Construction of Evaluation Index System of Green Development in the Yellow River Basin Based on DPSIR Model

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Abstract. Under the strategic task of promoting high-quality green development in the Yellow River Basin, building an evaluation system for green development indicators in the Yellow River Basin is an urgent problem to be solved. This article combines the characteristics of the Yellow River Basin, comprehensively considers the main factors such as the natural environment and social economic system in the basin. Based on the DPSIR model, it constructs an evaluation indicator system which is suitable for the green development of the Yellow River Basin. The results show that the green development index of the Yellow River Basin is 2.55 which means the green development level is relatively low. Therefore, various measures should be taken to improve the green development level of the Yellow River Basin.

1. Introduction
In September 2019, General Secretary Xi Jinping proposed a strategic task to promote high-quality and green development of the Yellow River at the Yellow River Basin Ecological Protection and High-quality Development Symposium [1]. The green development of the Yellow River Basin is a comprehensive advancement process. An evaluation system is needed to evaluate green development and reflect the overall characteristics of the basin's development. At present, the research direction of the evaluation system of the Yellow River Basin is mostly focused on "water resources" and "local ecological security", including Shulin Zhang et al [2] evaluated the balanced distribution of water resources in the Yellow River Basin, Wang Wei et al [3] evaluated the ecological safety of the Yellow River Delta wetlands. However, the guiding role of the indicator evaluation system for the green development of river basins has not attracted the attention of scholars. Therefore, there is an urgent need to establish a set of green development evaluation indicator system that conforms to the overall characteristics of the Yellow River Basin, use this indicator system to judge the current development status of the Basin, and point out a high-quality green development direction of the Yellow River.

2. Watershed development evaluation model and applicability analysis
The primary task of establishing an evaluation indicator system for green development in the Yellow River Basin is to select an appropriate evaluation model. Different evaluation models vary greatly. Commonly used river basin development evaluation models include PSR model, DSR model, DFSR model, and DPSIR model. The advantages, disadvantages and applicability analysis of each model are as follows:
PSR model: This model is mainly composed of a causal chain composed of pressure, state and response, and has a good continuous feedback effect in areas with few influencing factors. However, model indicators (especially response indicators) are too dependent on the subjective experience of the relevant personnel. Jing Zhang et al [4] used the PSR model indicator system to build an environmental performance audit evaluation indicator system for coastal industrial enterprises. Therefore, when the model is applied to the Yellow River Basin with more influencing factors, it cannot fully reflect the impact of each influencing factor on the development of the basin.

DSR model: This model is mainly composed of a causal chain composed of driving force, state and response, which makes up for the social and economic deficiencies of the PSR model. For example, Hui-Ling Tung et al [5] used the DSR model to establish a sustainable development evaluation indicator system for Taiwan. However, when evaluating the green development of the Yellow River Basin, because the proportion of environmental indicators in the model is too large, it is easy to make the evaluation indicator system of the green development of the Yellow River Basin incomplete.

DFSR model: The causality chain of this model is the same as the DSR model. It reflects the different aspects of sustainable development from social, economic, environmental and institutional aspects, and provides a widely accepted indicator system framework for sustainable development evaluation. For example, Xiujuan Zhang et al [6] applied the DFSR model to the sustainable development of the ecosystem of Yanchi County and provided countermeasures and measures. However, the model lacks a feedback process and cannot timely reflect changes in green development in the Yellow River Basin.

DPSIR model: This model is mainly composed of a causal chain composed of driving force, pressure, state, impact, and response. Structurally, the DPSIR model has the characteristics of both DSR and PSR, and is widely used in academia [7]. The advantage of the DPSIR model indicator system is that it can couple various factors such as social and economic development with changes in resources and environment, so as to obtain a comprehensive and scientific assessment of the current green development status in a certain area. Because it can reflect the impact of various aspects of social development including market, industrial environment, people's livelihood, in recent years, policy formulation in different regions has made reference to it. For example, Jing Zhu et al [8] and Xia Zhu et al [9] used the DPSIR model to construct a low-carbon city development evaluation system, and applied it to the development evaluation of Jiyuan City and Jiangsu Province, providing comprehensive theoretical reference for the development and construction of local low-carbon cities.

