

Development and Utilization of Yellow River Resources under the Background of Sustainable Development from the Perspective of Ecology

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Abstract:

As the ecological protection and high-quality development of the Yellow River Basin becomes a major national strategy, cities along the Yellow River are facing huge development opportunities. How to develop and utilize the Yellow River resource rationally in a sustainable development context, specially under the perspective of ecology, has become an urgent topic of research. Based on a traditional Analytic Hierarchy Process (AHP), this paper introduces entropy analysis into the quantitative model, quantitatively analyzes the main factors affecting the development and utilization of resources in Ji'nan, and constructs a production function model with the endowment of Yellow River resources. The study found that the exploitability and utilizability of the Yellow River landscape rank first and second respectively, which shows that the existing Yellow River landscape in Ji'nan is not enough to support its whole Yellow River resource utilization and development strategy. It is worth noting that the research and development of the Yellow River Basin and the harmony between man and nature rank fourth and fifth respectively, which fully illustrates the development trend of giving priority to ecological development and scientific and technological innovation. The conclusion is drawn that Jinan should attach importance to promoting the economic model of ecological priority and green development in the process of resources exploitation and utilization in the Yellow River basin. Since AHP is still a subjective analysis method, how to introduce a more objective quantitative model in future research is a research direction worthy of in-depth discussion.

Keywords: Sustainable development, Yellow River resource, Cobb-Douglas function, Analytic hierarchy process, Suggestions.

I. INTRODUCTION

The Yellow River, the mother river of the Chinese nation and the cradle of Chinese civilization, plays a very important role in China's economic and social development and ecological security. It is also a representative river that has an important impact on world civilization, spanning multiple geographical units and connecting multiple cultural sub regions. Originated from the Bayan Har Mountains of

Qinghai-Tibet Plateau, with a total length of 5,464 kilometers and a drainage area of 795,000 hectares, it flows through Qinghai, Sichuan, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan and Shandong provinces and passes through Xining, Lanzhou, Yinchuan, Hohhot, Zhengzhou and Ji'nan (refer to Figure1). The population concentration in the Yellow River Basin has become an important ecological security barrier and resource concentration area in China. However, in recent years, the development of regional economies and increasing urbanization have made the Yellow River ecological environment destruction increasingly prominent and unjustified exploitation of the Yellow River resource increasingly frequent [1]. In the Yellow River Basin, there are many serious problems, such as the destruction of surface vegetation, the alkalization of land and the sharp decline of water resources. Therefore, how to develop and utilize the Yellow River resource rationally in a sustainable development context has become an urgent topic of research. In addition, ecology exists in natural environment and has the characteristics of biological function, but ecology exists in social and cultural environment and is shaped by social culture. It is necessary to study the Yellow River governance and development from the perspective of ecology [2-4].



Figure 1: Schematic diagram of the Yellow River basin Source: Wikipedia.

The development and utilization of the Yellow River resources is a complex systematic project and an important decision made by the government with an eye to the overall development. However, the fragility of the ecological environment, the diversity of resource conditions and the imbalance of development status in the Yellow River Basin determine that the development and utilization of the Yellow River resources is not a simple process [5-6]. In 2019, Chinese national leader delivered an important speech at the symposium on ecological protection and high-quality development of the Yellow River Basin [5], and focused on the importance of the protection and utilization of the Yellow River ecological resources during his inspection in Henan. In September 2019, the ecological protection and high-quality development of Yellow River were promoted to a major national strategy. The cities along the Yellow River were facing a huge development opportunity, and as the only coastal province along the yellow central city and Yellow River, Ji'nan was facing an once-in-a-lifetime development opportunity.

Based on the study of Ji'nan, this paper discusses in detail how to develop and utilize the Yellow River resources under the background of sustainable development. Compared with the traditional qualitative research, the main innovation of this paper lies in the introduction of the Yellow River resources endowment into the Cobb-Douglas function and the conclusion that the development and utilization of the Yellow River resources play an obvious role in promoting the economic growth of Ji'nan, thus providing a theoretical basis for the development and utilization of the Yellow River resources in Ji'nan. At the same time, a quantitative analysis model based on analytic hierarchy process (AHP) is introduced, different factors are integrated by weight synthesis method, and their weights are modified by entropy method, and the factors influencing the development and utilization of resources in the Yellow River in Ji'nan are discussed in detail from multiple dimensions, thus providing a scientific basis for the follow-up suggestions in this paper.

