

# Analysis of Economic Resource Ecological Environment Coupling Coordination in Qinghai Province

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**Abstract:** Qinghai Province is the birthplace of the Yellow River, Yangtze River and Lancang River, which is an important water source and ecological sensitive area in China. Analyzing the coupling and coordination of economy, resources and ecological environment in Qinghai Province is of great significance for promoting the sustainable development of Qinghai Province and exploring the path of coordinated development of ecology and economy. The comprehensive evaluation index system of economic development, resource conditions and ecological environment was constructed. Based on the relevant data from 2011 to 2021, the entropy method and coupling coordination degree model were used to analyze the coordination relationship among the three systems. The results show that the coupling effect and coordination relationship among economic development, resource conditions and ecological environment in Qinghai Province have been improved, but the overall coordination degree is still not strong. Therefore, Qinghai province needs to continuously promote ecological economy and economic ecology, and actively explore a new path of coordinated development between ecology and economy.

**Keywords:** Economic development, Resource conditions, Ecological environment, Entropy method, Coupling coordination degree.

## 1. Introduction

Since the reform and opening up, China's economy has sustained rapid growth, which has produced negative effects such as environmental pollution, climate change, ecological damage, waste of resources, and distorted factor allocation under the traditional economic development model. Later, the 18th CPC National Congress placed ecological progress on a par with economic, political, cultural and social development. At the Fifth Plenary Session of the 18th CPC Central Committee, ecological progress was included in the national five-year plan for the first time, and the development concept of "innovation, coordination, green development, openness and sharing" was clearly put forward. As an important water source and ecologically sensitive area in China, Qinghai Province bears great responsibility for national ecological security and sustainable development. The coordinated development of economy, resources and ecological environment is an important way to achieve sustainable development. Therefore, the analysis of the coordination among the three systems of economic development, resource conditions and ecological environment in Qinghai Province is of great significance for further promoting the ecological economy and economic ecology of Qinghai Province, and exploring a new path of coordinated development of ecology and economy in line with local characteristics.

## 2. Literature Review

Grossman and Krueger, two American economists, first verified the relationship between economic development and environmental pollution, and proposed the famous environmental Kuznets curve. This curve reveals that with economic development, the degree of environmental pollution will first rise with economic growth, and when economic development reaches a certain level, it will decline with economic growth. This is mainly because when the economic development reaches a certain level, the income

level of residents is enough to meet their basic living needs, so people will have a higher pursuit for the quality of life and begin to pay more attention to the quality level of the environment on which human beings live. In addition, with the development of society, the level of environmental regulation and market mechanism is gradually mature, and the investment in pollution reduction and environmental pollution control will also increase.

The proposal of this theory has led a large number of scholars to focus their research on the development status of regional ecological economy, reflecting regional economic development and ecological environment quality by constructing a comprehensive evaluation index system. There are many comprehensive evaluation methods, such as principal component analysis, analytic hierarchy process, grey correlation degree, entropy method, coupled co scheduling, dynamic decoupling analysis, etc. Xu Qingyong et al. (2011) used principal component analysis and analytic hierarchy process to evaluate the ecological environment of the Yangtze River Delta [1]. Zhang Jiaqi et al. (2014) evaluated ecological security in poverty-stricken areas through grey correlation degree [2]. Li Yanfeng et al. (2014) constructed a comprehensive evaluation index system using environmental factors and ecological response as subsystems, and evaluated the ecological environment status of the Shandong Peninsula Blue Economic Zone based on the position of the subsystems in the cross judgment matrix [3]. Chen Yanli (2020) evaluated the ecological and economic development status of Shanghai, Beijing, Jiangsu, Zhejiang and Hunan provinces using the entropy method [4]. Jiang Lei et al. (2017), Wen Hao et al. (2019), Liu Guofeng et al. (2021), Yang Huifang et al. (2022) used entropy method and coupling coordination degree to study the coordination degree between regional economy and resource environment from different research perspectives [5-8]. Yan Mingtao (2022) studied the coordinated development of rural socio-economic and ecological environment in the Yellow River Basin through entropy weight analysis and coupling coordination degree [9]. Zhang Xuhong et al. (2022)

analyzed the coordination between tourism economy and ecological environment in the Yellow River Basin through dynamic decoupling [10].