Compared with other models, the DPSIR model has the advantages of comprehensiveness and completeness. From the perspective of social development and ecological environment, the DPSIR model is more suitable for the evaluation of green development in the Yellow River Basin. Therefore, according to the characteristics of the natural, social and economic activities of the Yellow River Basin, the DPSIR model framework is adopted to establish a green development evaluation indicator system.

3. Construction of the Yellow River Basin Green Development Evaluation Indicator System

3.1 Based on the improved DPSIR model of the Yellow River Basin green development evaluation system framework

After preliminary evaluation of the model, refer to the DPSIR model to build an evaluation system framework. The system can be divided into four levels, from macro to micro, from abstract to specific, namely the target layer-standard layer-element layer-indicator layer. On the basis of this structure, from the five levels of driving force, pressure, state, impact, response, select 12 representative elements, then consider the actual connotation of green development, select specific indicators at the indicator level, and establish specific green development evaluation system. The specific framework is shown in Figure 1.
3.2 Indicator layer selection and weight calculation for the green development evaluation system of the Yellow River Basin

After the construction of the indicator system is completed, around the 12 elements of green development in the Yellow River Basin, a total of 20 specific indicators are selected for green development evaluation.

The depth of green development in the Yellow River Basin depends on the improvement of the ecological environment, and the improvement of the ecological environment is also affected by various aspects such as resources, environment and economic conditions. Therefore, in the process of formulating the evaluation system, different indicators should be weighed to best reflect the true green development level of the region. As an information processing method of information entropy processing, the entropy weight method can ensure that in comprehensive evaluation, the greater the amount of information provided by the corresponding indicator, the greater its role. Therefore, the entropy weight method is very suitable for weighting the indicators in the green development system of the Yellow River Basin. Table 2 shows the specific indication of weight and indicator layer.

3.3 Calculation of the Yellow River Quality Green Development Index

Since the calculated green development indicator values usually do not meet the "good" and "bad" judgment habits, it is necessary to convert the specific indicator values to grades. According to the cognitive habits, referring to the research on the evaluation standard of the indicator evaluation system, the evaluation of green development indicators is divided into five levels. The higher the green development level, the higher the corresponding level. Dividing the five green development levels according to 0-5 levels and applying them to the evaluation system can more intuitively reflect the green development level of the Yellow River Basin (see Table 1). The indicator system evaluates each specific indicator in a hierarchical scoring manner. Calculate the indicator evaluation score with reference to the regions with high green development levels at home and abroad, and then perform the superposition calculation in the order of "indicator layer-element layer-standard layer-target layer". Through the analysis of green development evaluation indicators, the current development status is judged, and suggestions for future development are put forward. The formula for calculating the Green Development Index (GDI) is as follows:

$$GDI = \sum_{i=1}^{n} x_i \times y_i$$

In the formula, \(x_i\) in the formula is the score of five standard layer elements, and \(y_i\) is the weight of each element of the standard layer. The calculation data are mainly from the National Bureau of
Statistics, and some calculation data are extracted from the statistical yearbooks and water resources bulletins of the nine provinces in the basin.

**Table 1. Green development grade criteria**

| Grade     | Green development level | Score interval | Green development                                           |
|-----------|-------------------------|----------------|-------------------------------------------------------------|
| Level 1   | Excellent               | 4-5            | The ideal state of sustainable development                   |
| Level 2   | Good                    | 3-4            | Social development has little impact on environment          |
| Level 3   | Fair                    | 2-3            | The ecosystem has suffered some damage                       |
| Level 4   | Poor                    | 1-2            | Ecosystem services are severely degraded                     |
| Level 5   | Terrible                | 0-1            | Social development has done great damage                     |

**4. Analysis of the green development level of the Yellow River Basin**

Evaluate according to the indicators and calculate in stages. The calculation process and scores of each layer are shown in Table 2. After calculation, the green development index of the Yellow River Basin is 2.55. According to the green development grade standard, the green development of the Yellow River Basin is at a low level, and environmental pollution has been initially treated, but the problem of coordinated development of social economic development and ecological environment has not yet been resolved. The green development level of the watershed should be analyzed from five aspects: driving force, pressure, state, impact and response.

