Assessment of water environment risk management technology in the watershed during the "Thirteenth Five-Year Plan" period in Liaoning Province based on the analytic hierarchy process

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Abstract. This paper uses the analytic hierarchy process (AHP) as the basic framework, and evaluates the water environment risk management technology of the river basin in Liaoning Province, so as to scientifically and reasonably measure the advantages and disadvantages of the existing technology.The research results show that the best technical indicator is the research management technology of water environment quality monitoring technology; the best environmental indicator is the management technology of the research project of water quality safety assessment and early warning management technology in the basin. The highest overall score is the water environment quality monitoring technology method research management technology. Each management technology has certain advantages, and the management technology should be used jointly.

1 Introduction

The Liao River Basin is one of the areas in China where cities are concentrated, densely populated, and socially and economically developed. Under the dual pressure of high-intensity economic development and relatively lagging environmental management, the problems of water pollution and ecological deterioration have become economic and social sustainable in the region. The main constraints of development [1].Risk assessment is to identify and measure the possible loss of human health, social and economic development, ecosystems, etc. caused by or faced by various human development activities (including natural disasters). It includes sudden water environment risk assessment and cumulative water environment risk assessment [2].Sudden water pollution accidents mainly refer to accidents caused by accidents, where a large amount of pollutants enter the water body in a short time, which causes rapid deterioration of water quality, affects the effective use of water resources, seriously affects normal economic and social activities, and destroys the water ecological environment. Cumulative environmental risk means that after long-term accumulation of trace pollutants in human development activities to a certain extent, it will produce rapid ecosystem degradation or cumulative toxic effects, and ultimately endanger human health[3]. This risk has no obvious manifestation in the short term, but it has a long-term impact on human health and ecological security [4].

Liao River Basin water environment risk management technology includes: Through objective, scientific and reasonable evaluation of these management technologies, a series of post-evaluation mechanisms for river basin ecological protection policies are formulated to promote the development of post-evaluation mechanisms for national river basin ecological protection policies.

2 Materials and Methods

2.1 TestMethod

According to the characteristics of the technology to be evaluated, the indicators are preliminarily selected, and the analytic hierarchy process index system is established, including three levels. The first level is the criterion level (A) including technical indicators, economic indicators, and environmental indicators: the second level, the evaluation level (B), includes several indicators; the third level, the index level (C), includes several indicators. The analytic hierarchy process is used to assign weights to the criterion layer and the evaluation layer.

ProfessorSaaty'snine-digit ratioscale is used to compare the importance of the three indicators of the first level of criteria levels A1, A2 and A3 [5]. By analyzing the relative importance of the first-level indicators A1 to A3 at the criterion level, the judgment matrix shown in the following table 1 can be obtained.

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Table 1. Judgment matrix of the importance of each index

	A1	A2	A3
A1	1	1/3	5
A2	3	1	7
A3	1/5	1/7	1

Check the consistency of the constructed judgment matrix, and calculate the consistency index value CI=(λmax-n)/(n-1) and CI=CI/RI. Among them, λmax is the largest characteristic root of the judgment matrix, n is the matrix dimension, and RI is the average random consistency index. If CR<0.1, the judgment matrix is considered to be reasonable, otherwise the values of the elements of the judgment matrix are readjusted. In the same way, using the results and methods of single-level ranking, repeat the above steps, perform a comprehensive ranking of the secondary indicators in the evaluation layer, and obtain the weight of the secondary indicators.

For non-quantitative indicators such as technical readiness, difficulty of operation and management, or important indicators for which the amount cannot be obtained, it is necessary to carry out the standardized value of indicator evaluation. The index value is 0 point, 25 points, 50 points, 75 points, and 100 points, corresponding to 5 types of classifications: complex, more complicated, general, simpler, and simple.

After determining the tendency of various indicators, the maximum and minimum method is used to standardize the original data of the evaluation indicators, and the elimination dimension is normalized to the range of [0,1], and a standardized decision matrix Tmn=[yij]mn is constructed.For each type of technology, according to the sequence of indicator data, the entropy weight method is used to determine the weight of each three-level indicator.

For each type of technology, according to the sequence of indicator data, the entropy weight method is used to determine the weight of each three-level indicator.From this, a hierarchical comprehensive evaluation model is established for evaluation, which is essentially a three-time weighted synthesis of indicators at all levels. The first two layers use subjective evaluation methods, and the third layer uses objective evaluation methods. The combination of expert experience and objective data ensures the scientificity and reliability of the results.

