Review on the evaluation system of river regime change effect in the middle and lower reaches of the Yangtze River

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Abstract. In recent years, obvious changes have taken place in the middle and lower reaches of the Yangtze River, and some river regulation projects have gradually lost their original functions. Under the background of "great protection of the Yangtze River", the rapid economic and social development along the Yangtze River and the continuous enhancement of ecological civilization construction put forward higher requirements for the Yangtze River governance research under the new situation. This paper systematically discusses the characteristics of various evaluation system research methods, introduces the main theories and advantages and disadvantages of AHP in detail, and selects flood control, shipping, beach, water resources utilization and water ecology as the evaluation indexes of AHP, and summarizes the previous research results of each evaluation index under the condition of river regime change, so as to provide reference for the formulation and implementation of the control strategy of the middle and lower reaches of the Yangtze River Optimization provides theoretical support.

1. Introduction
The Yangtze River Basin is the strategic water source of water resources allocation, the main base of hydropower development, the "golden waterway" connecting the eastern, central and western regions, and the natural treasure house of rare aquatic organisms. It has an important strategic position in China's economic and social development. As the carrier of many social and natural functions, the evolution of the Yangtze River channel and the temporal and spatial distribution of sediment are the basis for the flood control safety, smooth navigation and effective utilization of beaches of the Yangtze River, and the important guarantee for the construction of the Yangtze River economic belt [1-2]. With the rapid development of economy and society along the Yangtze River, the demand for various social and natural functions of the middle and lower reaches of the river is increasing. However, under the dual influence of climate change and human activities, the river regime in the middle and lower reaches of the Yangtze River has changed significantly in recent years [3]. With the successive impoundment and operation of Xiangjiaba and Xiluodu hydropower stations in 2012 and 2013, the amount of sediment discharged has further decreased. The storage of the Three Gorges reservoir has further reduced the amount of sediment in the middle and lower reaches of the Yangtze River, and a large amount of sediment has been stored in the upstream cascade reservoirs, the sediment in the middle and lower reaches is greatly reduced, resulting in the opposite geomorphic process of sedimentation in the upper reaches and scouring in the middle and lower reaches [4]. Some river regulation projects have gradually lost their original functional properties [5-7]. At the same time, the original idea of river regulation will no longer adapt to the principle of "ecological priority and green development" under the new situation, so it is urgent to carry out the research on river regime
change and regulation strategy in the middle and lower reaches of the Yangtze River and formulate the relevant evaluation index system.

2. Research methods of evaluation system

"Indicator" comes from the Latin "indicate", which means "expose or point out, is open, give evaluation or give value" [8]. Over the centuries, indicators have been widely used to reflect the development of things and remind people of adverse changes. They not only cover the comprehensive information of complex system characteristics, but also can continuously reflect the development and evolution of things. Indicators provide an empirical and quantitative basis for the comparison of time and space, and also provide more opportunities to discover new relationships between things. Indicators generally deal with complex phenomena simply, which makes communication easier and more frequent, and makes it possible to quantitatively quantify problems. Most of the existing indicators are set for special functions.

River regime change impact assessment index refers to the corresponding variables or groups used to infer or explain other attributes of the system. River regime change impact assessment is affected by multi-level and multi factor, so it is impossible to use a single index to measure the impact of river regime change. Therefore, it is necessary to use multi factor comprehensive assessment to reflect the impact degree of river regime change. In recent years, there are many research methods proposed at home and abroad, which can be roughly divided into two categories from the perspective of index weighting methods. One mainly relies on experts' experience and subjective judgment to get index weights, such as Analytic hierarchy process, fuzzy comprehensive evaluation method, principal component analysis method, Delphi method, etc.; the other mainly determines weights according to the correlation and variation coefficient between indexes, such as variation coefficient method, entropy method, TOPSIS method, grey correlation method, etc., as shown in Table 1.