**Table 2. Calculation process of green development index**

| Criterion layer | Element layer | Indicator layer | Data | Unit | Indicator layer score | Element layer score | Criterion layer score | Green development score |
|-----------------|---------------|-----------------|------|------|-----------------------|--------------------|------------------------|-------------------------|
| Driving force   | Driving force of social development | Per capita disposal income | 23943 | yuan | 2.7 | 0.3721 | 1.2826 | 0.3818 | 2.653 | 0.1822 |
|                 |               | Per capita consumption expenditure | 16868 | yuan | 2.9 | 0.6279 |
|                 | Driving force of economic Development | Per capita gross regional product | 56883 | yuan /per | 2.9 | 0.4946 | 2.546 | 0.6182 |
|                 |               | Tertiary industry added value | 12929 | million | 2.2 | 0.5054 |
| Water Pressure  | Per capita water resources | 1407 | m³/per | 4.8 | 0.6934 | 4.245 | 0.663 | 3.472 | 0.2891 |
|                 | Total effluent discharge | 201006 | Ten thousand tons | 2.99 | 0.3066 |
| Regional Development Pressure | Energy consumption per unit of GDP | 1.39 | Tons of coal/100 00 yuan | 2.5 | 0.6221 | 1.937 | 0.337 |
|                 | Urban population density | 4491 | Per/km² | 1.01 | 0.3779 |
| Resource and Forest | 20.4 | % | 0.97 | 0.3672 | 2.06 | 0.4125 | 1.64 |
| Status | Environment al Status | coverage rate | Total import and export volume of the business unit location |  |
|--------|-----------------------|---------------|---------------------------------------------------------------|----|
|        |                       |               | 33.9 billion                                                  | 0.6328 |
|        | Economic status       |               | 5587 billion                                                  | 0.3084 1.34 0.5855 |
|        |                       |               | 62.82 billion dollars                                         | 0.61 0.6916 |
| Impact | Impact of Technology Industry Development | Technology market turnover | 392.7 billion | 3.31 1 3.31 0.4072 1.85 0.1827 |
|        | Impact of Technological Innovation | Information technology service revenue | 623 billion | 0.84 1 0.84 0.5928 |
| Response | Ecological Response | Harmless disposal rate of household garbage | 99.2 % | 4.2 1 4.2 0.1161 2.9 0.1225 |
|        | Employment Response | Urban registered unemployment rate | 3.3 % | 2.75 1 2.75 0.2408 |
|        | Social Response      | Urban basic medical insurance fund income | 612.4 billion | 2.17 1 2.17 0.4635 |
|        | Educational Response | Average number of college students per 100,000 population | 2562 per | 4.16 1 4.16 0.1796 |

4.1 Driving force level analysis
From the driving force analysis, the driving force index of the Yellow River Basin is 2.63. Among them, driving force of economic development (2.546) is obviously low. The tertiary industry score is only 2.2, and the problem of insufficient development of the service industry is obvious. The lack of
development of the tertiary industry indicates that the overall economic development level of the basin is not high [10], and there is still a large gap from high-quality green development. From the perspective of the momentum of social development, the score of per capita disposal income is 2.7, indicating that the river basin has a low standard of living and insufficient social development.

4.2 Pressure level analysis
From the pressure analysis, the pressure index of the Yellow River Basin is 3.57, and the basin pressure is at a good level. The water resources pressure in the river basin is low, and the water supply per capita is sufficient. In recent years, waste-water discharge has been significantly controlled. However, the development pressure of the Yellow River Basin is relatively large. The urban population density indicator score was only 1.01, and the energy consumption per unit of GDP score was 2.5. The dense population and large energy consumption will bring greater pressure to the basin's economy, social development and ecological environment.

