Retraction

Retracted: Evaluation Model of Eco-Environmental Economic Benefit Based on the Fuzzy Algorithm

Advances in Meteorology

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope

(2) Discrepancies in the description of the research reported

(3) Discrepancies between the availability of data and the research described

(4) Inappropriate citations

(5) Incoherent, meaningless and/or irrelevant content included in the article

(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] M. Gao and X. Lu, "Evaluation Model of Eco-Environmental Economic Benefit Based on the Fuzzy Algorithm," *Advances in Meteorology*, vol. 2022, Article ID 4161723, 9 pages, 2022.

Hindawi

Research Article

Evaluation Model of Eco-Environmental Economic Benefit Based on the Fuzzy Algorithm

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With the development of an ecological civilization gaining increasing attention in our country, an analysis of the environmental and economic impacts of all aspects of life has been developed gradually. However, because the study on the environmental and economic benefits of the tailwater diversion project is a weak link, the discussion on the environmental and economic benefits of the tailwater diversion project is novel. The variable fuzzy evaluation model is used to evaluate the comprehensive environmental and economic benefits of tailwater diversion engineering, in order to facilitate the exploration and application of tailwater diversion engineering. Simultaneously, by evaluating the method using the analytic hierarchy process and fuzzy optimum seeking method, linear comprehensive fuzzy optimization, average comprehensive fuzzy optimization, and variable fuzzy pattern recognition model of optimizing method, the results demonstrate that the method not only can be used to plan optimization but can also provide a good evaluation for each program, the result is reasonable and reliable, and applicable to the comprehensive benefits of water resource management.

1. Introduction

With the development of China's national economy, the degree of damage to the natural environment is deepening, which seriously violates the principle of sustainable development and people's growing material and cultural needs. However, in the new era, the economic development has also brought about a change in people's ideas, and the importance of environmental quality has been constantly improved. Especially in the construction process of water conservancy and hydropower projects, for the ecological environment, is undoubtedly a double-edged sword, in improving the surrounding microclimate at the same time, ecological destruction is inevitable. Therefore, it is of great significance to evaluate the ecological environment impact of hydraulic engineering.

From the definition of academic circles at home and abroad, the so-called "ecological dispatching" refers to the comprehensive reservoir dispatching mode that gives consideration to ecology. Criphin [1] mentioned that ecological

dispatching means that reservoirs should meet both human's demand for water resources and the demand for water of the ecosystem as much as possible. Wang et al. believes that ecological operation is the optimal ecological benefit of reservoir while exerting various economic and social benefits, which is aimed at the ecological problems in macroscopic water resources allocation and operation. Dong et al. [2] put forward the "multiobjective ecological operation of reservoirs", that is, the operation mode of reservoirs taking into account the demands of river ecosystems on the premise of realizing the socio-economic objectives of flood control, power generation, water supply, irrigation, and shipping. However, the ecological benefits of reservoirs are often restricted by social and economic benefits. Therefore, ecological dispatching is the result of mutual optimization and balance between ecological environmental interests and social economic interests in a certain period. Under the current situation, we should coordinate flood control, prosperity, and ecology. While realizing social development and flood control safety, we should reduce the negative

impact of reservoirs and gradually restore the ecosystem. Under the condition of protecting the ecological health of rivers, rational exploitation and utilization can promote the harmony between human and water and realize the sustainable development of resources and environment. It is predicted that in the near future, reservoir ecological operation will be a balanced optimal operation problem with flood control as the constraint and river health as the objective, and the objective will be achieved by coordinating various profit factors.

Water conservancy workers have made some explorations in bringing the ecological functions of reservoirs into full play and alleviating the adverse effects of reservoirs on the ecological environment. Jia et al. [3] discussed the relationship between reservoir operation and nutrient reduction. Fu et al. [4] advocated the combination of hydrology and ecology. Yu et al. [5] proposed that ecological storage capacity should be established in order to maintain appropriate river flow, and the ecological storage capacity of Haizi Reservoir in Daxi, Xinjiang was calculated. Niu et al. [6] discussed the ecological dispatching of the Three Gorges Project.

The comprehensive benefit assessment of water resource exploitation and utilization measures is a multiobjective, multilevel process involving a large number of influencing factors and their complicated interrelationships. Furthermore, the impact of comprehensive benefits varies significantly across cities and regions due to varying climates and environments [7]. Wang et al. [8] developed a system for evaluating the overall benefits of urban water resource development and utilization measures and used an analytic hierarchy process to evaluate Tianjin. Jin et al. [9] developed a comprehensive evaluation model for urban flood control planning schemes, with analytic hierarchy processing serving as the evaluation model's specific modeling process. While existing evaluation models have demonstrated effective evaluation, the majority of them focus exclusively on quantitative indicators and ignore indicators that are difficult to quantify, such as technical, economic, and social benefits. Meanwhile, evaluation models frequently employ a hierarchical analytic process to solve multiobjective problems using a single evaluation model [10].