2.2 Technology-Environmental Comprehensive Assessment Method

Technology-environmental comprehensive assessment mainly adopts methods such as literature review, actual investigation, model construction, on-site measurement, and expert consultation. It determines the weight of each technology evaluation index, quantifies each technology evaluation index, and scores the evaluation index of each technology to obtain a comprehensive evaluation result.

Expert consultation mainly takes the form of questionnaire surveys, telephone consultations or face-to-face interviews, with the help of experts' personal knowledge and practical experience to carry out comprehensive assessments. The composition of the Liao River Basin Management Technical Expert Group is shown in Table 2.

Table 2. Composition of Liao River Basin Management Technical Expert Group

source	R & D institutions	University	Business unit	Public institutions
Number of people	10	9	9	8

The Liao River Basin Risk Assessment Management Technology Assessment Index System includes two indicators, technology (A) and environment (B), and the weight results of the first-level indicators are shown in Table 3 below.

Table 3. First-level indicators and their weights

First-level index	Weight
technology	0.5
environment	0.5

The technical indicators of the secondary indicators include two sub-indices of management operation and technical performance; the environmental indicators include two sub-indices of local protection and practical application. The weight results of the secondary indicators are shown in Table 4 below.

Table 4. Second-level indicators and their weights.

Second -level index	Weight
management operation	0.5
technical performance	0.5
local protection	0.3
practical application	0.7

On this basis, management and operation indicators include three sub-indices: operational complexity (C1), operational safety (C2), and operational stability (C3);Technical performance indicators include three sub-indices of technical maturity (C4), process complexity (C5), and technological advancement (C6);Local protection indicators include two sub-indices of local policy improvement (C12) and managerial quality improvement (C13);Practical application indicators include three sub-indices: excellent control list (C14), new detection method (C15), threshold or management level (C16). The weight results of the third-level indicators are shown in Table 5 below. The entropy method is used to determine the weight of each third-level indicator, and the calculation results are shown in Table 5 below.

Table 5. Third -level indicators and their weights.

Third -level index	**Weight**	**Final weight**
Operational complexity	0.2	0.05
Operational safety	0.2	0.1
operational stability	0.4	0.1
technical maturity	0.4545	0.114
process complexity	0.091	0.023
technological advancement	0.4545	0.114
local policy improvement	0.5	0.075
managerial quality improvement	0.5	0.075
excellent control list	0.333	0.117
new detection method	0.333	0.117
threshold or management level	0.333	0.117

3 Results and discussion

In order to achieve the quantification of various evaluation indicators, with the help of fuzzy mathematics theory and the use of membership functions, the standardized evaluation values of various indicators of risk management technology are obtained.According to the risk management technology evaluation index system constructed in the previous article and the determined weights of each evaluation index, a comprehensive technology-environmental assessment of the risk management technology is carried out. The evaluation results are shown in Table 6 below.

Table 6. Evaluation results of water environment quality monitoring technical methods

First level index	Third level index	Third level indicator assignment	Third level indicator score	First level indicator score
A	C1	95	4.75	47.462
	C2	95	9.5	
	C3	98	9.8	
	C4	94	10.716	
	C5	96	2.208	
	C6	92	10.488	
B	C12	95	7.125	29.097
	C13	90	6.75	
	C14	95	11.115	
	C15	96	11.232	
	C16	0	0	

Table 7. Evaluation results of river basin water quality safety assessment and early warning management technology.

First level index	Third level index	Third level indicator assignment	Third level indicator score	First level indicator score
A	C1	96	4.75	47.085
	C2	94	9.5	
	C3	92	9.8	
	C4	94	10.716	
	C5	93	2.208	
	C6	95	10.488	
B	C12	95	7.125	29.856
	C13	97	6.75	
	C14	0	11.115	
	C15	97	11.232	
	C16	96	0	

Table 8. Evaluation results of water environment quality benchmark management technology.

First level index	Third level index	Third level indicator assignment	Third level indicator score	First level indicator score
A	C1	92	4.75	46.494
	C2	91	9.5	
	C3	92	9.8	
	C4	96	10.716	
	C5	94	2.208	
	C6	92	10.488	
B	C12	93	7.125	17.94
	C13	91	6.75	
	C14	95	11.115	
	C15	0	11.232	
	C16	0	0	

4 Conclusions

The research results show that the best technical indicator is the research management technology of water environment quality monitoring technology; the best environmental indicator is the management technology of the research project of water quality safety assessment and early warning management technology in the basin. The highest overall score is the water environment quality monitoring technology method research management technology. Each management technology has certain advantages, and the management technology should be used jointly.

Acknowledgments

This research was funded by the China National Critical Project for Science and Technology on Water Pollution Prevention and Control (2018ZX07601001), and thank you for the help of all the teachers and students on the paper.

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