| Method                          | Characteristic                                                                 |
|---------------------------------|-------------------------------------------------------------------------------|
| Analytic hierarchy process      | It is a better scientific decision-making method that combines qualitative analysis with quantitative analysis. It quantifies the qualitative problems that people judge by subjective experience through the method of pairwise comparison of scale values. It not only effectively absorbs the results of qualitative analysis, but also gives full play to the advantages of quantitative analysis. It not only contains subjective logical judgment and analysis, but also relies on objective accurate calculation and deduction, so that the decision-making process is highly organized and scientific. It can deal with many practical problems that traditional optimization technology can not start with, and has a wide range of applications. |
| Fuzzy comprehensive evaluation method | It is a bid evaluation method based on fuzzy mathematics. This method can transform the qualitative evaluation into the quantitative evaluation, and make the overall comprehensive evaluation for the objects restricted by many factors. This method can well combine the relationship between quantitative and qualitative, has strong systematicness and clear evaluation results, and is widely used in environmental pollution assessment. |
| Principal component analysis    | This method simplifies the data set by linear transformation and reduces the data dimension. |
Delphi
According to the procedure of the system, the anonymous way is adopted, that is, the experts can not discuss with each other, do not have horizontal contact, and can only have relations with the investigators. Through multiple rounds of investigation, the experts' views on the questions raised in the questionnaire are repeatedly consulted, summarized and modified, and finally the experts' basically consistent views are synthesized as the basis of decision-making.

Coefficient of variation method
Coefficient of variation is a commonly used statistical index to measure the difference of data in statistics. This method weights each index according to the degree of variation of the observed values of all the evaluated objects. In order to avoid the influence of different dimensions and orders of magnitude, the normalized value of coefficient of variation is directly used as the weight of each index.

Entropy weight method
In information theory, entropy is a measure of system disorder, which can measure the effective information provided by data. Entropy weight method is a method to determine the weight of each index according to the amount of information transmitted to the decision-maker. The greater the difference of an evaluation index, the smaller the entropy; the more information the index contains and transmits, the greater the corresponding weight.

TOPSIS analysis method
It is a multi-objective decision-making analysis method, which can rank the selected targets and make them approach the ideal state.

Grey relevant analysis method
This method can judge the relevant degree according to the change trend of factors in the development process, that is, the degree of similarity or difference between factors. This method can reduce the error caused by data information asymmetry to a certain extent.

Among the above methods, Analytic hierarchy process (AHP) can decompose the factors related to multi-objective decision-making into objective, criterion, index and other levels, and then use the analytic method of comprehensive decision-making with hierarchical weight. The biggest advantage is that it can simplify the evaluation system of river regime influence effect by using AHP. Firstly, the hierarchical structure is established, then the evaluation indexes are compared, and the optimal scheme is obtained by matrix calculation. Therefore, this paper focuses on the establishment of evaluation index model framework by AHP.

3. Analytic hierarchy process
Analytic hierarchy process (AHP) was first proposed in the 1970s by F.L.Santy, a well-known professor and operational research scholar of Pittsburgh University in the United States [9]. It is a combination of quantitative and qualitative analysis, which decomposes the factors related to multi-objective decision-making into objectives, criteria, indicators and other levels, and then synthesizes the decision-making through hierarchical weight. Its basic idea of solving problems is consistent with people's thinking of multi-level, multi-factor and complex decision-making problems. Its most prominent feature is hierarchical comparison and comprehensive optimization, so as to simplify the evaluation system. First, it establishes a hierarchical structure, and then compares the evaluation indexes in pairs to get the optimal scheme through matrix calculation. This method was extended to China in the 1980s, and has been widely used in decision-making, evaluation and ranking, index integration, prediction and so on. Tong Yinghua et al. [10] used AHP to evaluate the influencing factors of haze, and believed that through field investigation and expert scoring, AHP can solve many uncertainty problems in the evaluation, and quantify the influence degree of each index on haze. Zhu Tao et al. [11] used the AHP to evaluate the geological environment of the open-pit mining area in the
northern foot of Qinling Mountains, and considered that the AHP has a good evaluation effect, which is consistent with the field investigation results. Xia Jun et al. [12] combined with the grey theory, constructed the AHP grey dynamic ecological environment evaluation model, and considered that the model could reflect the change trend of each index, reasonably predict and evaluate the impact of small hydropower on the ecological environment in heyan area. Sun zongfeng et al. [13] established the index system by using the AHP, constructed the evaluation model, and then used the fuzzy comprehensive method to effectively evaluate the impact of water conservancy projects on the river ecological environment, and initially put forward the improvement measures. Shi yongbiao [14] used the hierarchical fuzzy comprehensive evaluation model to study the establishment of social evaluation index system for water conservancy construction projects.

