Research on Coordinated Development of Ecological Resources, Environment and Economy and Society in Sanjiang Region

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Abstract. An excellent environmental resource environment is a necessary condition for coordinated economic and social development in the Sanjiang region. This article uses four methods of literature review, qualitative analysis and quantitative analysis, static analysis and dynamic analysis, and a combination of theory and empirical research to comprehensively evaluate the degree of coordinated development and coordinated development of eco-resources, environment, economy and society in the Sanjiang region. Analyze the coordinated development of ecological resources, environment, and economy in the Sanjiang region and its spatiotemporal evolution, and propose specific suggestions and countermeasures. The study found that economic development and environmental protection are the two main issues facing social development in the Sanjiang Plain. On the one hand, we must rely on science and technology to vigorously develop the economy, promote the upgrading of the industrial structure, and then promote the development of regional society. The protection of the environment and avoiding environmental degradation direct constraints the development of human culture.

1. Introduction

Over the past three decades, China’s economy has grown rapidly and steadily. As an essential industrial base in China[1], after years of development, the region has accumulated a particular regional economic foundation, which is mainly reflected in a solid agricultural foundation, the establishment of an industrial system, and the growing prosperity of the port economy[2]. However, the rapid development of society and the economy have led to increasingly prominent contradictions with population, resources, and the environment[3]. Pursue economic benefits, focus on the development of heavy industry, and pay less attention to environmental protection indicators. These are essential reasons for the shortage of ecological resources and serious environmental pollution problems (frequent ecological issues such as fog and dust storms). Development and human life has had an adverse impact[4]. The factors that led to the smooth progress of the Sanjiang region are mainly the low level of resource utilization, the weak economic strength of the administrative unit, and the lack of regional centers. In summary, if the development of the Sanjiang region is to be promoted, it is necessary to realize the transformation of the model of economic growth, increase the protection of the environment, and embark on the road of coordinated development of economy and
environmental protection[5]. Based on this thinking, this paper aims to provide a basis for planning and decision-making on the ecological environment protection and coordinated economic development in the Sanjiang region, with a view to providing valuable ideas for solving the problems existing in the environmental environment construction of the Sanjiang region.

2. Overview of the study area
The Sanjiang Plain is one of the top ten "Xintianfu" in China, and its natural environment resources are very superior. The city of Sanjiang lies between 45°01′ to 48°27′56″ north latitude and 130°13′ to 135°05′26″ longitudes east. The rain and heat of the Sanjiang Plain are in the same season, which is suitable for growing with crops. The Sanjiang Plain is known as the "Great Northern Wilderness". Before the large-scale reclamation in the 1950s meadows and swamps were endless, and there were also forests and wild animals. After the restoration, many large state-owned farms were built. The "Beidahuang" has become the "Beidacang" and has become a vital commodity grain base in the country.

In 2015, the total population of the Sanjiang Plain area was 8.442 million, and the regional GDP was 223.675 billion (including the three major industries). Among the three major sectors, Jiamusi has the most significant output value and has the highest contribution to the regional economy. Qitahei has the most significant area. The output value of the industry and the secondary sector is the lowest, the tertiary sector in Hegang City is relatively backward, and the economy of each region has steadily improved. For a long time, the hinterland of the Sanjiang Plain has formed a production pattern dominated by farming economy and has not established an important regional economic centre. Regions have not significantly promoted the economy in the Sanjiang region. For the bridgehead of trade docking, most other counties and towns are also challenging to develop into regional economic centers. Compared with the state of economic development in the country, the Sanjiang region urgently needs rapid transformation and economic development. Empirical Research on the coordinated development of ecology and economy in the Sanjiang region provides the basic theoretical basis.

3. Establishing an evaluation index system for ecological and economic synergies

3.1. Research methods
The correct selection and reasonable measurement of evaluation indicators is the basis of systematic analysis and evaluation. Due to the complexity and timing of the coupling between ecological and economic systems, to facilitate the review and highlight the characteristics and laws of the coordinated development of the two systems, evaluation is set up. In the index, the four principles of comprehensiveness, objectivity, comparability and availability must be followed.

3.1.1. Range standardization. To ensure that the selection of indicators meets the laws of science, completeness, and operability, this study uses the method of extreme standardization to standardize the processing of raw data, using positive index normalization and harmful index normalization, respectively. The indicator is that the larger the number of indicators, the better the system development, while the negative signs are the opposite. Calculated as following:

1) Standardization formula for positive signs;
2) Standardization formula for negative signs.

\[ h_{ij} = \frac{Z_{ij} - \min Z_{ij}}{\max Z_{ij} - \min Z_{ij}} \]  \hspace{1cm} (1)

\[ h_{ij} = \frac{\max Z_{ij} - Z_{ij}}{\max Z_{ij} - \min Z_{ij}} \] \hspace{1cm} (2)

Note: \[ h_{ij} \] and \[ Z_{ij} \] are the original data and the standard data respectively: \[ \max Z_{ij} \] is the most significant data in the index data, and \[ \min Z_{ij} \] is the smallest data in the index data.