This paper is mainly divided into four parts. In the second part, it mainly discusses the present situation of the utilization of the Yellow River resources in Ji'nan, deeply excavates the problems existing in the development and utilization of the Yellow River resources in Ji'nan, and constructs a production function model containing the natural endowment of the Yellow River resources, thus providing theoretical support for the development and utilization of the Yellow River resources in Ji'nan. In the third part, the evaluation model of sustainable development of Yellow River resources in Ji'nan is constructed by combining AHP and entropy technology to quantify the main factors affecting the utilization and development of Yellow River resources in Ji'nan. Based on this, in the fourth part, appropriate suggestions are put forward to promote the development and utilization of Yellow River resources in Ji'nan. The fifth part is the summary of this paper.

II. THE PRESENT SITUATION AND NECESSITY OF THE DEVELOPMENT AND UTILIZATION OF THE YELLOW RIVER RESOURCES IN JI'NAN

Ji'nan, also known as "Spring City", is the capital of Shandong Province, one of the fifteen sub-provincial cities in China, the central city in the middle and lower reaches of the Yellow River and the south wing of the Bohai Rim region, located at 36°40' north latitude and 117°00' east longitude, in the eastern part of China, the central part of Shandong Province and the southeast edge of North China Plain, with a high topography in the south and a low topography in the north. It borders the Yellow River in the north and Mount Tai in the south. It has jurisdiction over 10 municipal districts and 2 counties with a total area of 10,244 square kilometers. The Yellow River obliquely crosses many districts, counties and functional areas of the city (refer to Figure 2). Separated by the mountainous areas in the south and the Yellow River in the north, Ji'nan has less land suitable for development and utilization, and the development of the core city faces the dilemma of saturation.

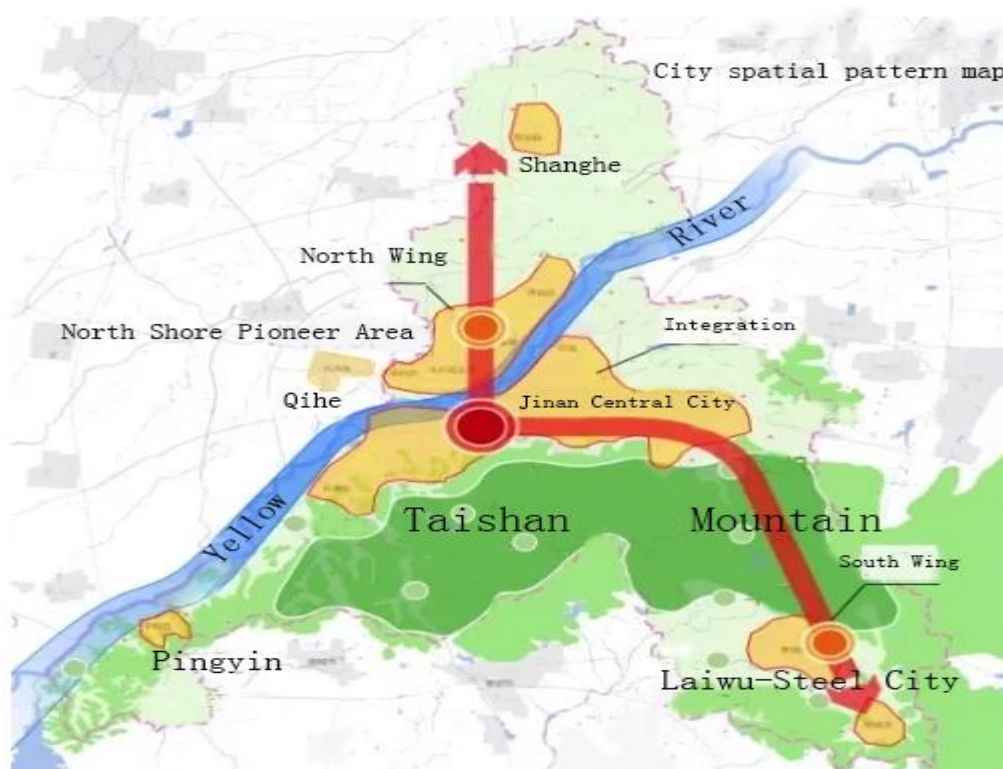


Figure 2: Schematic diagram of spatial pattern of urban development in Ji'nan.