4. Evaluation index of river regime change effect

The Yangtze River has large runoff and strong sediment transport, and there are large-scale cascade water conservancy and hydropower projects in the upper reaches. The river is affected by both natural changes and strong human activities. The relationship between water and sediment is not coordinated at the watershed scale, and the movement of water and sediment and the change of riverbed boundary are very intense [15]. The controlled water conservancy and hydropower projects cut off the continuity of river sediment, resulting in the sudden drop of sediment inflow in the downstream channel and the great change of water and sediment regime in the downstream channel, resulting in the riverbed scouring of the downstream channel [16-17]. In the process of continuous riverbed scouring, the section, plane and longitudinal section of different river types in the downstream channel are significantly adjusted [18-20], resulting in the longitudinal erosion of the downstream riverbed. This has an important impact on river flood control, navigation, beach and water resources utilization, water ecology, etc. [21-23]. Therefore, this paper selects flood control impact index, shipping impact index, beach shoreline impact index, water resources utilization and water ecological environment impact index to evaluate the impact of river regime changes in the middle and lower reaches of the Yangtze River.

4.1 impact of river regime change on flood control

The change of flood characteristics and river regime is the driving force leading to the new problems of river flood control and river regulation [24]. With the continuous scouring and silting evolution of the middle and lower reaches of the Yangtze River and the continuous adjustment of channel storage capacity, the river safety discharge corresponding to the flood control water level will also change, which will have an impact on the flood control situation and the operation of the engineering system in the middle and lower reaches of the Yangtze River [25-27].
Figure 1. Main flood control stations and corresponding flood control guaranteed water levels in the middle and lower reaches of the Yangtze River

On the basis of the prediction results of the erosion and deposition of the middle and lower reaches of the Yangtze River and the changes of its storage and discharge capacity, Xu et al. [28] compared and calculated the changes of the flood control operation of the reservoirs in the upper reaches of the Yangtze River and the excess flood volume in the middle and lower reaches of the Yangtze River under the current and future conditions of the storage and discharge capacity. It is considered that in the future, with the further scouring of the middle and lower reaches of the Yangtze River, the storage volume of the channel will increase, the safe discharge of the river will increase under the same flood control water level, the discharge of the Three Gorges reservoir will increase, the total flood storage will decrease, and the total excess flood in the middle and lower reaches of the Yangtze River will decrease. Through data analysis, Ning Lei [29] concluded that the relationship between water level and discharge at the outlet of the Three Gorges reservoir has almost no change after the impoundment and operation, and the overall performance of each reach at the outlet of chenglingjidao lake is continuous scouring, resulting in the increase of channel storage at the same water level. Wei Shanzhong [30] and Ma Shuishan [31] think that the long-term continuous adjustment of the river course under natural conditions, especially the change of the incoming water and sediment conditions in the middle and lower reaches of the Yangtze River caused by the construction and operation of the main and branch reservoirs in the upper reaches of the Yangtze River, will lead to the change of growth time, long-distance desire and the adjustment of river regime in some sections of the middle and lower reaches of the Yangtze River. The adjustment of river regime in some river sections has been intensified, and new bank collapses occur frequently, which has become a prominent weak link in the flood control infrastructure construction of the Yangtze River. The flood control guaranteed water level of the main control stations in the middle and lower reaches of the Yangtze River is shown in Figure 1.