As a critical component of the eastern route of the south-to-north water diversion project, the tail-water diversion project not only protects the water quality along the main route but also significantly improves the region's ecological environment. To comprehensively assess the necessity and feasibility of engineering construction, this paper discusses the influence of east tail water diversion projects from the south to the north area, as well as regional environmental conditions. A fuzzy algorithm-based evaluation index system for the ecological environment's economic benefits is established, and environmental analysis and evaluation of tail water diversion projects' economic efficiency have certain research value.

2. Water Resources Ecological Dispatching Model

2.1. Objective Function. Generally, water ecological operation in the reservoir scheduling of economic benefit, social benefit, and ecological benefit of comprehensive benefit as the objective function, the economic benefits such as power generation, irrigation, shipping benefits, social benefits such as flood control, water supply, ecological environment including the ecological benefits and environmental benefits. Therefore, on the premise of sustainable development, it is necessary to seek the non-inferior conversion relationship between the benefits of each target, so as to determine the optimal operation mode of water resources. For the convenience of description, the large-scale multiobjective optimization decision model of water resources is described as follows:

$$\begin{cases} \max & W(x) = [E_1(x), E_2(x), \ldots, E_n(x)], \\ \text{s.t.} & \begin{cases} X \in S \\ X \ge 0 \end{cases}, \end{cases} \tag{1}$$

where $E_i(x)$ is the i th comprehensive utilization target, including economic, social, and environmental benefits, etc. X is a vector of all the independent variables; n is the number of comprehensive utilization targets; S is the set of constraint conditions for all comprehensive utilization requirements.

2.2. Constraints. Water balance constraint:

$$V_{t+1} = V_t + R_t - Q_t - D_t - F_t. \tag{2}$$

Reservoir capacity constraint:

$$V_{t\min} \le V_t \le V_{t\max}. \tag{3}$$

Constraint of discharge under reservoir:

$$Q_{t\min} \le Q_t + D_t \le Q_{t\max}. \tag{4}$$

Power station output constraint:

$$N_{t\min} \le N_t \le N_{t\max}. \tag{5}$$

All the above variables are non-negative variables, where V_{t+1} is the reservoir storage capacity at the end of t period; V_t is the initial reservoir storage amount in the period t; R_t is the water inflow into the reservoir in the period t; Q_t is the outflow flow of reservoir in the period t; D_t is the amount of abandoned water in the period t; F_t is the reservoir loss flow (including evaporation and leakage, etc.) in the period t; $V_{t\min}$ is the minimum amount of water storage that should be guaranteed in the t period. $V_{t\max}$ is the maximum allowable storage amount of reservoir in time period t (such as flood control limit in flood season); $Q_{t\min}$ is the minimum downstream discharge that should be guaranteed in the t period (to meet the

comprehensive water demand of the downstream of the reservoir); $Q_{t \max}$ is the maximum allowable discharge in the t period; N_t is the output of the power station in period t; $N_{t \min}$ is the minimum allowable output of the power station in period t; and $N_{t \max}$ is the maximum generating capacity of the power station in period t.

3. Evaluation Index System of Eco-Environmental Economic Benefit Based on the Fuzzy Algorithm

3.1. Fuzzy Theory. When using classical control theory or modern control theory to actual control, control quantity and controlled quantity need to be clearly defined, but in the actual situation, the control process is not clear. In order to solve that may occur in the process of some control problem of fuzzy not clear, the traditional control theory, robust control, optimal control and other improved methods, but no matter how to improve traditional control must be based on the mathematic model of controlled object, it is increased a lot of difficulty to control complex system, some systems cannot even build complex mathematical models that meet the control requirements.

In 1965, the American control expert Chad (LA. Zadeh) initiated and developed the fuzzy theory, which provided a new theoretical guidance for the study and treatment of fuzzy problems. Fuzzy control transforms the language of logic rules into relevant control quantities to control the system. It is more suitable for the control system with complex, unclear or nonlinear controlled objects, and is one of the main ways of intelligent control. Its basic idea is to use machine to simulate human control of the system after fuzzifying the controlled object and establishing relevant models. It is based on fuzzy mathematics, combined with advanced computer technology, using language rules to describe knowledge and experience, through fuzzy reasoning to deduce the advanced control strategy, can conveniently combine the experience and thinking of experts to establish knowledge model.