Affected by the range normalization process, a value of 0 will appear in the data, but the entropy method uses logarithm when processing the data, so the normalized formulas (1) and (2) are translated, and the calculation formula is as follows:

\[ h_{ij}^* = h_{ij} \times 0.99 + 0.01 \] \hspace{1cm} (3)
Note: \( h'_{ij} \) and \( h_{ij} \) are the decoded data and normalized data, respectively. The calculation of \( h'_{ij} \) is mainly based on the entropy method. The standardization of the extreme difference must have 0 and 1, so it is calculated to reduce errors.

3.1.2. Entropy method. Combining the entropy weight method to determine its index weight, and judging the size of the entropy value, reflecting the degree of discreteness of the data, the importance of each index is obtained.

\[
P_{i,j} = \frac{h'_{ij}}{\sum_{i=1}^{n} h'_{ij}} \quad (4) \quad W_j = \frac{F_j}{\sum_{j=1}^{m} F_j} \quad (5)
\]

\[
F_j = 1 - E_j \quad (6) \quad F_j = -k \sum_{i=1}^{n} P_{ij} \ln P_{ij} \quad (7)
\]

Note: \( P_{ij} \) is the proportion of the \( j \)-th index in the \( i \)-th year; \( h_{ij} \) is the data after translation; the constant \( k>0 \) is related to the number of samples \( m \), generally let \( k = 1/\ln m \); \( \ln \) is the natural logarithm; \( E_j \) is the index information entropy; \( F_j \) is the information redundancy; \( W_j \) is the index weight. Table 1 is obtained through the construction of the indicator system and weight calculation.

3.2. Establishment of the indicator system
The establishment of the indicator system follows the principles of scientifically, operability, dynamics and systematization. It combines the actual conditions of the Sanjiang area to build two primary module layers, namely the economic subsystem and the ecological subsystem, with the total financial volume, economic structure, and financial benefits. Five reference layers of environmental resources and green environment and selected the 25 indicator layers of the Sanjiang region for the coordinated development of environmental and economic development order parameter evaluation index system (Table 1).
Table 1. Sequence and parameter evaluation system for coordinated development in the Sanjiang region.

| Overall target layer | Reference layer | Indicator layer | Weights | Nature |
|----------------------|-----------------|-----------------|---------|--------|
| Economic aggregate   | E1: Total social investment in fixed assets / 100 million yuan | 0.0407 | + |
|                      | E2: Fiscal revenue / 100 million yuan | 0.0412 | + |
| Economic structure    | E3: Proportion of total industrial output to GDP / % | 0.0387 | + |
|                      | E4: Research Expenditure as% of GDP | 0.0394 | + |
|                      | E5: GDP / yuan | 0.0397 | + |
|                      | E6: Per capita disposable income of urban residents / yuan | 0.0397 | + |
|                      | E7: Total retail sales of consumer goods/100 million yuan | 0.0401 | + |
| Ecology and economy coordinated development system maturity | E8: Population density / (person-km\(^{-2}\)) | 0.0379 | + |
|                      | E9: Urban registered unemployment rate / % | 0.0399 | - |
|                      | E10: Engel coefficient of urban residents | 0.0431 | - |
|                      | E11: Urbanization rate / % | 0.0407 | + |
|                      | E12: Health technicians / 10,000 | 0.0434 | + |
|                      | E13: Number of students in adult higher education | 0.0399 | + |
|                      | E14: Park green area per capita / (m\(^2\)person\(^{-1}\)) | 0.0383 | + |
|                      | E15: Water resources per capita / m\(^3\) | 0.0387 | + |
|                      | E16: Crude oil production per capita / (t-person\(^{-1}\)) | 0.0372 | + |
|                      | E17: Per Capita Raw Coal Production / (t-person\(^{-1}\)) | 0.0354 | + |
|                      | E18: Electricity consumption per capita / (kw-h) | 0.0402 | + |
|                      | E20: Sulfur dioxide emissions / 10,000t | 0.0405 | - |
|                      | E21: Total industrial wastewater discharge / 10,000t | 0.0394 | - |
|                      | E22: Comprehensive utilization of industrial substantial waste / 10,000 tons | 0.0391 | + |
|                      | E23: Domestic garbage removal volume / 10,000t | 0.0488 | + |
|                      | E24: Harmless treatment rate of domestic waste / % | 0.0424 | + |
|                      | E25: Total industrial wastewater discharge / 10,000t | 0.0394 | - |

3.3. Empirical analyzes of the maturity of the coordinated development of ecology and economy

3.3.1. Analysis of the relationship between ecosystems and economic systems. Compared with the data (Table 2), from 2009 to 2018, the degree of order of the ecological and economic subsystems has steadily increased, and the disorderly development has gradually improved since 2009. By 2015, environmental and economic subsystems have been developed. From disorder to orderly development, indicators such as the continuous expansion of forest coverage and the increase in arable land area are the main factors that promote the gradual and systematic shift of the ecological subsystem from disorder. Economic policies are inseparable. At the same time, the state's plans to benefit the people, such as investment in fixed assets and financial support for the Sanjiang region, ensure that farmers' net incomes continue to increase and per capita GDP is steadily rising.