Based on this, this article selects Qinghai Province as the research object and constructs a comprehensive evaluation index system from three aspects: economic development, resource conditions, and ecological environment. The entropy method and coupling coordination degree are used to analyze the degree of coupling coordination among the three systems and evaluate the ecological and economic development status of Qinghai Province.

### 3. Research Methods

The ecological economy emphasizes the promotion of industrial development and economic growth within the range that the ecosystem can carry, and always adheres to the highly

unified relationship between protecting the ecological environment and developing the economy, and always implements the concept of green and sustainable development. This article will construct a comprehensive evaluation index system from three aspects: economic development, resource conditions, and ecological environment, and calculate and analyze it through entropy method and coupling coordination degree.

#### 3.1. Construction of index system

This paper draws on the evaluation method proposed by Jiang Lei, Bai Ling and Wu Yuming (2017), combines the regional characteristics of Qinghai Province, and builds a comprehensive evaluation index system for ecological and economic development of Qinghai Province in accordance with the principles of scientific, holistic, hierarchical and data availability, as shown in Table 1 [5].

**Table 1.** Comprehensive Evaluation Index System of Ecological and Economic Development Status in Qinghai Province

The system	Subsystem	Evaluation indicators	Units	Plus/minus	
Economic development	Level of economy	Per Capita GDP	Yuan/person	active	
		Per capita fixed assets investment	Yuan/person	active	
	Industrial structure	Proportion of secondary industry	%	active	
		Proportion of tertiary industry	%	active	
Resource conditions	Energy conditions	Per capita energy reserves	Tons of standard coal/person	active	
	Water conditions	Per capita water resources	Cubic meter / person	active	
	Natural ecological conditions	Per capita desertification land area	Hectare/ person	negative	
		Forestry conditions	Per capita wetland area	Hectare/ person	active
			Per capita forestry land	Hectare/ person	active
	Per capita forest land		Hectare/ person	active	
Ecological environment	Pollutant discharge	Per capita sulfur dioxide emissions from exhaust gases	t/ person	negative	
		Per capita nitrogen oxide emissions from exhaust gases	t/ person	negative	
		Per capita chemical oxygen demand emissions in wastewater	t/ person	negative	
		Per capita ammonia nitrogen emissions from wastewater	t/ person	negative	
	Pollution control	Per capita green coverage area	Hectare/ person	active	
		Per capita investment in industrial pollution control projects completed	Yuan/person	active	

In terms of economic development, this paper chooses to evaluate from the two aspects of economic development level and industrial structure. Among them, per capita GDP can directly reflect the level of economic development, while per capita fixed asset investment can well reflect the power of regional economic development. Under normal circumstances, the higher the proportion of secondary and tertiary industries, the more rationalized and advanced the industrial structure, the better the economic development situation. Resources are an important factor affecting regional economic development, and Qinghai Province has abundant natural resources. In terms of resource conditions, this paper will be analyzed from four dimensions: energy conditions, water resources conditions, natural ecological conditions and forestry conditions. Among them, per capita sandy land area will have a negative impact on regional ecological economic development. The ecological environment is mainly affected

by the emission and treatment of pollutants. In this paper, per capita sulfur dioxide emission, per capita nitrogen oxide emission, per capita chemical oxygen demand emission and per capita ammonia nitrogen emission in waste gas emission are mainly selected to measure the emission status of pollutants. The higher the emission of these pollutants, the more detrimental it is to the development of regional ecological economy. In terms of pollution control, the per capita investment in industrial pollution control projects is mainly chosen to reflect the status of industrial pollution control, and the per capita green coverage area reflects the status of pollution control in urban garden construction.

#### 3.2. Entropy method

Since there are three systems in the comprehensive evaluation index system of this paper, and there are several subsystems in each system, it is necessary to obtain the

comprehensive evaluation index of each system by entropy method.

