchy process to establish the evaluation index system of water quality and safety, and using the rigor of logic and the comparison of the two factors to calculate and analyze the weight of each influencing factor, and then evaluate the main influencing factors of Qingshui River water quality. : 18 water quality indicators in Qingshui water quality safety evaluation system, the top five indicators are the straight row of domestic sewage, living pollution, river water temperature gradient, nitrification, nitrification bacteria activity, initial rain inclusion Coastal pollutant content.

1. Introduction

With the rapid development of China's economy, people's demand for natural resources is increasing, and with the improvement of people's living standards, various wastes are continuously produced and cannot be effectively explained. All these actions have adverse effects on environmental protection in various countries. And thus the long-term constraints of the human society, the further development of civilization (Azarnivand et al, 2015). And water resources protection is an important part of environmental protection. At the same time, the current situation of environmental protection in China, although in recent years, China has increased investment in river management, but in the river to improve the results, no obvious results, environmental improvement methods deviation of the theory and practice, water pollution was Less than improved, water environmental protection is still facing a grim form. As far as China's water resources are concerned, there are ten major river basins in China, but 60% of the river basins are brought together by rivers in different cities and eventually form large watersheds (Du et al, 2013). So if you want to control water pollution problems, is bound to first control the tributaries of the city river basin.

In recent years, many cities in the river basin water pollution is becoming increasingly serious, water pollution, water quality deterioration such as: water body odour, duckweed, water eutrophication, water colour changes and other issues (Chen et al, 2013). With the management and improvement in recent years, along the way to build 31 rubber dams, river banks on both sides of the construction of landscape engineering, lighting of the city of Zhangjiakou City, Project, and built a variety of pro-River Park, a number of landscape green space, improve the water environment. Qingshui River has built a set of flood control and drainage, landscape water, recreational functions as one of the city's rivers (Huang, 2012). However, with the rapid development of economy, the level of productivity has been improved, people's living standard has been improved day by day, and the 2022 Winter Olympic Games is approaching, people have put forward higher requirements for water environment. Therefore, it is very important to study the influencing factors of the Qingshui main water quality indexes and to analyse the weight of the Qingshui water quality indexes and find out the main factors affecting the Qingshui River water quality, so as to improve the Qingshui River ecological environment and put forward practical and feasible measures (Guo, 2011).

2. Indicator system and hierarchical structure

According to the basic principle of the establishment of comprehensive evaluation index system of water quality in different regions, according to the water quality status of Qingshui River in Zhangjiakou City, the

Please cite this article as: Luo Y., Liu X.B., Chen Q., Dong Na., Wei X.X., Huang A.J., 2016, Analysis on influencing factors of water quality of qingshui river system in zhangjiakou city, Chemical Engineering Transactions, 55, 487-492 DOI:10.3303/CET1655082

water quality evaluation system of Qingshui River was divided into target layer by using the AHP mathematical model, Criteria level and index level (Li et al, 2012). See Table 1.

Table 1: Qingshui River water quality evaluation system

Target layer	Criteria layer	Indicator level
Comprehensive index of Qingshui water quality index	COD influencing factors (B_1)	Gradient of river water temperature C_1
		Living pollution C_2
		Initial rainwater inclusions along the coastal pollutant content C_3
		Reduced suspended matter content C_4
		Decomposition of microorganisms in water C_5
	NH_3-N influencing factors(B_2)	Coastal sewage straight C_6
		Gradient of river water temperature C_1
		Nitrification, denitrification of the activity of bacteria C_7
		Industrial wastewater discharge C_8
		Precipitation dilution C_9
	pH influencing factors (B3)	Plant photosynthesis C_{10}
		Microbial respiration C_{11}
		Gradient of river water temperature C_1
		Water hardness C_{12}
	DO influencing factors(B4)	Rubber dam water or oxygen C_{13}
		Water surface area C_{14}
		Wind Speed and Water Velocity C_{15}
		River natural ecosystem integrity C_{16}
		River organics, aquatic organisms oxygen consumption C_{17}
	Influencing factors of TP(B5)	Pesticides, chemical fertilizers infiltration C_{18}
		Coastal sewage straight C_6
		Initial rainwater inclusions along the coastal pollutant content C_3