4.2 Impact of river regime change on shipping

Waterway regulation project must take the law of river evolution as the basic premise and guidance. Therefore, it is very important to correctly understand and master the law of channel evolution, especially the evolution of shoal and its analysis method, and deepen the understanding of river system. Many scholars have carried out extensive research on the influence of riverbed evolution on channel conditions under the condition of river regime change. Jiang Ling and Li Yitian [32] analyzed the evolution characteristics of different types of riverbed in Jingjiang sandy reach since the impoundment of the Three Gorges project, predicted and calculated the scouring process of riverbed in the
downstream of the reservoir, and then discussed the evolution trend of riverbed and its impact on the waterway. The research and analysis show that in the initial stage of impoundment, the upper Jingjiang thalweg is obviously cut down, but the navigation depth is insufficient in the widening section; the Lower Jingjiang thalweg alternates with scouring and silting, the transition section of the deep channel in the Changshun straight (slightly curved) reach moves down, and the water flow at the entrance of the bend is relatively scattered, resulting in the instability of the navigation channel. Based on the calculation results of the mathematical model, it is predicted that the taipingkou Ouchikou reach will be strongly scoured after 5-10 years of water storage, and the low flow channel in the branching section will be wider and shallower, resulting in the deterioration of channel conditions, and the development of branching will affect the navigation conditions of the main channel; In the early stage of scour below Ouchikou, whether the shoal in the transition section hinders navigation is mainly related to the process of water recession, but the development of the bend will change the position of the channel. After 15-20 years of impoundment, the scour above the Ouchi estuary is basically completed, and the slightly curved Hanhe river type of the upper Jingjiang River tends to be stable; strong scour occurs below the Ouchi estuary, and the elevation of the shoal in the transition section decreases, which is conducive to the increase of navigation depth, and the bend may appear partial deflection, resulting in the displacement of the navigation channel. Liu Xiaoqiang et al. [33] analyzed the scouring and silting law of the Jingjiang river reach and the change of channel conditions after the impoundment of the Three Gorges Project by using the measured water, sediment and terrain data. Taking YaoJian river reach as the research object, the adaptability of the guard type project and the adjustment type project to the impoundment process after the flood season was simulated by using the two-dimensional water and sediment mathematical model. It is considered that under the premise of "clear water scouring" after impoundment of the Three Gorges reservoir, the guard type project plays a positive role in improving the channel effect, but it needs to meet certain conditions, mainly because the shallow water channel is in a better evolution stage, and there is little gap between the regulation target and the current conditions; In order to improve the channel conditions of the river reach which is more sensitive to the post flood impoundment process of the Three Gorges reservoir, it is necessary to adopt certain regulation projects. Li Ming et al. [34] considered that under the new river regime, for the main branch with longer flow in the branching channel, in order to stabilize its branching ratio and channel water depth conditions, it is necessary to control the operation of the branching channel and limit its development; for the branching channel with relatively balanced flow ratio, the development trend of the branch with shorter flow is clear, and it should be treated as the main navigable branch.

4.3 Study on the influence of river regime change on beach shoreline
In recent years, the river regime changes in the middle and lower reaches of the Yangtze River have intensified, the contradiction between the development and protection of shoreline resources has become more and more prominent, and the impact of river regime changes on the shoreline of beaches has become more and more far-reaching. As a result, the main stream of the Yangtze River, especially the middle and lower reaches, has become one of the areas with the most problems in the development of shoreline resources in China. Zhao Weiyang et al. [35] took the Shashi reach near the sandy riverbed of the downstream of the Three Gorges Dam as the research object, using the measured water and sediment data from 1955 to 2018 and the measured topographic data from 1975 to 218, Based on the study of riverbed erosion and siltation, riverbed morphology, beach morphology adjustment characteristics and driving causes, it is concluded that the east of Shashi reach has a cumulative scouring trend from 1975 to 2018, in which the scouring amount of low flow channel accounts for 3.1% of the total scouring amount of the whole channel, and the beach area has a synchronous decreasing trend with the sediment discharge and channel scouring, and the riverbed scouring intensity has increased since 2009. Among them, sand mining accounts for 15.9% of the river bed erosion, and dredging and dumping have little effect on the river channel erosion and deposition. Huang Yong et al. [36] also reached a similar conclusion. The research results of Qu Geng et al. [37] show that with the successive impoundment and operation of the main and branch reservoirs in the upper reaches of the
Three Gorges project, the river downstream of the dam will be scoured by clean water for at least 300 years, and the river regime adjustment in the bend section from Xiongjiazhou to Chenglingji will be more severe, which will lead to the continuous reduction of the bending half diameter of the qiyinling bend, the deterioration of the flow conditions, and the main flow will top the concave bank of qiyinling, resulting in "beach cutting and skimming" in this section. In addition, the bank line of baxingzhou will continue to collapse and retreat, and the speed of collapse and retreat will be more intense. Based on the measured data, Xia Junjiang [38] summarized the temporal and spatial distribution and characteristics of bank collapse in the middle reaches of the Yangtze River, and analyzed the main factors affecting bank collapse. The results show that: on the whole, the bank collapse in the Jingjiang river section of the middle reaches of the Yangtze River is the most severe, and the degree of bank collapse in the Lower Jingjiang River is greater than that in the upper Jingjiang River, the length of bank collapse in the left bank is greater than that in the right bank, and the bank collapse in the Chenghan river section is mainly concentrated in Jizhou Bay. After the operation of the Three Gorges project, the average annual length of bank collapse in the middle reaches of the Yangtze River has increased, and the reach of strong and severe bank collapse has decreased significantly. The increase of current scouring intensity is the main factor affecting the bank collapse, and the increase of water recession rate also aggravates the bank collapse in the middle reaches of the Yangtze River. Zhang Xibing et al. [39] think that the change of water and sediment and the adjustment of river regime will have a certain impact on the shoreline utilization of some river sections. There is a superposition of flood level and flow velocity in the intensive reach of shoreline utilization project, which has a certain impact on the flood discharge of the river. Therefore, the countermeasures to mitigate the cumulative impact should be put forward for different river related projects, and the river monitoring and analysis should be strengthened. Li Xiyao et al. [40] combined with the water and sediment data of Datong hydrological station, analyzed the relationship between the estuarine area and the water and sediment amount, and found that the change of water and sediment has a very significant impact on the Yangtze River Estuary. There is a good positive correlation between the annual average area of the Yangtze River Estuary research area and the average annual discharge and average annual sediment concentration of Datong hydrological station. The water and sediment conditions with abundant water and sediment are conducive to the development of the beach shoreline of the Yangtze River Estuary.