Compared with classical or modern control, fuzzy control does not require the establishment of a clear mathematical model of the controlled object, but a little prior knowledge of the controlled object cannot have a good design. It still needs to fully understand the characteristics of the controlled object, but the difference is that the control model must be formed by the induction of fuzzy information of the controlled process and the empirical summary of operation, which is also called the knowledge model. Fuzzy control is generally realized through the following steps:

3.1.1. Determining the Input and Output Variables of Fuzzy Control. The aim and significance of fuzzy control are analyzed, and the input and output variables of fuzzy control are determined.

3.1.2. Blur the Input and Output Variables. Membership function is generally used to fuzzier variables, and there are three main methods to determine membership function:

fuzzy statistical method, third method, and increment method. There are also many membership functions, the more common are trapezoidal membership function, trigonometric membership function, Gaussian membership function, and so on.

3.1.3. Making Fuzzy Rules. Making appropriate fuzzy control rules is the key to design fuzzy control. Generally speaking, fuzzy control rules are based on the experience and knowledge of experts in the field to establish a fuzzy algorithm for the control object to achieve the control goal, and then established after simple verification.

3.1.4. Fuzzy Reasoning. The process of generating fuzzy output stage is fuzzy reasoning. After the establishment of fuzzy rules, the fuzzy input set and the premise of fuzzy rules are compared and matched by inference mechanism, and the membership degree of a series of input variables is determined. Then, the qualitative output membership function is obtained by applying the rules formulated in Step (3). Finally, the membership degree of fuzzy control output variables is obtained by fuzzy clustering.

3.1.5. Blur. The output of the fuzzy control must be a definite value before it can be implemented in detail, and the output result of Step (4) is a fuzzy set. Only by de-fuzzifying the output of fuzzy reasoning can the exact result be obtained. Common anti-fuzzy methods include maximum membership function method, weighted average method, and gravity center method.

The calculation of the maximum membership method is very simple. It directly takes the maximum membership function value of the output fuzzy set as the output, also known as the direct method. The direct method is more suitable for fuzzy system with less requirement of anti-fuzzy performance because it is rough and loses a lot of secondary information.

The weighted average method is suitable for the output fuzzy set with symmetric membership function and is widely used in fuzzy control system. Its calculation formula is as follows:

$$e^* = \sum_{j=1}^{n} \frac{\mu_{c_j}(e_j)e_j}{\sum_{j=1}^{n} \mu_{c_j}(e_j)}, \tag{6}$$

where e_j and $\mu_{c_j}(e_j)$ are the centroid and membership function values of each symmetric membership function, respectively.

The center of gravity method, also called center of area method, is the most reasonable and common anti-fuzzy method.

$$e^* \int_e \frac{\mu_c(e)e\mathrm{d}e}{\int_e \mu_c(e)\mathrm{d}e}. \tag{7}$$

It can also be seen from the formula that this method does not lose the output information of fuzzy subset

elements. Although the calculation is more complex than the first two methods, it is also more accurate.

3.2. Variable Fuzzy Decision-Making Model.

Fuzzy concepts (things, phenomena) under a certain combination of space-time conditions often have relativity or dynamic variability [11]. Accordingly, their membership degree and membership function should also be relative and dynamic. The variable fuzzy set theory is developed on the basis of relative membership degree definition. Variable fuzzy set includes fuzzy optimization model, fuzzy pattern recognition model, fuzzy clustering cyclic iteration model, fuzzy decision, recognition, and clustering unified model, etc.

3.2.1. Two-Level Variable Fuzzy Decision-Making Model.

For two-level variable fuzzy decision-making, there are

$$u_j = \frac{1}{1 + \left(d_{jg}/d_{jb}\right)^{\alpha}}. \tag{8}$$

Among them, $d_{jg} = \left\{\sum_{i=1}^{m} \left[w_i(1 - r_{ij})^p\right]^{1/p}\right\}$, $d_{jb} = \left[\sum_{i=1}^{m} (w_i r_{ij})^p\right]^{1/p}$. u_j for decision set (j $j = 1, 2, \ldots, n$; n is decision number) comprehensive relative superior degree; d_{jg} is the optimal distance of decision j; d_{jb} is the distance between decision j and inferiority; w_i is the weight of index i ($i = 1, 2, \ldots, m$); r_{ij} is the relative membership degree of eigenvalues of index i of sample j ($i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$); α is the optimization criterion, $\alpha = 1$ is the least square criterion, $\alpha = 2$ is the least square criterion; p is the distance, $p = 1$ is the Hamming distance, and $p = 2$ is the Euclidean distance.