4.3 State level analysis
From the state level analysis, the state index of the Yellow River Basin is 1.64, and the green development state of the river basin is poor. The problems of resources and environmental conditions are outstanding. The forest coverage rate indicator score was 0.97. There is an urgent need to improve the greening level of the river basin. A large amount of industrial pollution emissions have seriously damaged the environment. A large amount of local fiscal budget is required every year to control pollution. In addition, as far as the economic situation is concerned, the score of general budgetary expenditures of local finance of the basin is 2.67, and score of total import and export volume of the business unit location is only 0.61, indicating that the basin’s foreign trade is still in the growth stage, and the economic development status is far from high quality green development.

4.4 Impact level analysis
From the impact analysis, the impact index score of the Yellow River Basin is 1.85, which highlights the serious problem of insufficient development momentum in the Yellow River Basin. Among them, the score of impact of technological innovation (0.84) is extremely poor. In the long run, insufficient technological innovation will lead to the slow development of the technology industry, which is extremely unfavorable for achieving high-quality green development. The impact of technology industry development score is 3.31, which is higher than the average. The main reason is that large-scale technology industries in Shandong and Gansu have improved the overall level of the Yellow River Basin. However, the objective reality of the backward development of the science and technology industry in the middle and upper reaches of the Yellow River still exists and must be faced.

4.5 Response level analysis
From the analysis of response level, the response index score of the Yellow River Basin is 2.91. Among them, the employment response (2.75) and social response (2.17) scored lower, indicating that the demand for labor in the region is low, and the social security system problems is more serious, which is not conducive to promoting employment. The population density of the Yellow River Basin is very high. From the perspective of ecological response (4.2) and educational response (4.16), the overall ecological improvement quality and education quality of the Yellow River Basin have reached a good level. However, there are still some areas where the ecological environment is worrying (such as the Loess Plateau). In addition, we should pay attention to the main defects of the high-end talent training system.

5. Recommendations for high-quality green development in the Yellow River Basin
With the gradual increase of national investment in ecological environment governance, the future social and economic development of the Yellow River Basin should be based on ensuring the safety of the ecological environment. Therefore, improving the level of green development is an inevitable
choice for the further development of the Yellow River Basin. Based on the analysis of scores at various levels, green development suggestions are proposed for the Yellow River Basin:

(1) From the analysis of driving force, the improvement of the basin driving force index should focus on the development of the tertiary industry, increase the income level of residents, and increase the financial support of the tertiary industry. When tertiary industry added value reaches 245 billion yuan and the per capita disposal income reaches 36,000 yuan, the driving force index can be increased to about 3.8, which greatly promotes the green development of the river basin.

(2) From the analysis results of pressure level, the increase of pressure level should focus on controlling the population density of cities and towns, reducing the density of urban construction planning, and creating external employment opportunities in cities and towns. On the basis of controlling the urban population density to 2,000 people / km², the pressure index can be increased to more than 4 to achieve a high-quality green development level.

(3) From the results of the state level analysis, the focus of state level improvement is to increase forest coverage and promote the development of import and export trade. In the aspect of ecology, it is necessary to consider regional characteristics and properly return farmland to forest; in the aspect of trade, we should optimize industrial exports and increase the dependence on foreign trade. When the forest coverage rate reaches 40% and total import and export volume of the business unit location reaches 345 billion US dollars, the state index will reach 4, reaching the high-quality green development level.

(4) From the results of the impact analysis, the next green development plan of the Yellow River Basin should focus on promoting the development of science and technology and the innovation of industrial production technology. Among them, it is particularly important to increase technology market turnover. In addition, information technology and related technologies should be introduced to strengthen the training of talents in basic sciences so that the total impact level score reaches 4.0 or higher to promote the overall development of the Yellow River Basin.

(5) From the analysis results of the response level, the green development plan of the Yellow River Basin should focus on solving the problems of employment and social security. By stabilizing the development of small and medium-sized enterprises and increasing support for small and medium-sized enterprises, the urban registered unemployment rate was reduced to below 2.8%, the urban basic medical insurance fund income increased to 113 billion yuan, and the response score could reach 4.1 or higher to satisfy the overall goal of green development of the Yellow River Basin.

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