2.1 Research methods to determine the weight of influencing factors of water quality in Qingshui River

In order to more accurately determine the influencing factors of the Qingshui River water quality, this paper adopts the method of Analytic Hierarchy Process (AHP) to analyses the influence factors of water quality of the Qingshui River, The paper analyses the influential factors of water quality, and divides the problem into different constituent factors(Lei et al, 2014). According to the correlation of the influencing factors and the subordinate relation, the influencing factors of different levels are aggregated and combined to form a multi-level and multi-angle analysis structure Model, so as to finally solve the lowest relative to the top relative to the weight value of the problem (Mikaeil et al, 2011). See Table 2.

Table 2: AHP scaling method and its description

Scale	Meaning
1	means that one factor is just as important as the other
3	indicates that one factor is slightly more important than the other
5	indicates that one factor is significantly more important than the other
7	indicates that one factor is more important than the other
9	indicates that one factor is more important than the other
2, 4, 6, 8	the median of the two adjacent judgments
reciprocal	Factor i and factor j compared to determine U_{ji}, then factor j compared with factor i to determine $U_{ji} = 1 / U_{ij}$

2.2 Construct the judgment matrix

The judgment matrix is a mathematical model that determines the relative importance of all the factors of this layer to a factor in the upper layer. By comparing the two methods to determine the relative weight of each factor, the use of AHP scales method to reduce the number of different factors in the comparison of the difficulties. At the same time the final calculation of the matrix of the CI, CR value of the consistency test (Sae-Lim, et al, 2013) to ensure accuracy.

For example, a B-level element is associated with a next level element (C_1, C_2, C_3, C_4, C_5). If B_i is more important than B_j for B, then U_{ij} (u_{ij}> 1) and vice versa. $U_{ji} = 1 / U_{ij}$ according to the AHP scale law U_{ij} generally take 1.2.3……9.

Consistency check: calculate CI;CR=CI/RI(if CI and CR are both less than 0.1 then meet the consistency test).

Table 3: A-B Comparison Judgment Matrix

A	B_1	B_2	B_3	B_4	B_5
B_1	1	1/2	4	3	2
B_2	2	1	5	4	3
B_3	1/4	1/5	1	1/2	1/3
B_4	1/3	1/4	2	1	1/2
B_5	1/2	1/3	3	2	1

Table 4: B1-C Comparison Judgment Matrix

B_1	C_1	C_2	C_3	C_4	C_5
C_1	1	1/4	2	1/3	1/2
C_2	4	1	5	3	3
C_3	1/2	1/5	1	1/4	1/3
C_4	3	1/3	4	1	2
C_5	2	1/3	3	1/2	1

Table 5: B2-C Comparison Judgment Matrix

B_2	C_1	C_6	C_7	C_8	C_9
C_1	1	1/3	1/2	3	2
C_6	3	1	3	5	4
C_7	2	1/3	1	4	3
C_8	1/3	1/5	1/4	1	1/2
C_9	1/2	1/4	1/3	2	1

Table 6: B3-C Comparison Judgment Matrix

B_3	C_1	C_{10}	C_{11}	C_{12}
C_1	1	1/3	1/2	2
C_{10}	3	1	2	4
C_{11}	2	1/2	1	3
C_{12}	1/2	1/4	1/3	1

Table 7: B4-C Comparison Judgment Matrix

B_4	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}
C_{13}	1	2	3	5	5
C_{14}	1/2	1	2	4	4
C_{15}	1/3	1/2	1	3	3