First of all, in order to make comparisons between the indicators, the infinite tempering process should be carried out by formula (1).

$$X_{ij} \begin{cases} \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} & \text{active} \\ \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} & \text{negative} \end{cases} \quad (1)$$

Then, gradually calculate the information entropy value  $e_j$ , information utility value  $d_j$ , and weight coefficient  $w_j$  using the following formula. The formula is as follows:

$$\text{sampling weight } P_{ij}: P_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}} \quad (2)$$

Information entropy value  $e_j$ :

$$e_j = -\frac{1}{\ln(n)} * \sum_{i=1}^n (P_{ij} * \ln(P_{ij})) \quad (3)$$

Information utility value  $d_j$ :

$$d_j = 1 - e_j \quad (4)$$

weight coefficient  $w_j$ :

$$w_j = \frac{d_j}{\sum_{j=1}^m d_j} \quad (5)$$

The comprehensive score of each system, denoted as  $Z_1$ ,  $Z_2$ ,  $Z_3$ . The formula is:

$$Z_i = \sum_{j=1}^m w_j x_{ij} \quad (6)$$

Among them, in the formula,  $m$  is the number of indicators within the subsystem,  $n$  is the number of samples, and  $X_{ij}$  represents the value of the  $j$ th indicator in the  $i$ -th year,  $i=1,2,\dots, n$ ;  $J=1,2,\dots, m$ .

### 3.3. Coupled co scheduling

On the basis of the comprehensive score obtained by the entropy method above, the coupling degree and coupling co scheduling are calculated using the following formula:

$$\text{Coupling degree: } C = \left( \frac{Z_1 * Z_2 * Z_3}{((Z_1 + Z_2 + Z_3) / 3)^3} \right)^{1/3} \quad (6)$$

coupling coordination degree:

$$D = \sqrt{C * T}, \quad T = a * Z_1 + b * Z_2 + c * Z_3 \quad (7)$$

Among them, the value of coupling degree  $C$  is between 0 and 1, and the closer  $C$  is to 1, the greater the coupling degree.  $T$  is the comprehensive evaluation index for coupled and coordinated development, and  $a$ ,  $b$ , and  $c$  are undetermined coefficients, set manually. This article believes that economic development, resource conditions, and ecological environment are equally important, therefore setting  $a$ ,  $b$ , and  $c$  as 1/3.

## 4. Empirical Analysis

According to the above formula, the collected data is subjected to infinite tempering treatment and related calculations to obtain comprehensive scores, coupling degree, and coupling coordination degree results.

### 4.1. Data Selection and Sources

This article selects relevant data from Qinghai Province from 2011 to 2021 for empirical analysis. The relevant data on economic development comes from the Qinghai Statistical Yearbook, while the data on resource conditions and ecological environment comes from the China Environmental Statistical Yearbook over the years.

### 4.2. Empirical Results

The comprehensive scores of each system obtained through the entropy method are shown in Table 2:

**Table 2.** Comprehensive Evaluation Scores of Each System

year	economic development	resource conditions	ecological environment
2011	0.4336	0.4748	0.0506
2012	0.4258	0.5320	0.0466
2013	0.3867	0.6350	0.0705
2014	0.4003	0.6843	0.1242
2015	0.4930	0.4123	0.1466
2016	0.5783	0.3758	0.8019
2017	0.6261	0.4084	0.7788
2018	0.6581	0.6791	0.7973
2019	0.6311	0.6771	0.8704
2020	0.5374	0.5468	0.6130
2021	0.6189	0.4459	0.6500

Data source: calculated by the author

The coupling degree, comprehensive evaluation index for coupling coordinated development, and results of coupling

coordinated degree obtained through formula calculation are shown in Table 3:

**Table 3.** Comprehensive Evaluation Index and Coupling Coordination Results

year	C	T	D
2011	0.6831	0.3196	0.4673
2012	0.6551	0.3348	0.4683
2013	0.7106	0.3641	0.5086
2014	0.8042	0.4029	0.5692
2015	0.8842	0.3506	0.5568
2016	0.9543	0.5853	0.7474
2017	0.9661	0.6044	0.7642
2018	0.9964	0.7115	0.8420
2019	0.9903	0.7262	0.8480
2020	0.9983	0.5657	0.7515
2021	0.9866	0.5716	0.7510

