Research Article

An Empirical Study on Coordinated Development between Ecological Environment and Regional Economy by Big Data Mathematical Model Analysis in Tibetan Area

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Abstract

The cold and high altitude Tibetan area (hereinafter referred to as Tibetan area) is a special geographical area in western China. Whether the local economic development and EE (ecological environment) are coordinated or not directly affects the sustained and healthy economic and social development of the whole Tibetan area. Firstly, this paper discusses the relationship between economic growth and EE on the basis of existing related theoretical research. Then, 15 indicators of economic system and environmental system were selected, and the coupling degree model and coupling coordination degree model were constructed to quantitatively analyze the dynamic model of regional economic and EE coupling and coordinated development in Tibetan areas from 2010 to 2020. The research found that in the past 11 years, the comprehensive index of EE of four regions in Tibetan areas has changed from 0.5 to 0.6, and the comprehensive index of the economy of four regions in Tibetan areas has changed from 0.51 to 0.74. On the whole, the coordination degree and coordinated development degree of green development in Tibetan areas have changed at the same time compared with the years, and since 2016, both of them have had the same trend and both of them are beginning to develop in a good direction. Since 2017, the economic development has been relatively advanced, while the EE has lagged behind, showing a fluctuating state, while the level of coordinated development has been continuously improved. This study has certain reference value for promoting ecological protection and green development in Tibetan areas.

1. Introduction

China’s economy has turned to the stage of high-quality development. Ecological protection and green development are the important aspects to measure high-quality development, and they are also the realistic needs to realize high-quality development. Promoting high-quality development must take the road of “ecological priority and green development.” Cold and high altitude Tibetan area (hereinafter referred to as Tibetan area) is an important ecological functional area in China, with high altitude, steep terrain, and rich ecological species, and its development is restricted or prohibited in most areas. On the other hand, Tibetan areas are important Tibetan settlements, but their economic development is slow due to high altitude, bad weather, and inconvenient transportation, which is a typical poverty-stricken area. The ecological stability of Tibetan areas is an important ecological security barrier for China and even the world. However, Tibetan areas are faced with a huge task of economic development due to the task of getting rid of poverty, which makes the economic development in an extremely important position, and the pressure on the environment arises spontaneously.

Ji et al. constructed the evaluation index system of economic-environmental system coordination according to the principle of synergy theory [1]. On the basis of Deng Julong’s research, Liu et al. put forward the formula of coordination degree between regional economy and environment and gave several types of coordination degree ranges [2]. Based on Shi’s concept of sustainable development and the reality of China’s
environmental development, the basic principles of sustainable development measurement are put forward, including index system construction and evaluation methods. In addition, the quantitative index of coordination is defined as coordination degree. Since then, academic research on the measurement of EE (ecological environment) and green development has increased greatly [3]; Yuan et al. used entropy weight method and multilevel evaluation method to measure and analyze the regional green development level. The research shows that there is a certain spatial correlation effect in the regional green development level [4]. Raab explored the interactive stress effect of urbanization and EE from three dimensions: population urbanization, economic urbanization, and spatial urbanization [5]. Wang et al. analyzed the relationship between enterprises green development and sustainability from the perspective of resource allocation. Generally speaking, the research on EE and green development started earlier at home and abroad [6], with rich research contents, and it is still a hot spot in academic circles.

The EE in Tibetan areas is primitive and fragile, the traffic conditions are backward, the accessibility is poor, the economic development is backward, and the contradiction between economic development and EE protection is prominent. After decades of rapid economic development, it has stepped into a basic well-off society, but the environmental damage caused by the rapid economic development has become irreversible. How to live in harmony with the green development in Tibetan areas has become a difficult problem that Tibetan areas must face in building a well-off society in an all-round way. This paper makes targeted research on the Tibetan economy, trying to find out the problems in the coordinated development of Tibetan ecology and economy, and seek solutions, hoping to provide reference for relevant departments to formulate industrial development plans.