4.4 Impact of river regime change on water resources utilization

The operation of the Three Gorges Project and other water storage buildings has significantly improved the comprehensive utilization capacity of water resources in the Yangtze River Basin, providing nearly 900 billion kwh of hydropower clean energy every year, ranking first in the world, solving the drinking water safety problem of 190 million rural people, and the effective irrigation area is 163.3 billion m². The level of unified management and operation of water resources has been continuously enhanced, and 100 water projects including 40 control reservoirs in the upper and middle reaches of the Yangtze River have been put into joint operation. The allocation capacity of water resources has been greatly improved [41]. According to the statistics of Gao Yulei [42], the Three Gorges project started from the experimental impoundment to 2017. The total amount of water supply is more than 190 billion m³, which is compared with the preliminary design. The downstream flow compensation standard of the reservoir in dry season has been improved. The discharge of the reservoir from January to April in dry season is controlled at about 6000 m³/s, which is about 1500 m³/s more than the natural flow. The average depth of the channel is increased by 0.7 m, which improves the downstream shipping conditions and effectively meets the downstream water demand for production, living, shipping and ecology. Although the operation of the Three Gorges project has played a positive role in the development and utilization of water resources in the middle and lower reaches of the Yangtze River, the impact of river regime change on the water intake guarantee rate of water intake facilities and lakes and wetlands along the Yangtze River still can not be ignored. The research of Zhang Xibing [43] shows that after the normal operation of the Three Gorges project, the
water level at the outlet of Dongting Lake will drop mainly due to the influence of reservoir operation mode and main stream channel scour survey. The decrease of flood level in flood season is beneficial to flood control, while in dry season, especially in the impoundment period of the Three Gorges, the decrease of water level will have a negative impact on the utilization of water resources in the lake area, and the guarantee rate of water intake will be greatly reduced. Duan Kai et al. [44] showed that the water level and quantity of the Three Gorges project had a certain adverse impact on the development and utilization of water resources in Dongting Lake area at the initial stage of its construction and operation. On the one hand, the continuous decrease of Jingjiang River Diversion leads to the decrease of available water resources in this area year by year, especially in the dry season, which is faced with seasonal water shortage. On the other hand, the water level of sinkou river system decreases in the dry season. The extension of the total water cut-off period also makes it difficult for the existing water diversion and lifting facilities to take water normally, which aggravates the engineering water shortage. Xu Jijun et al. [45] and Ding Huijun et al. [46] studied the impact of the Three Gorges Project on the utilization of water resources in Poyang Lake, and reached similar conclusions.