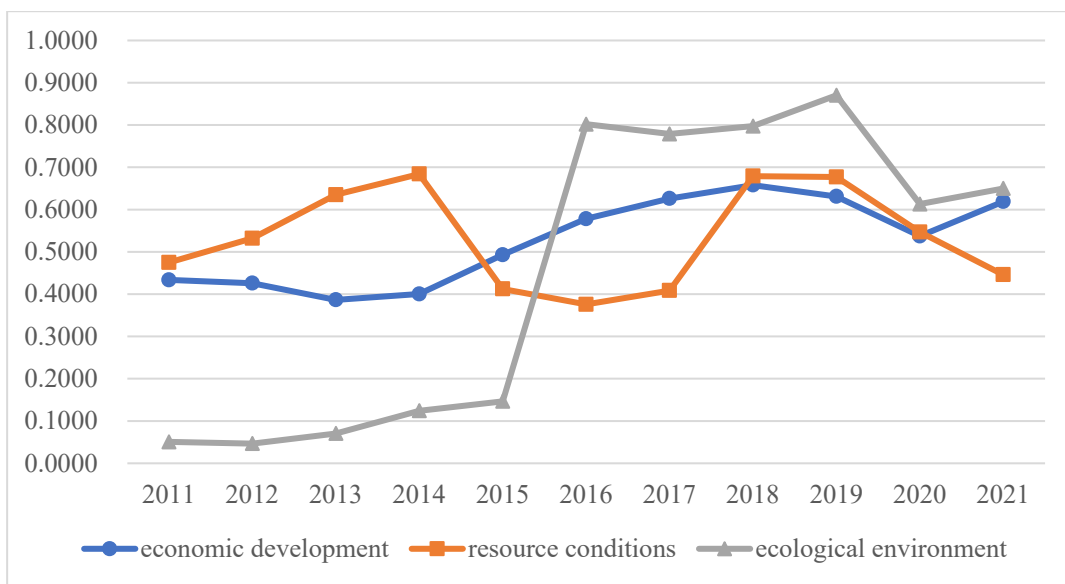
Data source: calculated by the author

### 4.3. Result analysis

#### 4.3.1. Comprehensive evaluation scores of each system

The changes in comprehensive evaluation scores of various

systems in Qinghai Province over the years are shown in Figure 1:



**Figure 1.** Changes in Comprehensive Evaluation Scores

As shown in Figure 1, the economic development of Qinghai Province shows a fluctuating growth trend of first decreasing and then increasing. From the analysis of the original data, it can be seen that the per capita GDP of Qinghai Province is showing a rising trend, while the per capita fixed assets investment is declining year by year, which indicates that the role of investment in Qinghai Province in stimulating the economy is gradually declining. In terms of industrial structure, the proportion of the secondary industry in Qinghai Province is generally decreasing, while the proportion of the tertiary industry is generally showing an upward trend. Generally speaking, the trend of economic service has become an important feature of industrial structure upgrading. It can be seen that the industrial structure of Qinghai Province is gradually becoming more advanced.

The overall score of resource conditions in Qinghai Province shows a trend of first increasing, then decreasing, then increasing, and then decreasing. From the original data (Appendix 2), it can be seen that the per capita energy reserves and water resources in Qinghai Province show a trend of first increasing, then decreasing, and then increasing. The per capita sandy land area, per capita forest land, and per capita forestry land show an overall downward trend, while the per capita wetland area shows an overall trend of first

increasing and then decreasing. It can be seen that Qinghai Province has been actively taking measures to address resource issues such as land desertification. However, overall, natural resources in Qinghai Province are relatively sensitive and subject to significant fluctuations, requiring strict government control to prevent excessive resource consumption and advocate for the correct and reasonable use of natural resources.

The overall score of the ecological environment in Qinghai Province shows a trend of first increasing, then decreasing, and then increasing, with a rapid increase rate from 2015 to 2016. In 2016, the per capita pollutant emissions in Qinghai Province sharply decreased, and the investment in per capita industrial pollution control projects reached its peak, which indirectly reflects the good implementation of the "Qinghai Province Ecological Civilization Construction Promotion Regulations" implemented in 2015. The main reason why the comprehensive score of the ecological environment began to decline in 2020 is that the per capita investment in industrial pollution control projects decreased sharply in that year, reaching the lowest value. In the process of urban landscaping construction, the per capita green coverage area in Qinghai Province has steadily increased. Overall, the ecological environment in Qinghai Province is in good condition.