2. Related Work

2.1. Qualitative Research on Environmental Protection and Economic Development. The difference between qualitative research on green development lies in research methods. Gie et al. used the method of system dynamics to analyze the relationship between economic and environmental development and found that there is a mutual feedback mechanism between them [7]. Dong et al. studied the relationship between green development from the perspective of maximizing social welfare and put forward the best investment environment [8]. Cazorla et al. found that the intervention of environmental protection policy will make the trend of EKC (environmental Kuznets curve) become flat or the peak value appears earlier [9]. By defining and discussing the concepts of coordination, development, and coordinated development, the activities put forward the concepts and measurement models of coordination degree and coordinated development degree [10].

Zhang et al. brought the environment into the neoclassical growth model as a factor of production, regarded the environment as a kind of input capital, and thought that the optimal pollution tax or environmental standard was a necessary condition to maintain the optimal environmental quality, but not a sufficient condition [11]. Ha et al. introduced environment or pollution into endogenous economic growth model, trying to answer the question of the conditions for coordinated development of economy and the environment under the constraints of natural resources and environment [12]. Zhao and Cao used equilibrium model, metabolism model, and harmonious development model to measure and evaluate the integration of social, economic, and natural factors of comprehensive urban ecosystem [13]. Cui et al. defined the dynamic optimization process of the whole economic system, established a model to prove the conclusion of EKC, and adjusted the development of environment and economy [14].

2.2. An Empirical Study on the Coordinated Development of Economy and EE. The environment and the development of human economy and society interact and influence each other. The environment is not only the necessary condition for the development of human economy and society but also the result of its development influence. To realize the harmonious coexistence of human economy, society, and EE, it is necessary to change the development concept and mode and take the road of green development.

Daniel et al. adopted the system dynamics and sensitivity model, taking some regions and cities in the world as examples to analyze and reveal the interaction mechanism between urban development and environmental evolution [15]. Zaimiche and Sutton used the input-output model to analyze the relationship between economic behavior and EE [16]. Zhang et al., based on the coordination degree of multiobjective linear weighted sum or weighted product, think that the evaluation indexes in the evaluation system of sustainable development are complementary and the evaluation systems are overlapping [17]. Chen, based on the coordination degree of coordinate system, classified it according to the internal interaction of environmental economy system and gave a more simplified criterion of coordinated development of the environmental economy [18]. Tian et al. think that the conflict between environmental protection and economic development in the environmental-economic system is a disorderly state, and solving the conflict is to coordinate the development of two interrelated subsystems [19].

Yuan et al. analyzed from the angle of entropy law, it is thought that the limit of economic growth comes not only from the scarcity of natural resources but also from substitution and technological progress that cannot eliminate the constraint of scarcity of resources [20]. Xiao et al. used a wider range of environmental quality index data for cross-border panel model analysis and found that the environmental quality would not continue to deteriorate with economic growth [21]. Xie et al. found that there is a positive correlation between solid waste and carbon emissions and economic growth, that is, with economic growth, the more solid waste and carbon emissions [22].
3. Research Method

3.1. Theoretical Analysis Framework. The theory of coordination calls for the realization of harmony and rationality of various elements in regional economic and social activities, so as to maximize the total benefits. It guides people to correctly handle the relationship of various elements in regional development and theoretically overcome the one-sidedness of the external economy. Therefore, the theory of coordinated development is one of the important theoretical foundations of sustainable development.

Faced with the increasingly acute contradiction among social economy, ecological resources, and environmental carrying capacity, we must fully understand the importance of resource conservation and environmental protection, and strengthen the protection of EE [23].

The total amount and per capita of water resources in Tibetan areas rank first in China, and the reserves and exploitable amount of water resources in Tibet rank first [24]. After the full development and utilization of hydropower, the Tibetan areas will be self-sufficient in electric power, and the transmission of electricity from Tibet can also be realized. As a necessity of production and life, enough water provides a basic guarantee for our production and life. Due to the unique geographical environment and climatic conditions in Tibetan areas, there are many unique tree species in Tibet, which provide abundant biodiversity in China and forest diversity in plateau areas. Because of their uniqueness, forest resources in Tibetan areas have strong research value and economic benefits.

