STUDY ON RESPONSE OF ECOLOGICAL ENVIRONMENT IN URBANIZATION PROCESS OF ORDOS, CHINA

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Abstract ： Taking Ordos in Inner Mongolia as the research object, a coupling coordination and decoupling model was constructed to analyze the interaction and coupling relationship between urbanization and ecological environment in Ordos from 2003 to 2018. The results showed that: (1) the comprehensive development level of urbanization and ecological environment showed an upward trend, and the development of urbanization was ahead of the ecological environment for a long time; (2) The coupling degree and coupling coordination degree of urbanization and ecological environment continue to increase; (3) The decoupling index shows mainly three decoupling regimes: strong decoupling, weak decoupling and strong negative decoupling. (4) It is suggested to explore the ecological economic development model that is compatible with the carrying capacity of resources and environment.

Key words: Urbanization ； Ecological environment ； Coupling Coordination Model；Decoupling index; Ordos

Coordinated development of urbanization and ecological environment is an important research content for ecological security and high-quality development in the Yellow River basin. Ordos, as an important ecological node city in the Yellow River basin, is located in the southwest of Inner Mongolia Autonomous Region, surrounded by the Yellow River on three sides in the northwest, the ancient Great Wall on the south, and adjacent to three provinces and regions of Jin, Shaanxi and Ning. It is a typical resource-based city, with extremely rich coal and gas resources. With the implementation of the strategy of opening up to the West and the rapid development of Inner Mongolia's industrial economy, Ordos has rapidly developed into the country's largest coal production base and a resource-based industrial city dominated by the coal and gas industries. Its social economy continues to grow at a rapid rate, and the level of industrialization and urbanization continues to improve. At the same time, ecological and environmental issues have become increasingly prominent in the rapid urbanization process. Ecological and environmental issues have become important obstacles to high-quality development in urbanization. Therefore, ecological environment response studies have been carried out during the urbanization process, and corresponding countermeasures and recommendations have been

proposed for sustainable development policies and coordinated development of urbanization and ecological environment in the Ordos region.

1. Literature review

Academics from home and abroad have made rich research achievements on the interplay between urbanization and the ecological environment. A large number of empirical studies have been carried out in foreign countries, mainly using PSR model [1], EKC curve [2] and decoupling theory [3]. Chinese scholars have innovatively proposed the Coupled Rubik's Cube theory [4], focusing on multiple research directions such as coupling model analysis and prediction [5], coupling driving mechanism [6], decoupling model [7], and geographic detector [8]. Empirical analysis has focused on the Yangtze River Basin, Yellow River Basin, Beijing-Tianjin-Hebei Province and other levels. Based on this, this paper takes Ordos from 2003 to 2018 as an example to construct a coupling coordination model of urbanization and ecological environment, and diagnoses the interaction between the two with the help of decoupling theory, in order to provide references for the coordinated development of urbanization and ecological protection in resource-based cities.

2. Index system and research methods
2.1 Index System

In accordance with the principles of scientific comprehensiveness and data availability, we construct a comprehensive system of evaluation metrics for urbanization systems and ecological environment systems, and establish the weights of each metric using the entropy weighting method. The urbanization system consists of population urbanization, social urbanization, economic urbanization, and spatial urbanization. The eco-environment system consists of three sub-systems: eco-environment level, eco-environment pressure, and eco-environment response. The data used in the study are mainly from the China Municipal Statistical Yearbook and the Ordos Statistical Yearbook from 2004 to 2019. In order to eliminate line effects, the raw data was normalized using bias-normalized data processing when evaluating the integrated development levels of the two systems.

2.2 Research method

Coupling degree model: Based on the relevant research results of the coupling model, T is the comprehensive development index of urbanization $U(x)$, ecological environment $E(y)$; D is the degree of coupling coordination, reflecting the level of system development; C is the degree of coupling, the strength of the interaction between the reacting systems; α, β is the undetermined weight, which is proposed as $\alpha = \beta = 1/2$ in this study.

$$C = \sqrt{\frac{U(X) \cdot E(y)}{\left(\frac{U(X)+E(y)}{2}\right)^2}} \; ; \quad D = \sqrt{C \times T} \; ; \quad T = \alpha f(x) + \beta g(y)$$

Decoupling model: DI_t represents the decoupling index of ecological environment to urbanization in t period. E_t and E_{t-1} represent the comprehensive index of ecological environment in year t and year t-1 respectively. U_t and U_{t-1} represent the comprehensive index of urbanization in year t and year t-1 respectively.