### 4.3.2. Analysis of coupling coordination degree

The changes in coupling and coordination over the years in

Qinghai Province are shown in Figure 2:

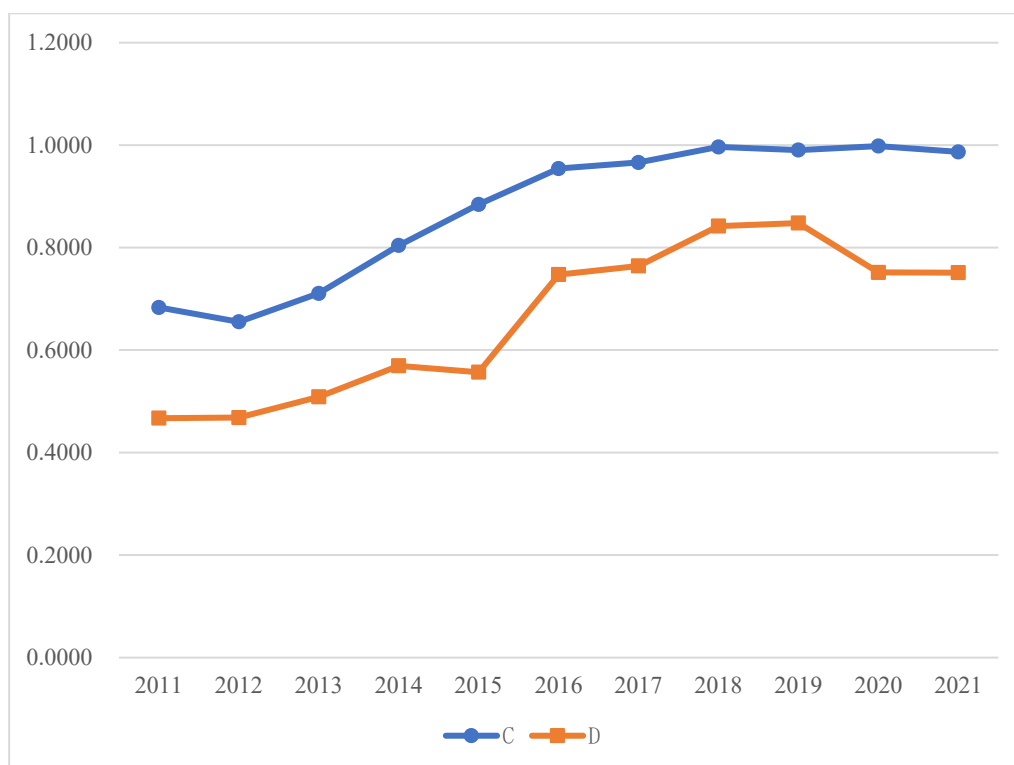


Figure 2. Changes in coupling and coordination

From Figure 2, it can be seen that overall, the coupling degree C and coupling coordination degree D in Qinghai Province show an upward trend, indicating that the interaction and coordination between economic development, resource conditions, and ecological environment in Qinghai Province

are gradually strengthening. In order to observe the empirical results more intuitively, this article divides the coupling degree and coupling coordination degree into levels, as shown in Table 4:

Table 4. Coupling degree and coupling coordination stage division

Value range	Coupling level	Value range	Coupling coordination level
0—0.5	Weak coupling effect	0—0.5	maladjustment
0.5—0.6	Weak coupling effect	0.5—0.6	Forced coordination
0.6—0.7	Moderate coupling effect	0.6—0.7	Primary coordination
0.7—0.8	Strong coupling effect	0.7—0.8	Intermediate coordination
0.8—0.9	Strong coupling effect	0.8—0.9	Good coordination
0.9—1	Strong coupling effect	0.9—1	Quality coordination

As can be seen from Table 3, the lowest value of coupling degree C is 0.6551, and the highest value is 0.9983. The minimum and maximum values of coupling coordination degree D are 0.4673 and 0.8480. Combined with Table 4, the coupling action and coupling coordination between the three systems can be analyzed respectively:

**Coupling effect:** From 2011 to 2012, the coupling degree of economic development, resource conditions and ecological environment in Qinghai Province was between 0.6-0.7, and the coupling effect among the three systems was moderate; From 2013 to 2015, the coupling degree hovered between 0.7 and 0.9, and the coupling effect between the three systems was strong. Since 2016, the coupling degree has always been greater than 0.9, and constantly tends to 1, and the coupling effect between the three systems is very strong. In general, the coupling between the three systems has been strengthening.