Source: Official website of Ji'nan Natural Resources and Planning Bureau.

In response to Chinese national leader's important speech on the utilization and development of the Yellow River resources, Shandong Province proposed to show Shandong's commitment and make greater contribution in the process of promoting the ecological protection and high-quality development of the Yellow River Basin, and explicitly requested Ji'nan to demonstrate the ecological protection and high-quality development of the Yellow River Basin. Although a series of development strategies have been put forward in the development and utilization of Yellow River resources in Ji'nan, the main problems are still outstanding [7], mainly in the following aspects.

(1) The Yellow River Basin has a prominent form of water resources security and severe water resources overload. 80% of the industrial and domestic water in Ji'nan comes from external water resources, including the water of the Yellow River. Although Ji'nan has successively restored more than ten beautiful rivers, lakes and wetland landscapes such as Jixi Wetland, Xiaoqing River and Dawen River, its dependence on the water of the Yellow River is still serious, the contradiction between supply and demand of water resources is increasingly prominent, and the water storage capacity of the Yellow River is inadequate and unevenly distributed.

(2) The Yellow River Basin has extensive management of water resources, unclear status of some law enforcement subjects and inadequate management authority. Although Shandong Province has made it clear that Ji'nan should take the Yellow River Basin as its strategic target for development, there is still a lack of strong restraint mechanism and means in actual operation. Some government bodies have placed too much emphasis on ecological protection and neglected the economic development of the Yellow River basin. Besides, their management methods are difficult to meet the requirements of coexistence of ecological protection and economic development.

(3) The ecological protection of the Yellow River Basin is not closely integrated with the economic development of Ji'nan, which overemphasizes ecological protection and neglects the harmonious coexistence between man and nature and economic development. The government emphasized the importance of ecological protection and environmental governance in the Yellow River Basin, but also pointed out the urgency of accelerating the green transformation of production and lifestyle around the Yellow River Basin and constructing a modern industrial system with regional characteristics according to local conditions. Therefore, the Yellow River Basin should not only be protected, but also be revitalized by green science and technology, so as to build a new pattern of modernization with harmonious development between man and nature.

Based on these problems, this paper holds that Ji'nan should rationally develop and utilize the Yellow River resources and adhere to the policy of sustainable development. In order to further illustrate the necessity of the development and utilization of Yellow River resources to the economic growth of Ji'nan, this paper constructs the following Cobb-Douglas function [8-9].

$$Y(t) = K(t)^a H(t)^b [A(t)L(t)]^{1-a-b} \quad (1)$$

Where,

Y=the total output;

K=the capital stock;

H=the resources of the Yellow River;

A=the knowledge;

L=the labor input.

The corresponding coefficient constraint is $a > 0, b > 0, a + b < 1$. Assuming that the initial level of capital, labor and knowledge is given and the resource endowment of the Yellow River is fixed.

$$dL(t)/dt = nL(t), dA(t)/dt = gA(t), dR(t)/dt = \beta R(t), \quad (2)$$

Where,

n =the growth rate of labor productivity;

g =the rate of technical progress;

β =the development rate of the resources of the Yellow River [8].

If the output is divided into consumption and investment and the proportion of investment in the output is s , the depreciation rate of capital is δ , then

$$dK(t)/dt = sY(t) - \delta K(t).$$

The following formula can be obtained by simultaneously dividing the above formula by $K(t)$

$$\frac{dK(t)/dt}{K(t)} = s \frac{Y(t)}{K(t)} - \delta.$$

In order to analyze the effect of the Yellow River resource development rate on economic growth, the logarithm of the above Cobb-Douglas function is taken on both sides, and the following formula is obtained

$$\ln Y(t) = a \ln K(t) + b \ln R(t) + (1 - a - b)[\ln A(t) + \ln L(t)]. \quad (3)$$