Table 8: B5-C Comparison Judgment Matrix

B_5	C_3	C_6	C_{18}
C_3	1	1/2	2
C_6	2	1	3
C_{18}	1/2	1/3	1

2.3 Hierarchical single sequence and its consistency test

By calculating the impact of the level of the impact of factors on the level of the impact of changes in the proportion of indicators, According to the results of the calculation of the importance of the various factors to sort (Brandt and Kordi, 2012) at the same time, It is also necessary to determine the maximum eigenvalue of the judgment matrix and the corresponding eigenvector of each judgment matrix for consistency checking of the hierarchical single sort (Wei, 2013). This paper selects the root method, the calculation steps are as follows:

(A) Calculate the nth root of the product of each row of the judgment matrix:

$$\overline{w_1} = \sqrt[n]{\prod_{j=1}^{n} a_{ij}}\ (i = 1, 2, \ldots, n) \quad (1)$$

(B) Will be normalized:

$$\frac{\overline{w_1}}{w_i} = \frac{\overline{w_1}}{\sum_{i=1}^{n} \overline{w_1}} \quad (2)$$

$W = (w_1, w_2, \ldots, w_n)^T$ is the approximate value of the matrix eigenvector;
(C) Find the maximum eigenvalue corresponding to the feature vector W:

$$\lambda_{max} = \frac{1}{n}\sum_i \left(\frac{(AW)_i}{w_i}\right) \quad (3)$$

(D) After the consistency test, we can know that the six judgment matrices are within the allowable range, which shows that the logical distribution of the weights is reasonable, and the judgment matrix and calculation results are shown in Table 9.

Table 9: Hierarchical Single Sequence and Its Consistency Test

Judgment Matrix	a_1	a_2	a_3	a_4	a_5	CI	RI	CR	Consistency check
A-B	0.263	0.417	0.062	0.097	0.160	0.017	1.12	0.015	Satisfactory Consistency
B-C_1	0.096	0.446	0.061	0.239	0.158	0.011	1.12	0.001	-----
B-C_2	0.158	0.446	0.239	0.061	0.096	0.015	1.12	0.013	-----
B-C_3	0.180	0.423	0.279	0.119		0.029	0.89	0.033	-----
B-C_4	0.423	0.270	0.168	0.079	0.060	0.030	1.12	0.027	-----
B-C_5	0.319	0.457	0.223			0.063	0.58	0.048	-----

2.4 Overall ranking of layers and its consistency test

Hierarchical sorting refers to the weighting of hierarchical single sorting and one by one combination, thus the C layer to the relative importance of the A layer of the order. Through the above data, calculate and analyse the C layer on the A layer relative weight, that is the overall ranking, See Table 10 below, the total weight of water quality index ranking: $C_6 > C_2 > C_1 > C_7 > C_3 > C_5 > C_{13} > C_9 > C_{18} > C_{10} > C_{14} > C_4 > C_8 > C_{11} > C_{15} > C_{16} > C_{12} > C_{17}$. After the consistency test, we can see layer A Layer A layer has satisfactory consistency.

Table 10: Water Quality Index of Qingshui River

Numbering	Evaluation index	Weight value
C_1	Gradient of river water temperature C_1	0.1023
C_2	Living pollution C_2	0.1173
C_3	Initial rainwater inclusions along the coastal pollutant content C_3	0.0673
C_4	Reduced suspended matter content C_4	0.0255
C_5	Decomposition of microorganisms in waterC_5	0.0421
C_6	Coastal sewage straighC_6	0.2591
C_7	Nitrification, denitrifying of the activity of bacteriaC_7	0.0997
C_8	Industrial wastewater dischargeC_8	0.0254
C_9	Precipitation dilutionC_9	0.0400
C_{10}	Plant photosynthesis C_{10}	0.0262
C_{11}	Microbial respiration C_{11}	0.0173
C_{12}	Water hardness C_{12}	0.0074
C_{13}	Rubber dam water or oxygen C_{13}	0.0410
C_{14}	Water surface area C_{14}	0.0262
C_{15}	Wind Speed and Water Velocity C_{15}	0.0164
C_{16}	River natural ecosystem integrity C_{16}	0.0077
C_{17}	River organics, aquatic organisms oxygen consumption C_{17}	0.0049
C_{18}	Pesticides, chemical fertilizers infiltration C_{18}	0.0357