**Coupling coordination:** From 2011 to 2015, the coupling coordination degree of economic development, resource

conditions and ecological environment in Qinghai Province was always less than 0.6, and the relationship between the three systems was between disordered and barely coordinated. From 2016 to 2017, the coupling coordination degree was between 0.7-0.8, and the three systems were in the intermediate coordination stage; In 2018-2019, the coupling coordination degree was between 0.8-0.9, and the three systems achieved good coordination; In 2020-2021, the coupling coordination degree decreases and returns to the intermediate coordination stage. On the whole, 2016 is an important node for the coordinated development of the three systems in Qinghai Province. After 2016, the coupling coordination degree of the three systems has always been higher than 0.7, and the coordinated development trend is good, but the overall coordination degree is not strong, and it still needs to be strengthened.

## 5. Summary and Suggestions

### 5.1. Conclusion

Taking Qinghai Province as the research object, this paper constructs a comprehensive evaluation index system from three aspects: economic development, resource conditions and ecological environment. Based on the relevant data from 2011 to 2021, this paper conducts an empirical analysis through entropy method and coupling coordination degree. The research results show that: Generally speaking, the coupling effect and coordination relationship between economic development, resource conditions and ecological environment in Qinghai Province are gradually strengthening. Although the coupling degree between the three systems is high and the interaction is strong, the coupling coordination degree is still low, and there is a large room for improvement. Qinghai Province needs to continuously promote ecological economy and economic ecology, and actively explore a new road of coordinated development of ecology and economy.

### 5.2. Suggestions

#### 5.2.1. Firmly implement the concept of sustainable development

Protecting the ecological environment means protecting the productive forces, and improving the ecological environment means developing the productive forces. At present, Qinghai Province has gradually realized the importance of ecological environmental protection, and has introduced a number of policies, laws and regulations to protect the ecological environment, restrict the excessive exploitation of natural resources and pollution of the ecological environment, adhere to the priority of ecological environmental protection, take the road of sustainable development, and promote high-quality economic development. However, relying only on the government to promote the construction of ecological civilization is not feasible, and it needs the joint practice of enterprises and every citizen. Enterprises should attach importance to ecological environmental protection, consider it as a business cost, strictly comply with the relevant requirements of the government environmental protection department, and do a good job in environmental protection management. Everyone in the society should consciously enhance the awareness of ecological and environmental protection, starting from saving resources, insisting on garbage classification, and caring for plants.

#### 5.2.2. The government and the market jointly promote the optimization of industrial structure

Promoting the optimization of industrial structure is an important way to promote high-quality economic development, which requires cooperation between the government and the market. On the one hand, enterprises can not realize the optimization of industrial structure through independent adjustment, and the government needs to play its macro-control role. The government should base on the scientific concept of development and the actual situation of Qinghai Province, make reasonable planning for industrial development, take appropriate measures to effectively implement industrial development policies, and formulate appropriate reward and punishment systems to regulate enterprise behavior. It is necessary to give full play to the government's function of guiding and supervising enterprises and create a good market environment for the transformation of enterprises and the adjustment of industrial structure. On

the other hand, it is necessary to pay attention to the government should not excessively intervene in the market, fully release the vitality of the market, give play to the basic role of market resource allocation, and promote the coordinated development of industries.

#### 5.2.3. Vigorously develop ecological industries

First of all, we should combine the development of agricultural economy with the protection of ecological environment, attach importance to the development of forestry and fishery in Qinghai Province, constantly adjust the structure of livestock herds, and develop agriculture according to local conditions according to the structure of local soil and water resources and climate characteristics. Secondly, the relationship between various departments of the secondary industry should be properly adjusted, the past development model of ecology for economy should be changed, industrial technological innovation should be accelerated, resource-based industries should be updated and iterated, and emerging industries such as new energy and new materials should be prioritized. Finally, we should vigorously develop ecological tourism. Make full use of the advantages of eco-tourism resources and distinctive folk culture of Qinghai Province, develop emerging tourism products, innovate tourism models, improve infrastructure, so that tourists can more truly feel the charm of Qinghai Province and customs and culture, form a distinctive eco-tourism system, and promote economic development.

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