Ecology requires people to pay attention to the sustainability of resource utilization while utilizing resources to achieve economic development, and the right of future generations to utilize resources should not be damaged by economic development. The most important thing is that an eco-economy requires an “efficient” economic development mode and pays more attention to a “low energy consumption and high output” production mode. It is hoped that through technological progress and optimal allocation of resources, the output efficiency of resources and the reuse efficiency of industrial wastes will be continuously improved, and the full utilization of resources will be realized. At present, the circular economy is the most well-known one in the development of the ecological economy.

On the basis of the above, the coupling mechanism between EE system and green development system is constructed and analyzed. The coupling mechanism of environment and the green development is shown in Figure 1.

The coupling mechanism between environment and green development is mainly manifested in the interaction or mutual influence between them. If they promote each other and coordinate together, it is benign coupling, and vice versa, it is vicious coupling. The ecosystem and green development system have rich connotations. They are obviously different but closely related and have a coupling relationship of mutual promotion and mutual restriction.

3.2. Selection of Data Sources and Indicators. The data involved in this section are all from the Tibet Statistical Yearbook, China Environmental Yearbook, Tibetan Statistical Information Network, and China Statistics Bureau Network. Combined with the characteristics of various models, this paper selects the range normalization method to standardize the original data, uses the entropy weight method in the objective weighting method to determine the weight.

When selecting evaluation indicators, we should consider the following:

1. Scientific principle: the establishment of index system is based on science at first. There should be no obvious scientific problems in index selection and data processing. The processing methods and data analysis and collation conform to the norms.

2. Dynamic principle: it should also be dynamic, so as to reduce the errors caused by other external factors to the system evaluation so that the obtained index can guarantee the authenticity and reliability of the evaluation research on the harmonious development of the two systems.

3. Principle of comprehensiveness: comprehensiveness means that the index system of coordinated development of economic development and EE should have sufficient coverage.

Accordingly, this paper selects the evaluation indexes of green development in Tibetan areas and constructs a comprehensive evaluation index system (as shown in Figure 2). The selected indicators fully consider the overall economic strength, economic structure, economic vitality, economic prosperity, environmental pollution, environmental state, and environmental governance.

The specific explanation of the three-level indicators is shown in Table 1.

3.3. Dynamic Model Construction. Before determining the weight, this paper uses the range normalization method to deal with the indicators so that the indicators are comparable. In this study, to avoid too many subjective factors affecting the evaluation results, objective weighting method, and entropy weighting method (entropy weighting method for short) are adopted to determine the index weight.

If there are n samples with m indicators, let $x_{ij}$ represent the value of the index of the sample, where $i = 1, 2, \ldots, n$.

Specific gravity conversion is shown as follows:

$$s_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}}$$

(1)

Calculate entropy is shown as follows:

$$h_j = -\sum_{i=1}^{n} s_{ij} \ln s_{ij},$$

(2)

where $h_j \in [0, \ln n]$.

Entropy inversion is shown as follows:

$$a_j = \frac{h_{j_{\text{max}}}}{h_j},$$

(3)

where $h_{j_{\text{max}}}$ represents the maximum value in $h_j$ and $a_{ij} \geq 1$. 
Calculate weight is shown as follows:

$$w_j = \frac{a_j}{\sum_{i=1}^{m} a_j}$$

where $\sum_{j=1}^{m} w_j = 1$.

From a horizontal perspective, it is assumed that the country is composed of several regions, and each region is composed of several subregions. Choose the maximum value and the minimum value from all the positive indicators in each subregion and take the combination of all the selected
maximum and minimum values as the positive ideal solution of these subregions.