In general, α and p can be paired in one of four ways:

(1) $\alpha = 1, p = 1$

Formula (8) becomes

$$u_j = \sum_{i=1}^{m} w_i r_{ij}. \tag{9}$$

In this case, Formula (9) is a fuzzy comprehensive evaluation model, which is a linear model.

(2) $\alpha = 1, p = 2$

Formula (8) becomes

$$u_j = \frac{d_{jb}}{d_{jb} + d_{jg}}. \tag{10}$$

In d_{jg} and d_{jb} expressions, $p = 2$, that is, Euclidean distance, and formula (10) is the ideal point model.

(3) $\alpha = 2, p = 1$

Formula (8) becomes

$$u_j = \frac{1}{1 + \left((1 - d_{jb})/d_{jb}\right)} = \frac{1}{1 + \left(1 - \left(1/\sum_{i=1}^{m} w_i r_{ij}\right)\right)}. \tag{11}$$

In this case, Formula (11) is Sigmoid type, or S-type function, which can be used to describe the nonlinear characteristics or excitation functions of neurons in the neural network system.

(4) $\alpha = 2, p = 2$

Formula (8) becomes

$$u_j = 1/1 + \left(\frac{d_{jg}}{d_{jb}}\right)^2 = 1/1 + \frac{\sum_{i=1}^{m} \left[w_i\left(1 - r_{ij}\right)\right]^2}{\sum_{i=1}^{m} \left(w_i r_{ij}\right)^2}. \tag{12}$$

In this case, Formula (12) is a fuzzy optimization model.

3.2.2. Variable Fuzzy Pattern Recognition Model.

The two-level variable fuzzy decision model only involves the superior and inferior extremes. Through the subsequent case analysis, it is found that the evaluation results of this model are relatively poor, and there is a great difference between the relative superior membership degree of different model indexes in the same scheme. The utilization of water resources is a continuous and dynamic process of gradual development. It is necessary not only to evaluate its benefits but also to evaluate the utilization plan. Therefore, on the basis of analyzing the two-level variable fuzzy decision model, the variable fuzzy pattern recognition model is further analyzed [12]:

$$u_{hj} \begin{cases} 0, & h < a_j \text{ or } h > b_j, \\ \dfrac{1}{\sum_{k=a_j}^{b_j} \left\{\sum_{i=1}^{m} \left[w_{ij}\left(r_{ij} - s_{ih}\right)\right]^p / \sum_{i=1}^{m} \left[w_{ij}\left(r_{ij} - s_{ik}\right)\right]^p\right\}^{\alpha/p}}, & a_j \leq h \leq b_j, \ d_{hj} \neq 0, \\ 1, & d_{hj} = 0. \end{cases} \tag{13}$$

where h is the level; a_j is the level lower limit of decision j; b_j is the level upper limit of decision j; s_{ih} is the relative membership degree of standard eigenvalues of level h indicator i; and d_{hj} is the generalized weight distance of the difference between decision j and level h. The rest of the symbols are the same. There are also 4 combinations.

(1) $\alpha = 1, p = 1$

$$d_{hj} = \sum_{i=1}^{m} w_i (r_{ij} - s_{ik}). \tag{14}$$

(2) $\alpha = 1, p = 2$

$$d_{hj} = \left\{ \sum_{i=1}^{m} \left[w_i (r_{ij} - s_{ik}) \right]^2 \right\}^{1/2}. \tag{15}$$

(3) $\alpha = 2, p = 1$

$$d_{hj} = \left\{ \sum_{i=1}^{m} \left[w_i (r_{ij} - s_{ik}) \right] \right\}^2. \tag{16}$$

(4) $\alpha = 2, p = 2$

$$d_{hj} = \sum_{i=1}^{m} \left[w_i (r_{ij} - s_{ik}) \right]^2. \tag{17}$$

For the above four models, we define

$$z_j = \sum_{h=a_j}^{b_j} (d_{hj})^{-1}, \tag{18}$$

has the optimal relative $u_{hj} = (d_{hj} \cdot z_j)^{-1}$.