Table 2. Order degree of ecological subsystem and economic subsystem

| Years | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|-------|------|------|------|------|------|------|------|------|------|------|
| Ecosystem | -0.98 | -0.85 | -0.41 | -1.03 | -1.11 | -0.18 | -0.36 | 0.96 | 1.59 | 2.37 |
| Economic subsystem | -0.48 | -0.43 | -0.49 | -0.54 | -0.36 | -0.6 | -0.07 | 0.54 | 0.48 | 0.95 |
3.3.2. The maturity of the coordinated development of ecology and economy. The value range of collaborative timeline should be between. When the cooperative maturity value is \(<0\), it indicates that the two subsystems are not cooperating; when the collaborative maturity value is \(>0\), it is proved that the two subsystems are in coordinated development; the closer the cooperative maturity value is to 1, it indicates the synergy between the two industries. The closer it is, the better the results achieved by collaborative development, such as in Table 3:

| Years | 2010  | 2011  | 2012  | 2013  | 2014  | 2015  | 2016  | 2017  | 2018  |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Maturity | 0.081 | -0.075| -0.055| -0.125| -0.310| 0.504 | 0.517 | 0.531 | 0.683 |

Analysing the maturity curve of the coordinated development system of ecology and economy, we can get: (1) The collaborative maturity of the collaborative development system has generally increased steadily from 0.081 in 2010 to 0.683 in 2018, that is, in the past ten years, the ecological and economic policies have never developed in concert and gradually transitioned to an increasingly close synergy relationship. The collaborative relationship slowly eased. (2) Based on collaborative maturity, and considering the ordering of the two subsystems, it can be obtained that the ordering degree of the ecological subsystem is significantly increased, and the orderly degree of the economic subsystem is relatively small. It shows that the entire composite system is not in a well-coordinated development trend, and economic development is relatively lagging. (3) The degree of synergy maturity in 2011-2014 is negative because in recent years, the country has increased its emphasis on ecological protection. Although it has not been given up on economic development, the economic development of the area is essentially due to its environmental protection status. Due to the fragility of the environmental environment and historical reasons for social progress, the economic development of the Sanjiang region is lagging, making the relationship of coordinated development in an unbalanced state. After 2014, the synergistic relationship between ecology and economic systems is in the process of gradual synergy, but the effect of synergistic development is not very satisfactory.

4. Countermeasures for the Coordinated Development of Ecology and Economy in the Sanjiang Region

4.1. Relying on science and technology to develop a low-carbon circular economy

During the development of the Sanjiang Plain, we should use a systematic way of thinking to think about problems. Promote the construction of ecological civilization. Strictly implement national
policies on environmental protection and ensure that they are in place. Actively develop regional organic agriculture and promote the circular and green development of the agricultural economy. Eliminate backward and heavily polluting enterprises and increase the environmental supervision of existing enterprises. Check the efforts; actively introduce enterprises with high technological content, low pollution, and significant economic benefits to promote the upgrading of industries; give full play to regional resource advantages, and create tourism business cards.

4.2. Overall planning and coordinated development
The Sanjiang Plain area is facing twin pressure of environmental protection and economic and social development. A pleasant environment is a prerequisite for economic and social development. Therefore, coordinating economic and social development and ecological protection is naturally the key to sustainable development in the Sanjiang Plain.

5. Conclusion
Developing the economy and protecting the environment are the two main issues facing social development in the Sanjiang Plain area. On the one hand, we must vigorously improve the economy, promote the upgrading of the industrial structure through economic development, change the backwardness of the region, increase the income of the people, and accelerate the comprehensive well-off the pace of social construction, thus promoting the development of regional society. A pleasant environment is a prerequisite for the existence and development of human culture. Therefore, in the economic development process of the Sanjiang Plain, we must attach importance to the protection of the environment, the prevention and control of atmospheric, river, and soil pollution in the region, develop a circular economy, and actively build environmental industries, creating beautiful and ecologically liveable urban agglomerations. Through an excellent green environment, attracting investors, and promoting the overall development of the regional society, it is essential to coordinate economic growth and environmental protection. It needs to be guided by scientific concepts and regulated by correct principles.

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