Determine the ideal solution and negative ideal solution

\[
x^→_i = \left\{ \left( \min_{j \in J} x_{ij}, \max_{j \in J} x_{ij} \right) \right\}_{i = 1, 2, \ldots, n}
\]

\[
x^→_i = \left\{ \left( \max_{j \in J} x_{ij}, \min_{j \in J} x_{ij} \right) \right\}_{i = 1, 2, \ldots, n}
\]

where \( J \) in the formula is the benefit-oriented target set and \( J' \) is the cost-oriented target set.

The distance between each attribute value of each sub-region and the positive ideal solution is

\[
s^+_i = \sqrt{\sum_{j=1}^{m} (x_{ij} - x^+_j)^2}, \quad i = 1, 2, \ldots, n.
\]

The distance to the negative ideal solution is

\[
s^-_i = \sqrt{\sum_{j=1}^{m} (x_{ij} - x^-_j)^2}, \quad i = 1, 2, \ldots, n.
\]

Calculate the relative proximity of each attribute value of each sub-region to the negative ideal solution, that is, the relative coordination degree

\[
C^*_i = \frac{s^-_i}{s^+_i + s^-_i},
\]

\[0 \leq C^*_i, \quad i = 1, 2, \ldots, n.\]

If each attribute value of a sub-region is a positive ideal solution, the relative harmony degree is 1, if it is a negative ideal solution, it is 0, and the general harmony degree value is between 0 and 1. In addition, in order to avoid the calculated value of coordination degree being too concentrated, this study will square the abovementioned value as the final value of coordination degree.

Development degree can comprehensively summarize the development degree of economic growth and EE

\[
T = \alpha f(x) + \beta g(y),
\]

where \( T \) represents the degree of development, \( f(x) \) and \( g(y) \) are the economic benefit index and eco-environmental benefit index defined above. \( \alpha, \beta \) is the undetermined coefficient. We think that economy and eco-environment are equally important, so the undetermined coefficient \( \alpha, \beta \) is 0.5.

According to the concepts of coordinated development and coordinated development degree, this paper defines the coordinated development coefficient, which is expressed by \( D \) to measure the level of coordination between economic development and environment.

\[
D = \sqrt{\frac{C \times T},}
\]

\[
T = \frac{[f(x) + g(y)]}{2},
\]

where the larger the \( D \) value, the higher the coordination between economic development and environment. \( T \) is the comprehensive evaluation index of economic development and environment.

Nowadays, scholars mainly use the method of uniform distribution function to delimit the classification system and criteria. Some of them are divided into 5 grades, others into 8 grades, and some scholars divide them into 10 grades, but basically, 0.5 is used as the boundary value for the coordination between EE and the economic system.

This paper mainly refers to the uniform distribution function method (see Table 2), and classifies the degree of coupling and coordination between EE and economy in Tibetan areas to better explain the degree of coupling and coordinated development of regional EE and economy.

By clearly dividing the level of the coupling and coordinated development of regional eco-environment and economy, it is convenient to compare and analyze the coupling and coordinated development status and trend characteristics of eco-environment system and economic system in a certain region and provide a certain theoretical basis for improving the coupling and coordinated development level.

### 4. Result Analysis

#### 4.1. Descriptive Statistical Analysis of Data

The construction of economic projects based on EE runs through the ecological concept in the actual economic construction and promotes the harmonious development of economy and ecology in China. The environment plays an important role in regional economic development. On the one hand, it pays attention to the discharge of pollutants in economic development, which protects the EE, on the other hand, it also...
provides important production factor resources for industrial economy.

Due to the large amount of data, this paper selects three equidistant time nodes in 2010, 2016, and 2020, and makes descriptive statistical analysis on the index data of these three years by using EXCEL software (shown in Figures 3–5).

It is found that the regional distribution of some indicators in Tibetan EE and green development system is significantly different. In terms of ecosystem indicators, there is a big gap among regions in urban greening coverage area (A4), industrial wastewater treatment capacity (A6), and total investment in environmental pollution control (A5). It is an area with serious soil erosion in Tibetan areas.

Generally speaking, except for a few indicators, most indicators have a good development trend. Comparing the standard deviations of three years, among the 15 indicators, 9 are in an upward trend and the other 6 are in a downward trend, indicating that 40% of the regional differences of indicator values tend to widen.