4. Experimental Design and Results

4.1. Index System Construction

4.1.1. Evaluation Index Selection. The environmental impact of tail water diversion project of the eastern route of the south-to-north water diversion project is mainly reflected in the centralized treatment stage of sewage and wastewater, the reuse stage of the tail water up to standard and the stage of discharge into the receiving area. On the one hand, the tail water diversion project of the eastern route of the south-to-north water diversion project cuts off the inflow load of the main line of the south-to-north water diversion project, and centralizes the sewage into the sewage treatment plant for purification treatment through the sewage pipe network, avoiding the domestic sewage and industrial wastewater from entering the main line of the south-to-north water diversion project and ensuring the water quality of the main line of the water diversion project. On the other hand, the tail-water diversion project effectively solves the problem of tail-water in the region, improves the ecological environment of the region, and is conducive to improving the function of urban landscape and maintaining the stability of the ecosystem. In addition, after centralized treatment of tail water, the water quality of tail water can mostly meet the water quality standard of reclaimed water, which can be used as agricultural water and industrial water to realize the resource utilization of tail water. For part of the tail water that cannot be reused, it will be transported to the receiving water area by pipeline after being treated to the first-level discharge standard. By making full use of the sewage carrying capacity of the receiving water body, the safe discharge of the tail water can be realized within the allowable environmental capacity. Based on the basic principles of scientific nature, objectivity and operability, based on the analysis of the tail water diversion project, on the basis of the environmental impact, through on-the-spot investigation and consulting experts, selected to ensure water mains water, agricultural irrigation tail water recycle, tail water industry recycling efficiency, promoting the value of landscape and affecting biodiversity benefits as evaluation indexes.

4.1.2. Determination of Index Parameters. (1) *Ensure the water Quality Benefit of the Main Line.* According to the cost accounting method, the calculation formula of tailwater diversion project to ensure the water quality benefit of the main line is as follows:

$$E_1 = Q_{\text{COD}} \times C_{\text{COD}} + Q_{NH_3-N} \times C_{NH_3-N}. \tag{19}$$

Among them, E_1 is the water quality benefit generated by tailwater diversion project; Q_{COD} is the total amount of COD discharge reduced by the main water transport line after the implementation of tail water diversion project; C_{COD} is the unit treatment cost of COD in sewage treatment plant. Q_{NH_3-N} is the total amount of $NH_3 - N$ discharge reduced by the main water transport line after the implementation of the tailwater diversion project; C_{NH_3-N} is the unit treatment cost of sewage treatment plant $NH_3 - N$.

(2) *Agricultural Irrigation and Reuse Benefit of Tail Water.* According to the cost accounting method, the calculation formula of agricultural irrigation benefit of tail water diversion project is as follows:

$$E_2 = Q \times (P_1 - P_2). \tag{20}$$

Among them, E_2 represents the tailwater agricultural irrigation reuse benefit generated by tailwater diversion project; Q represents the irrigation water amount provided by tail-water diversion project for farmland; P_1 represents the corresponding price of tap water; and P_2 represents the market price of tail water after treatment.

(3) *Industrial Reuse Benefit of Tail Water.* According to the cost accounting method, the calculation formula of industrial reuse benefit of tail water diversion project is as follows:

$$E_3 = Q' \times (P_1' - P_2). \tag{21}$$

Among them, E_3 represents the industrial reuse benefit of tail water generated by tail water diversion project; Q' represents the industrial water consumption provided by the tailwater diversion project; P_1' represents the corresponding tap water price; P_2 represents the market price of tail water after treatment.

(4) *Enhance Landscape Value Benefit.* It is assumed that since the completion of the project, the number and income of domestic tourists will increase to a certain extent due to the influence of tailwater diversion project, then the value of tourism income generated by the impact of landscape on foreign tourists is as follows:

$$E_w = \sum_{i}^{i+n} I_i \times \eta_i \times a, \qquad (22)$$

where E_w represents the income value generated by foreign tourists; I_i is the income of domestic tourism in year i; η_i is the growth rate of the i th year; and a is the correlation adjustment coefficient.

If the potential tourism value of local citizens is considered, assuming that there are N_i thousand person-times of this city visiting the river landscape every year, and the ticket price is SET as C_i yuan/person-time according to the assumption, the potential tourism value of local citizens is as follows:

$$E_N = C_i \times N_i, \qquad (23)$$

where E_N represents the potential tourism value of local citizens; C_i represents the set ticket price; and N_i stands for annual visits by local residents.