$$DI_t = \frac{(E_t - E_{t-1})/E_{t-1}}{(U_t - U_{t-1})/U_{t-1}}$$

3. Results and analysis

3.1 Timing analysis of the comprehensive level of urbanization

From 2003 to 2018 , the overall urbanization index showed a rapidly fluctuating upward trend, rising from 0.0613 in 2003 to 0.8289 in 2018 , with an average annual growth rate of 0.0467. Due to the impact of the global financial crisis and regional industrial structure optimization policies, the urbanization index showed a rapidly fluctuating upward trend. The two small fluctuations in 2008 and 2015 were reduced. After 2015, the comprehensive urbanization index showed a period of steady development, with sustained and rapid economic and social development on the back of abundant natural resources and the vigorous development of the resource-based economy.

3.2 Time series analysis of ecological environment comprehensive level

The overall composite index of ecological environment systems showed a slow fluctuation and upward trend, rising from 0.4447 in 2003 to 0.6601 in 2018 . The overall index of the ecological environment has grown relatively slowly, and the protection and construction of the ecological environment has achieved certain results. In urban economic development, where natural resources are the leading industry, ecological environment governance and ecological environment construction have largely achieved synchronized development. It is particularly important to accelerate the improvement of the resource and energy structure, optimize the economic and industrial structure of the city, and continuously promote the construction of an ecological environment.

3.3 Timing analysis of coupling degree between urbanization and ecological environment

The coupling ratio increased from 0.6527 in 2003 to 0.9936 in 2018, an increase of 0.3409 and an annual increase of 0.0213. The trend of the change in the degree of coupling shows a rapid rise and tends to stabilize. The coupling degree type experienced the coupling evolution process of running-in (2003) - high-level coupling

(2004) - high-quality coupling (2005-2018), and the coupling degree of urbanization system and ecological environment system was always in the high-quality coupling stage from 2009 to 2018, and maintained a long-term stable development trend of high-quality coupling.

3.4 Timing analysis of coupling coordination degree between urbanization and ecological environment

The degree of coupling coordination increased from 0.4064 in 2003 to 0.8601 in 2018, an increase of 0.4537 and an annual increase of 0.0284. The trend of the degree of coupling coordination shows a fluctuating, slowly rising trend. The coupling coordination degree type experienced the coupling coordination process of mild dissonance (2003-2006) - moderate coordination (2007-2008) - good coordination (2009-2018), and reached the maximum coupling coordination degree of 0.8601 in 2018, but there is still a certain gap from achieving high-quality coupling.

3.5 Analysis of the decoupling index between urbanization and ecological environment

From 2003 to 2018, the urbanization and ecological environment decoupling index mainly shows five types of decoupling states: strong decoupling, expansionary negative decoupling, weak decoupling, strong negative decoupling, and regressive decoupling. In terms of the proportion of time in the decoupling index, the strong decoupling is 35.71 %, the expansionary negative decoupling is 28.57 %, the weak decoupling is 21.43 %, and the strong negative decoupling is 21.43 %. The overall process alternates between four decoupled states, indicating that the urban development of Ordos is in a passive and unsustainable state for the ecological environment.

4. Conclusions and Suggestions

Based on the coupling degree model and decoupling theory, this paper analyzes the ecological environment response in the process of urbanization by taking Ordos as an example, and draws the following conclusions: Ecological environment is an important factor restricting the development of urbanization, ecological environment governance and protection is an important basis and guarantee for realizing high-quality development of urbanization, and the basic concept of urbanization development with ecological priority and green development must be established; the decoupling exponents mainly show four decoupling regimes: strong decoupling, expansive negative decoupling, weak decoupling, and strong negative decoupling. Urbanization and the ecological environment have been in a long-term evolution of mutual adaptation and change, with the rate of urbanization growing faster than the rate of resource consumption and discharge of pollutants, while the regional

ecological environment has not been effectively improved.

Ordos delves into ecological economic development models that are compatible with the carrying capacity of resources and the environment. The first is to strengthen the comprehensive management of the ecological environment, promote regional green development and speed up the construction of ecological protection barriers. We will jointly control water pollution in key river basins and strengthen cross-regional prevention and control of air pollution. The second is to optimize and adjust the industrial structure, change the economic development pattern, focus on ensuring a national energy security strategy, increase the utilization rate of energy and mineral resources, and promote industrial chain refinement and modernization. Third, vigorously introduce high-tech enterprises and research and development institutions, promote the upgrading of traditional industries and emerging industries in the region, promote the upgrading and development of traditional industries, vigorously develop emerging industries such as cultural tourism, and promote the integrated development of urban and rural economy and enhance the attractiveness of cities.

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