4.2. Dynamic Characteristics of EE and Economic Development in Tibetan Areas. Eco-environmental pressure and eco-environmental level constitute the eco-environmental system, including the current environmental state and green coverage rate. These indicators are particularly important for the construction of urban civilization and also the driving force to promote regional economic development. At present, with the continuous improvement of people’s living standard, people’s requirements for living environment are gradually improved, which also urges the society to pay more attention to the effective improvement of EE. In the development of regional economy, both import and export trade and foreign investment need a good EE as a support. Therefore, only by actively maintaining and developing the EE can we promote the growing prosperity of economic trade and promote the overall development of society.

Figure 6 shows the calculation results of the annual ecological comprehensive index of four regions in Tibetan areas.

It can be seen that the comprehensive index of EE in four regions in Tibetan areas has changed from 0.5 to 0.6 in the past 11 years, and the comprehensive index of EE in the east is in a wave state as a whole. The comprehensive index of EE in the middle part of China varies from 0.54 to 0.66, showing a wave-like upward trend as a whole.

Table 2: Grading of coupling coordination degree between regional EE and economy.

| $D$  | Grade          | $D$  | Grade          |
|------|----------------|------|----------------|
| 0–0.09 | Extreme disorder | 0.50–0.59 | Reluctantly coordinate |
| 0.10–0.19 | Serious maladjustment | 0.60–0.69 | Primary coordination |
| 0.20–0.29 | Moderate disorder | 0.70–0.79 | Intermediate coordination |
| 0.30–0.39 | Mild disorder    | 0.80–0.89 | Good coordination |
| 0.40–0.49 | On the verge of maladjustment | 0.90–1.00 | Quality coordination |

Source: Table 2 is reproduced from the article: Fei Meng, 2022, Mathematical Problems in Engineering, https://doi.org/10.1155/2022/5653945 (under the Creative Commons (attribution license/public domain)).
which the comprehensive economic index of the eastern region changed from 0.56 to 0.74, showing a wave-like state as a whole and tending to be stable in recent years. The comprehensive economic index of the western region as a whole shows a fluctuating and declining state. The comprehensive economic index of southern China varies from 0.54 to 0.66, showing a fluctuating state as a whole and has a downward trend in recent years. The comprehensive economic index of central China varies from 0.53 to 0.63, showing a state of first rising and then falling, then rising and then falling.

4.3. Evaluation and Classification of Coordinated Development Degree between Economic Growth and EE in Tibetan Areas. The coordination degree cannot reflect the overall function of environment and economy or the size or development level of comprehensive environmental-economic benefits. Compared with the degree of coordinated development, the degree of coordinated development can better reflect the comprehensive strength level of the regional economy and EE.

From the calculated EE and economic development degree and coordination degree, the value of coordinated development degree is calculated by using the formula, and the calculation result is shown in Figure 8. The calculation results of coordination between economic and environmental development in Tibetan areas from 2006 to 2015 are shown in Table 3.

It can be seen that, on the whole, the coordination degree and coordinated development degree of green development in Tibetan areas have changed at the same time relative to the year, and the trends of both have been the same since 2016, and both of them have started to develop in a good direction.

In 2016, as a turning point between the preceding and the following, Tibet’s economy developed rapidly, and the environment could not be completely purified due to the damage to the environment. The economy and environment in Tibetan areas showed an uncoordinated situation. However, since the Central Tibet Work Forum proposed to build Tibet into a national ecological security barrier, Tibet began to attach importance to environmental protection, which led to a better trend of economic and environmental development in Tibet from the perspective of development.

In the process of interaction between EE and economic development, with the continuous development of economy since 2017, economic development has been relatively advanced, while EE has been relatively lagging behind. However, the comprehensive index of EE and economic development level has been increasing, and the overall level of coordination degree is high, but it is in a fluctuating state, and the level of coordinated development is constantly improving.