Therefore, the landscape value benefit generated by tailwater diversion project should be the sum of tourism income value of foreign tourists and potential tourism value of local citizens.

$$E_4 = E_w + E_N. \qquad (24)$$

(5)*Impacts on Biodiversity Benefits.* As for the diversity value of biological species, scholars usually choose the public willingness to pay method to calculate the value of ecosystem maintaining biodiversity [13, 14]. The public's willingness to pay for biodiversity protection can be obtained by investigating the costs local people are willing to pay for biodiversity protection, and then correcting the characteristics that affect local biodiversity during the implementation of tailwater diversion project. The calculation formula is as follows:

$$E_5 = I \times N, \qquad (25)$$

where E_5 represents the economic benefit of tailwater diversion project on biodiversity; I represents an individual's willingness to pay for the conservation of biodiversity; N represents the number of people willing to pay for biodiversity conservation.

According to the statistical bulletin of national economic and social development, the price bureau and the questionnaire results of biodiversity individuals' willingness to pay over the years, the total benefit of environmental and economic impact brought by the project is 124,269,300 yuan, as shown in Figure 1. It can be seen that the ensured water quality benefit affects the most, and the industrial reuse benefit of tailwater has a minimal impact.

4.1.3. Grading of Evaluation. According to the actual situation of tailwater diversion project and referring to the research results of related water conservancy projects [15], this paper divides the tone operators of the evaluation of
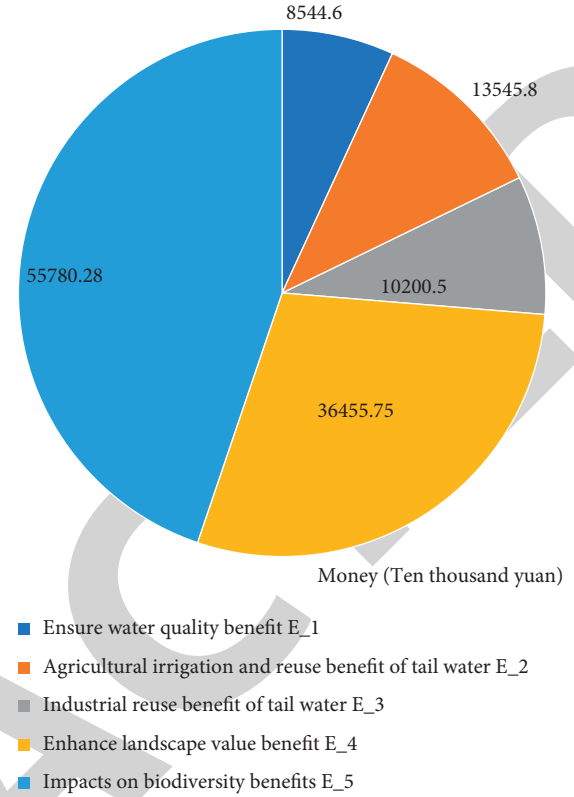

FIGURE 1: Tail water diversion engineering environment affecting economic profit and loss.

comprehensive environmental and economic benefits of tailwater diversion project in the eastern route of south-to-north water diversion project into four levels, which are high (level 1), high (Level 2), average (level 3), and low (level 4).

4.1.4. Evaluation Index Classification. In order to better evaluate the comprehensive environmental and economic benefits of the tailwater diversion project, this paper determines the classification of evaluation indexes of the comprehensive environmental and economic benefits of the tailwater diversion project in the eastern route of the south-to-north water diversion project based on the calculation results of environmental and economic benefits of related studies. Among them, project national economic evaluation (X1), tailwater agricultural irrigation reuse benefit (X3), and biodiversity impact benefit (X6) are all positioned as level 4, with values of 1, 2, 3, and 4 respectively.

4.2. Determination of Index Relative Membership Matrix. The standard interval matrix, range matrix and point value matrix of the environmental and economic comprehensive benefits of tail water diversion engineering in this area are as follows, respectively:

$$I_{ab} = \begin{bmatrix} [4, 3] \\ [5000, 3000] \\ [4, 3] \\ [30000, 20000] \\ [60000, 50000] \\ [4, 3] \\ [3, 2.5] \\ [3000, 2000] \\ [3, 2.5] \\ [20000, 15000] \\ [50000, 20000] \\ [3, 2.5] \\ [2.5, 2] \\ [2000, 1000] \\ [2.5, 2] \\ [15000, 5000] \\ [20000, 10000] \\ [2.5, 2] \\ [2, 1] \\ [1000, 0] \\ [2, 1] \\ [5000, 0] \\ [10000, 0] \\ [2, 1] \end{bmatrix}, \tag{26}$$