The formula describing the change of growth rate can be obtained by differentiating time on both sides of the above formula, namely

$$g_{Y(t)} = a g_{K(t)} + b \beta + (1 - a - b)[n + g]. \quad (4)$$

Since $g_{Y(t)}$ and $g_{K(t)}$ must be equal on the equilibrium path, the growth rate of Y and the growth rate of output per capita on the equilibrium path can be obtained as follows

$$g_Y^* = \frac{(1-a+b)(n+g)+b\beta}{1-a}, \quad (5)$$

$$g_Y^* - n = \frac{(1-a+b)g+(\beta+n)b}{1-a}. \quad (6)$$

From the above two formulas, it can be concluded that the development and utilization of Yellow River resources can obviously promote economic growth, that is, the development and utilization of Yellow River resources will promote the development of productivity and promote the progress of technology in

Ji'nan, which provides a theoretical basis for the development and utilization of Yellow River resources in Ji'nan.

III. EVALUATION OF YELLOW RIVER RESOURCES DEVELOPMENT AND UTILIZATION IN JI'NAN BASED ON AHP

In order to further analyze the current situation of the utilization of the Yellow River resources in Ji'nan, the AHP and entropy technology are combined in this part to construct the evaluation model of sustainable development of the Yellow River resources in Ji'nan [10-11]. The AHP is a combination of qualitative analysis and quantitative calculation, which was put forward by T.L.Saaty, the strategist of Pittsburgh University in 1970s. The specific steps are: (1) to investigate and analyze the utilization of Yellow River resources in Ji'nan extensively, find out the potential influencing factors, and then construct a chromatographic analysis model; (2) to invite experts to score the impact factors, thus constructing a judgment matrix; (3) to carry out a consistency test on the judgment matrix and get the row-to-row weight of each factor in the evaluation factor layer; (4) to analyze the utilization of Yellow River resources in Ji'nan based on the obtained results.

After consulting various information and making on-the-spot visits, this paper divides the evaluation model of the utilization of the Yellow River resources in Ji'nan into three levels, among which the target layer A is the overall evaluation of the utilization and development of the Yellow River resources in Ji'nan, and the criterion layer B has three parts, namely resource conditions, ecological development and economic value, while the sub-criterion layer C is constructed corresponding to the three parts of the criterion layer, among which the resource conditions include the appreciation of the Yellow River landscape, the singularity of the Yellow River landscape, the exploitation of the Yellow River landscape, and the availability of the Yellow River landscape; ecological development includes environmental protection, water resources utilization, greening, ecological carrying capacity and harmony between man and nature in the Yellow River Basin; and the economic value includes industrial value, cultural value, total investment value, the degree of attracting labor force and scientific research investment in the Yellow River Basin. Figure 3 shows the specific evaluation model.