2.5 Study on the accuracy of determining the weight of factors of Qingshui River by analytic hierarchy process

The results showed that the main influencing factors were direct sewage, living pollution, gradient of river water temperature, nitrification and denitrifying bacteria activity, and the initial pollutant content of rainwater inclusions along the coast. Through the field research, it can be found that a large area of farmland exists along the upper reaches of the Qingshui River and the downstream of Weiyi Bridge. There are many light

industry industries on both sides of the river, Zhangjiakou Pharmaceutical Factory, Zhangjiakou Roberts Factory, Zhangjiakou Leather Shoes Factory and Zhangjiakou top Factory. Although in recent years to increase the supervision of these enterprises, but the investigation found that there are still waste-water phenomenon. Qingshui River upstream of the liberation of the bridge near the large-scale residential areas, belonging to the old city, the old city water supply and drainage pipe network aging, more complex civilian facilities, pipeline housing old cannot on the underground pipe network for a wide range of changes, only sewage Plus a simple treatment measures, but the domestic sewage harmful substances have not been effectively treated directly into the river phenomenon. Downstream Weiyi Bridge to Weisi bridge between the bridge is mainly a new development zone, underground pipe network layout is perfect, basically no sewage discharge phenomenon. Therefore, it can be found through the field survey that the conclusion of the weight analysis is consistent with the facts, which verifies the accuracy of the influencing factors of Qing shui River.

3. Conclusions and recommendations

From the 1.4 Qingshui River water quality indicators of the 18 influencing factors of the overall ranking of the results we can see: Determination of Weight of Six Indicators in Water Quality Evaluation Index System of Zhangjiakou City in Qingshui River Basin, the top five are the coastal domestic sewage C6, the living pollution C_2, the river water temperature gradient C_1, the activity of nitrification and denitrifying bacteria C_7, the initial rainwater inclusions in the coastal pollutant C_3. By analysing the influence of each influencing factor of indicator layer on the elements of the criterion layer, it can be seen that NH_3-N is greatly influenced by the activity level of C_6, the activity level of nitrification and denitrifying bacteria C_7 and the gradient of river water temperature C_1 are larger. While the COD is affected by the pollution of life C_2 is greater, the TP is almost straight along the coast of domestic sewage C_6 and the initial rain mixed with coastal pollutant content of C_3 determined. So, It can be concluded that NH3-N, COD and TP have a great influence on water quality of Qingshui River.

Therefore, to improve the water quality of the Qingshui River Basin in Zhangjiakou City, which should start from the above aspects, strictly prohibit living sewage discharge, garbage dumping and other inhabitants of uncivilized behaviour, supervision departments to strengthen the supervision and education responsibilities, so as to improve the quality of river water in the long term. as the main source of ammonia nitrogen is ammonia nitrogen fertilizer, agricultural wastewater and domestic sewage, it is recommended that the relevant departments to strengthen management and regulate the upper reaches of agricultural pesticide residues in the application of fertilizer to prevent the abuse of indiscriminate use; reuse of livestock wastewater, reduce rain erosion of the environment ; Solid wastes and other pollutants are not allowed to be accumulated along the coast to prevent organic pollutants entering the river course with rainwater. The coastal pollutant storage sites should be waterproof, anti-leakage, anti-loss treatment; unified collection, centralized treatment of domestic sewage, supervision and management of factory wastewater treatment and emissions should be up to the national standard before discharge. Planting plants in the river, improving the living environment of nitrification and nitrifying bacteria, providing favourable conditions for the chemical reaction to proceed smoothly and degrading the organic matter in the water; afforestation along the rivers to reduce the soil and water loss in the upper reaches.

Acknowledgement

Financial support for this work is provided by Hebei University of Architecture Research Fund Project (2016XJJZD02)

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