4.4. Countermeasure Analysis of Promoting the Coordinated Development of Tibet’s Green Development. People should...
pay more attention to it, realize the important influence of the environment, set up the values of protecting the environment, and abandon the ecological view that is not in line with the sustainable development of mankind. According to the suitability of natural conditions, carrying capacity of resources and environment, scientific planning of industrial layout, and taking environmental protection as the premise and environmental self-purification as the foundation, orderly development will be carried out to form a spatial structure, industrial structure, and mode of production that can save resources and protect the environment. Efforts will be made to build a national security ecological barrier, and the construction of ecological civilization and beautiful Tibet will be practically promoted.

Considering the special natural environment in Tibetan areas, the development of local economy should be guided by the scientific development concept, change the mode of economic growth, focus on intensive agriculture, and develop characteristic agriculture. Therefore, it is necessary to strengthen the optimal utilization and protection of natural resources, which will not only improve the local ecological and economic benefits but also facilitate the rational material conversion and energy flow between the economic system and the ecosystem. We must vigorously protect and rationally utilize natural resources; pay equal attention to development and conservation; comprehensively develop and utilize them; strengthen ecological protection; and realize efficient and sustainable utilization of resources.

Service industries derived from tourism, such as accommodation, catering, Tibetan specialties, etc., should also keep pace with the development of tourism, provide tourists with the best service, and build the tourism brand advantage of Tibetan areas. With people’s increasing yearning for a better life, people’s demand for nature, leisure, and health care is increasing. Tibetan areas have good ecological conditions, so it is possible to build a leisure resort integrating leisure, health care, tourism, and summer vacation to cultivate new green industries and new economic growth points, and realize the sustainable development of the economy and ecology.

Strengthen green supervision. Improve the pollutant discharge permit system and implement the total pollutant discharge control system of enterprises and institutions. The compensation system shall be strictly implemented for those responsible for EEal damage, and criminal responsibility shall be investigated according to law.

Strengthen the training of professionals. Based on the needs of ecological protection and characteristic economic development, Tibetan areas urgently need to introduce a
group of specialized talents. However, Tibetan areas are cold and lack of oxygen, and the living environment is extremely bad. Young people are rarely willing to stay for long-term development. They can increase the salary level and welfare benefits of talent introduction, and attract specialized talents to stay in local development. Compared with the talents in other places, the local residents in Tibetan areas know more about the local development situation and are more suitable for the local living environment. Therefore, it is possible to set up majors suitable for the actual needs of Tibetan areas in the college entrance examination or secondary vocational school stage in conjunction with universities inside and outside the province, so as to lower the scores or train specialized talents by directional training or entrusted training.

Pay attention to EE protection. The eastern and central regions should make paid use of resources and ecological compensation for the western region, improve the property right system, and use control system of natural resources assets. It shall be registered in a unified way to form a property right system of natural resources assets with clear ownership, clear rights and responsibilities, and effective supervision. Delineate the control limits of production, living and ecological space development, implement the user control, and improve the system of economical and intensive use of energy, water, and land.

5. Conclusion

This paper selects the appropriate index and uses the entropy weight method to determine the index weight. Quantitatively measure the spatial and temporal differences of the comprehensive indicators of energy conservation, environmental protection, and coordinated regional economic development in Tibetan areas. The main conclusions are as follows. In Tibetan areas, in the past 11 years, the comprehensive economic and energy index has changed from 0.5 to 0.6, and the economic comprehensive index of the four Tibetan areas has changed from 0.51 to 0.74. The degree of coordination and degree of coordinated green development in Tibetan areas have shown synchronous changes relative to the years. Since 2016, the trends of the two have been consistent, and both have begun to develop in a positive direction. It shows that the coordinated development level of ecological environment and regional economy in Tibetan areas is on the rise, but there are differences in different years. The environment and the development of human economy and society interact and influence each other. The environment is not only a necessary condition for human economic and social development but also the result of its development influence. In order to realize the harmonious coexistence of human economy, society, and ecological environment, it is necessary to change the development concept and method and take the road of green development.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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