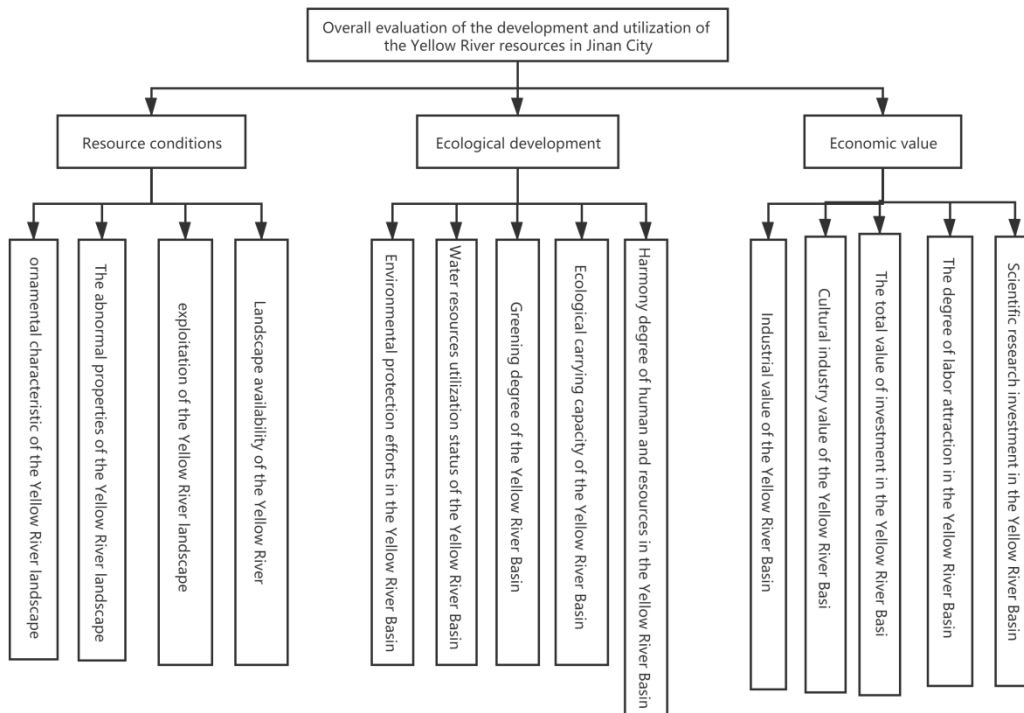


Figure 3: Evaluation model for utilization and development of Yellow River resources in Ji'nan.

After the evaluation model is established, the influence or importance between each layer needs to be calculated, and the relative importance scale is shown in the following TABLE I.

TABLE I: Relative importance scale.

Scale	Meaning
1	Two factors are equally important by comparison
3	One is slightly more important the other when two factors are compared
5	One is significantly more important the other when two factors are compared
7	One is strongly more important than the other when two factors are compared
9	One is extremely more important than the other when two factors are compared
2,4,6,8	Between the above-mentioned factors

At the same time, the column vectors of matrix A need to be normalized to get a standard matrix B, and then the column vectors obtained by summing the rows are the eigenvectors of the matrix. It is necessary to solve the maximum eigenvalues and standardized eigenvectors of each judgment matrix when solving the weights of each level and consistency check, so as to carry out consistency check. For specific

steps, please refer to You Ruiling and Yang Guiling (2012) [12]. In this paper, AHP and entropy are combined to correct the weight, because AHP has certain subjective deviation According to Zhong Qizhu (2020) [13], entropy method mainly determines the index weight according to the contribution provided by each index, which is an objective weighting method, thus avoiding the deviation caused by subjective factors of AHP to a certain extent. The specific steps are as follows:

(1) Normalize each column vector of the constructed judgment matrix A to get a standard matrix B; calculate the output entropy $E_j = -K \sum_{i=1}^n b_{ij} \ln b_{ij}$ of the j -th index f_j , of which constant $K = (\ln n)^{-1}$.

(2) Solve the deviation $d_j = 1 - E_j$ of index x_j . Calculate the information weight $\mu_j = d_j / \sum_{j=1}^n d_j$ of index x_j .

(3) Correct the weight vector w obtained by AHP by dint of information weight μ_j . And calculate the comprehensive score, in which the higher the comprehensive score, the better.

According to the above calculation process, a total of 25 experts were consulted in this paper, and the following weight vector results were obtained (refer to TABLE II).

TABLE II: Weight vectors after entropy correction.

Index layers	Codes	E_j	d_j	μ_j	λ_j	w_j
A-B	B1	0.789	0.263	0.338	0.692	0.681
	B2	0.751	0.276	0.384	0.263	0.285
	B3	0.620	0.193	0.273	0.045	0.034
B1-C	C1	0.853	0.285	0.520	0.578	0.463
	C2	0.862	0.096	0.063	0.013	0.010
	C3	0.754	0.043	0.182	0.296	0.185
	C4	0.951	0.166	0.298	0.113	0.342
B2-C	C5	0.813	0.183	0.283	0.123	0.073
	C6	0.802	0.112	0.190	0.312	0.062
	C7	0.683	0.174	0.299	0.220	0.091
	C8	0.735	0.176	0.241	0.243	0.077
	C9	0.862	0.023	0.092	0.102	0.009
B3-C	C10	0.973	0.085	0.175	0.163	0.012
	C11	0.956	0.052	0.193	0.307	0.028
	C12	0.913	0.083	0.163	0.053	0.030
	C13	0.992	0.066	0.177	0.236	
	C14	0.955	0.047	0.397	0.241	

TABLE III: Ranking of evaluation factors in layer B and layer C.