$$I_{c\,d} = \begin{bmatrix} [4, 3] \\ [5000, 2000] \\ [4, 3] \\ [30000, 10000] \\ [60000, 40000] \\ [4, 3] \\ [3, 2.5] \\ [2000, 1000] \\ [3, 2.5] \\ [10000, 5000] \\ [40000, 20000] \\ [3, 2.5] \\ [2.5, 2] \\ [1000, 500] \\ [2.5, 2] \\ [5000, 2000] \\ [20000, 10000] \\ [2.5, 2] \\ [2, 1] \\ [500, 0] \\ [2, 1] \\ [2000, 0] \\ [10000, 0] \\ [2, 1] \end{bmatrix}, \tag{27}$$

$$M_{ih} = \begin{bmatrix} 4 & 2.78 & 2.18 & 1 \\ 5000 & 1333.33 & 1666.67 & 0 \\ 4 & 2.78 & 2.18 & 1 \\ 30000 & 13333.33 & 6666.67 & 0 \\ 60000 & 43333.33 & 16666.67 & 0 \\ 4 & 2.78 & 2.18 & 1 \end{bmatrix}. \tag{28}$$

According to the matrix I_{ab}, $I_{c\,d}$, and M_{ih}, the sample characteristic value x_{ij} is judged to be on the left or right side of M_{ih} point, and then the relative membership degree of the index to h grade $\mu A(x_{ij})_{ho}$ is calculated. From this, the relative membership matrix of the indicators at the level $h = 1, 2, 3, 4$ of the tailwater diversion engineering in this area can be obtained, and the row vector can be normalized, and the relative membership matrix after treatment can be obtained as follows:

$$U_j = \begin{bmatrix} 0.78 & 0.28 & 0 & 0 \\ 0.65 & 0.35 & 0 & 0 \\ 0.65 & 0.24 & 0 & 0 \\ 0 & 0.45 & 0.48 & 0.06 \\ 0.30 & 0.65 & 0.06 & 0 \\ 0.50 & 0.50 & 0 & 0 \end{bmatrix}. \tag{29}$$

4.3. Determination of Index Weight. When determining the main variable factors in the variable model parameter CB in the variable fuzzy evaluation method, this paper adopts the binary comparative fuzzy decision analysis method and superscalar multiple weighting method respectively as the basis for determining. The non-normalized weights of each index are, respectively, as follows:

$$\overline{\omega}_1 = (0.24\ 0.28\ 0.25\ 0.11\ 0.08\ 0.16),$$
$$\overline{\omega}_2 = (0.18\ 0.25\ 0.21\ 0.15\ 0.18\ 0.14). \tag{30}$$

4.4. Comparative Analysis of Evaluation Results. According to the standard value vector $S = (1\ 0.8\ 0.6\ 0.3\ 0)$ corresponding to the excellent, good, medium, acceptable and bad, scheme grades is judged. The results of the five methods are shown in Figures 2 and 3.

Following the evaluation results, it is clear that the analytic hierarchy process, fuzzy optimum seeking method, linear comprehensive fuzzy optimization, the average extensive fuzzification model, and the variable fuzzy pattern recognition model used for optimizing the evaluation results are identical; the entropy weight fuzzy optimization evaluation result for the solution of 2, 3, and the evaluation results are consistent with the other four kinds of methods; only one program evaluation is carried out.