4.5 Impact of river regime change on water ecological environment

From the research of river ecosystem at home and abroad for nearly half a century, a large number of case studies have shown that runoff plays a decisive role in river ecosystem, and the change of river flow pattern has a chain effect on the ecological integrity of river system. Ran Jingjiang et al. [47] believe that the physical structure of natural environment and biological habitat of rivers is largely determined by physical processes, especially water flow. In a river, various flow events contribute to and maintain different habitat characteristics. For many river organisms, a series of different habitat types are needed to complete the life cycle, and these habitat types are controlled by the hydrological situation over time. Human activities change the hydrological situation, which also changes the natural hydrological changes, thus changing the dynamic changes of habitat and creating a new habitat environment, which may be difficult for local communities to adapt to. Shuai Hong [48] and Huang Tao [49] found that after the completion and operation of the Three Gorges Dam, the main pollutants in Dongting Lake area are still total nitrogen and total phosphorus, and the water quality of the lake area has changed from poor to moderate nutrition to mild eutrophication, and the water quality has further deteriorated; the impoundment of the Three Gorges has changed the hydrological rhythm and siltation of the original Lake area, resulting in the change of water quality indicators; the discharge of the Jingjiang River and the four water basins has increased, The effect on the water quality of the lake area is gradually enhanced; the wetland exposure time is advanced, and the wetland ecosystem is damaged to a certain extent. Tang Ping [50] found that the impact of the operation of the Three Gorges Project on the water quality in the downstream of the dam during the impoundment period and the weakening of the dilution capacity of the water body, but the concentration of pollutants in the downstream of the dam does not increase significantly, because the content of suspended solids in the sediment decreases due to the impoundment of the dam. During the dry season from January to March, replenishing water to the downstream of the dam is beneficial to the overall water quality. The mass concentration of representative parameters of water quality in nanjinguan section under the dam is basically the same or slightly decreased. Zou Jiaxiang [51] found that after the impoundment of the Three Gorges reservoir, the water temperature at the downstream of the dam is low in spring and summer, high in autumn and winter, and the dissolved gas supersaturation at the downstream of the dam. Due to the regulation of the reservoir and the decrease of sediment inflow, the aquatic habitats in the lower reaches of the dam are affected to varying degrees. In the middle and lower reaches of the Yangtze River, the proportion of endemic fish decreased from Yichang to hukou, and the proportion of "four big fish" decreased first and then increased.
5. Build the evaluation system of river regime change impact effect

Using the AHP (AHP), the impact of river regime change in the middle and lower reaches of the Yangtze River is listed as the first layer; Five categories of river regime change impact are introduced, namely the above five impact factors, which are listed as the second layer; based on the five impact indicators in the second layer, the third layer is obtained by further subdividing the characteristic quantity (show as Fig.2).

![Diagram of AHP model for river regime change impact assessment](image)

According to the principle of AHP, the scale is used to quantify the weight of two things, and the index scale is used to calculate. The factors in each layer are compared according to the index scale to form the judgment level: equally important, slightly important, important, obviously important, strongly important and extremely important. Firstly, the hierarchical structure model is established and the pairwise comparison matrix is constructed. Then the weight vector $W = (w_1, w_2, w_3, \ldots, w_n)$ is calculated, according to the formula $AW = R_{\text{max}}W$, the eigenvalue $R_{\text{max}}$ of the largest eigenvector $W$ of the judgment matrix $A$ is calculated. Then the consistency test is done with formula $CI = (R_{\text{max}} - n)/(n - 1)$ and formula $CR = CI / RI$. Finally, according to the relative importance of the indicators, the judgment matrix is listed (Table 2), and the evaluation system of river regime change in the middle and lower reaches of the Yangtze River is established.

| $X_i$/ $X_j$ | Equally important | A little more important | Important | Very important | Extremely important |
|--------------|-------------------|------------------------|-----------|----------------|---------------------|
| $a_{ij}$     | 1                 | 2                      | 3         | 4              | 5                   | 6                   | 7           | 8           | 9           |

6. Conclusion

(1) The changes of river regime in the middle and lower reaches of the Yangtze River have caused different degrees of impacts on flood control, navigation, beach and shoreline, water resources utilization, and water ecology. These impacts have both advantages and disadvantages. In the evaluation system of river regime changes, we should show the advantages and disadvantages in a
quantitative way, objectively and comprehensively. The change of river regime in the middle and lower reaches of the Yangtze River was evaluated.

(2) In general, AHP method has both advantages and disadvantages in river evaluation. For example, AHP method can only choose the best one from the given strategies, but can not give a new strategy, and the index system used needs the support of expert system, if the index given is not reasonable, the result is not accurate. When AHP is used for multi-layer comparison, consistency comparison is needed. If it does not meet the requirements of consistency index, AHP will lose its function. Therefore, it is necessary to use other evaluation methods to supplement and verify AHP.

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