Constraint layer B	Weighted value	Order	Restraint layer	Weighted value	Order
Resource condition B1	0.624	1	Landscape appreciation of the Yellow River C1	0.103	3
			Singularity of the Yellow River C2	0.062	7
			Development of the Yellow River C3	0.283	1
			Utilizability of the Yellow River C4	0.105	2
Eco-development B2	0.203	2	Environmental protection in the Yellow River Basin C5	0.015	13
			Water resources utilization in the Yellow River Basin C6	0.082	6
			Greening degree of the Yellow River Basin C7	0.039	9
			Ecological carrying capacity of the Yellow River Basin C8	0.056	8
			Harmony between man and nature in the Yellow River Basin C9	0.088	5
Economic value B3	0.173	3	Industrial value of the Yellow River Basin C10	0.016	12
			Cultural industry value of Yellow River Basin C11	0.028	10
			Total investment value of Yellow River Basin C12	0.006	14
			The degree of labor attraction in the Yellow River Basin C13	0.019	11
			Scientific research	0.098	4

	investment in the Yellow River Basin C14		
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According to the results of TABLE III, the weight of resource conditions is 0.624, the final factor of the development and utilization of the Yellow River resources in Ji'nan, which is consistent with the reality. Thus it is clear that the key to determine the development in the development and utilization of the Yellow River resources is to fully tap the available resource conditions. The weight of ecological development is 0.203, which is higher than the weight of economic value, indicating that Ji'nan has fully realized the concept of ecological development of "Lucid waters and lush mountains are invaluable assets", and prioritize the protection of ecological development over economic development.

Among the 14 results of the constraint layer, the exploitability and utilizability of the Yellow River landscape rank first and second respectively, which shows that the existing Yellow River landscape in Ji'nan is not enough to support its whole Yellow River resource utilization and development strategy, and how to excavate the Yellow River landscape with ecological and economic value is still the top priority in the subsequent development. It is worth noting that the research and development of the Yellow River Basin and the harmony between man and nature rank fourth and fifth respectively, which fully illustrates the development trend of giving priority to ecological development and scientific and technological innovation.

IV. SUGGESTIONS ON DEVELOPMENT AND UTILIZATION OF YELLOW RIVER RESOURCES IN JI'NAN

This paper analyzes the factors influencing the exploitation and utilization of Yellow River resources in Jinan city. It is suggested that Jinan should regard the Yellow River as a kind of exploitable resource, focus on the exploitation and utilization of the Yellow River resources, and develop the urban development mode of co-existence with the Yellow River. This paper puts forward the following suggestions on the exploitation and utilization of Yellow River resources from the perspective of ecology.

First, it is necessary to comprehensively strengthen the ecological protection and management of the Yellow River Basin, continuously promote the comprehensive management and landscape construction along the Yellow River. Take the opportunity to accelerate the construction of national economic and ecological corridor and other projects to create an all-round and harmonious development of the ecological economy of the Yellow River Basin. The prerequisite for development is that resources can be utilized and developed. However, the existing resources of the Yellow River in Ji'nan are almost saturated and mostly not well protected. Under the turning point that the ecological protection and high-quality development of the Yellow River Basin have become a major national strategy, Ji'nan must do a good job in ecology, continue to promote the restoration and improvement of the ecological landscape along the Yellow River. Meanwhile, Ji'nan should excavate new landscape points, and coordinate the ecological protection and landscape development to form a new pattern of ecological priority and green development with Ji'nan characteristics.

Second, Ji'nan should promote industrial upgrading, change to connotation-intensive, quality-effective development mode, and strengthen the coordinated development of industrial chain, so as to jointly build a sharing platform for resources development elements in the Yellow River Basin with cities along the river. It is also beneficial to optimize the allocation of resources elements and productivity layout in Ji'nan. The periphery of the Yellow River Basin is an important ecological barrier and economic zone in Ji'nan, which plays a very important role in the economic and social development of the city. Ji'nan must promote industrial upgrading, reduce industrial pollution and resource consumption, encourage the development of new industries, and fundamentally realize the sustainable utilization of Yellow River resources by developing new equipment and technologies (such as big data, cloud computing, new materials and other new products). At the same time, it should develop in coordination with the surrounding provinces and cities, and choose a win-win development model according to the factor endowment and resource conditions, so as to promote the differentiated and collaborative development of the Yellow River basin area.