The primary reason for this discrepancy is the difference caused by the use of different weight vector calculation methods. Entropy weight method is used for multilevel and
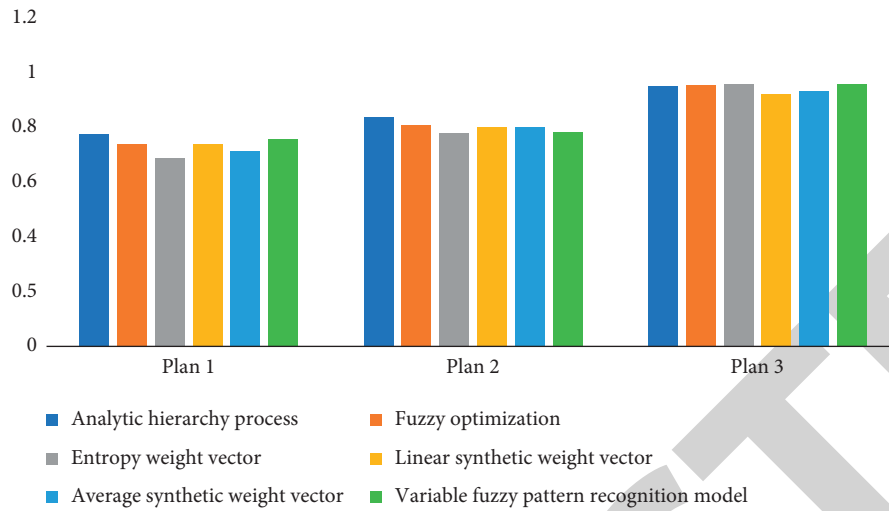
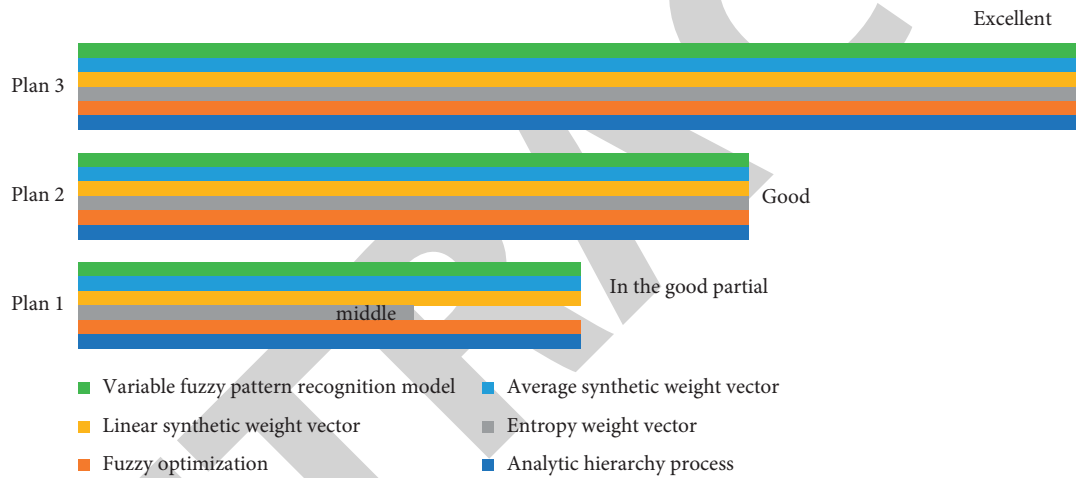Figure 2: Comprehensive evaluation value of each program.

Figure 3: Evaluation levels of each program.

multiobjective comprehensive evaluation problems. The basic idea behind the method is that when the weight vector of each index is calculated at the input layer, the greater the difference between each index and its weight will be used to determine how important the weight is to be used. It is objective and reasonable to reflect the index's contribution to decision-making from the data itself and to eliminate the artificial factors that are used to determine the index's weight in the first place. According to [16], there is a significant difference between the calculation of weight vector in the middle layer, as well as a completely different situation between subjective weight and objective weight. Subjective weight and objective weight should be considered in conjunction with one another in order to completely eliminate this phenomenon. Although it is possible to determine the weight solely based on the difference degree of the index, that is, the entropy value, this approach does not provide a comprehensive solution. The subjective weight reflects the different emphasis placed on the evaluated things at various stages of the evaluation process. The linear synthesis method and the average synthesis method are both more scientific

and reasonable methods of calculating the weight vector, and the final evaluation result is more accurate and representative of the real world.

5. Conclusion

The variable fuzzy evaluation model is used in this paper to evaluate the comprehensive environmental and economic benefits of tailwater diversion engineering, in order to facilitate the exploration and application of environmental and economic benefits of tailwater diversion engineering. The model is a variable fuzzy evaluation model and has its application in other fields.

(1) This article is based on an analysis of environmental impact, on the basis of tailwater diversion projects from guarantee water mains, tailwater recycling agricultural irrigation water quality, tailwater industry recycling, and improving landscape engineering value and its effect. According to the research findings, the tail-water diversion project's

environmental and economic benefits are greater in this area, while the main line's water quality benefits are more obvious. The evaluation findings are consistent with the practical benefits generated by tail-water diversion engineering operations in this area.

(2) Relevant data are derived during the analysis process from the statistical bulletin of national economic and social development over time, the price bureau, and the results of biodiversity individual willingness to pay questionnaires, among others. The indicators developed in this paper can be quantified using currently available technologies. Simultaneously, based on the results of environmental and economic benefits in each region of the tailwater diversion project of the eastern route of the south-to-north water diversion project in this area, the classification of evaluation indexes of comprehensive environmental and economic benefits of the tailwater diversion project of the eastern route of the south-to-north water diversion project in this area is determined, which can ensure the effectiveness.

In the future, we will introduce more advanced fuzzy algorithms and formulate a more comprehensive evaluation system.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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