Third, Jinan should give full play to the favorable resource conditions and cultural heritage in the Yellow River basin and strengthen the development of tourism resources. What is important is to firmly practice the concept of green development. Explore new tourist attractions in the Yellow River basin with sustainable development by using clean and safe resource utilization and green economic development mode. Strive to form a green tourism brand with strong influence. Establish a long-term mechanism for the development of green tourism industry, especially pay attention to the application of digital technology, such as the Internet of Things, cloud computing, big data, blockchain, smart city and other new technologies in the smart era. Strive to use new technology to drive the economic, social and ecological benefits of the Yellow River basin scenic spots greatly improved.

V. CONCLUSIONS

In recent years, the Chinese government has been strengthening its efforts to protect the ecological environment. How to explore a set of resources exploitation and utilization system of harmonious coexistence between man and nature has become the main problem facing China's economic development. This paper first combs the problems existing in the process of harnessing and developing the Yellow River in Jinan. Then, it quantitatively analyzes the main factors affecting the exploitation and utilization of resources in Jinan city. On this basis, several feasible suggestions and measures are put forward, emphasizing the importance and urgency of promoting ecological priority and green development economic model. This paper innovatively constructs a production function model with the resource endowment of the Yellow River. In the follow-up study, the author will collect more data for empirical analysis. Entropy analysis is introduced into the quantitative model based on traditional AHP to improve the accuracy of the model. However, since AHP is still a subjective analysis method, how to introduce a more objective quantitative model in future research is a research direction worthy of in-depth discussion.

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REFERENCES

- [1] Liu C.M. (2019) Some understandings on ecological protection and high-quality development of the Yellow River basin. *Yellow River*, 10, 158.
- [2] Johannes B., Meike W. (2020) Environmental Concern and Urbanization in India: Towards Psychological Complexit. *Sustainability*, MDPI, 24, 1-25.
- [3] Rasmus P. (2019) How to ask better questions? Dewey's theory of ecological psychology in encouraging practice of action learning, *Action Learning: Research and Practice*. Taylor & Francis Journals, 2, 107-122.
- [4] He W.G., Song G.W. (2012) Ecological Psychology: Its Theoretical Orientation and Implications. *Journal of Nanjing Normal University (Social Science Edition)*, 4, 110-115.
- [5] Jin F.J., Ma L., and Xu D. (2020) Diagnosis and identification of optimal path of industrial development on ecological environment in the Yellow River basin. *Resources Science*, 1, 127-136.
- [6] Ma L., Tian H.Z., and Kang L. (2020) Ecological environment impact and spatial control path of mineral resources development in the Yellow River basin. *Resources Science*, 1, 137-149.
- [7] Xi J.P. (2019) Speech at the Symposium on ecological protection and high-quality development of the Yellow River basin. *QiuShi Journal*, 20, 1-5.
- [8] Tang Y.C., Wang C.X., Wang R.L., Xue M.Y., and Dou W.S. (2020) Study on the coupling between urban expansion and land use efficiency based on smart development based on a case study of the main urban area of Ji'nan. *Human Geography*, 4, 91-98.
- [9] Zhu N., Zhang M.J. (2011) Random dynamic Cobb-Douglas production function with energy. *Economic Mathematics*, 9, 28-32.
- [10] Huang Q., Yi H. (2020) An overview of the application of Cobb-Douglas production function in economics. *Advances in Applied Mathematics*, 9, 2353-2357.
- [11] Sun W.F., Wang Y.S. (2018) Dependence on natural resources, technological progress and economic growth. *Resources & Industries*, 1, 83-89.
- [12] You R.L., Yang G.L. (2012) Evaluation of tourism resources and sustainable development strategies based on hierarchical entropy analysis--a case study of Jiaozuo city. *Journal of Central China Normal University (Natural Science Edition)*, 1, 379-384.
- [13] Zhong Q.Z. (2020) Research and application of evaluating media flow based on entropy value and fuzzy hierarchy method. *Telecommunications Science*, 4, 145-153.