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The New Urbanization of Urban Agglomerations in the Yellow River Basin is Coupled and Coordinated with the Performance of Ecological and Environmental Welfare

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Abstract: The coordinated development of new urbanization and ecological environment welfare performance is a core requirement for ecological protection and high-quality development in the Yellow River Basin. As the core carrier of development in the basin, the level of coupling and coordination between these two systems in urban agglomerations directly determines the quality of the basin's development. This paper analyzes the coupling and coordination mechanism of the two systems, and builds an evaluation index system and a research method framework. Combined with the regional characteristics of urban agglomerations in the Yellow River Basin, it studies the temporal and spatial evolution, spatial correlation and dynamic evolution characteristics of their coupling and coordinated development, and puts forward targeted countermeasures. The study finds that the coupling and coordination of the two systems in the urban agglomerations of the Yellow River Basin shows a spatial differentiation with the upper reaches falling behind and the middle and lower reaches taking the lead. There are obvious positive spatial correlation and path dependence characteristics, and the radiation and driving effect of core cities has not been fully exerted. This paper provides theoretical support for the basin to resolve the contradiction between urbanization and ecological protection and realize coordinated development.

Keywords: Urban Agglomerations in the Yellow River Basin; New-Type Urbanization; Ecological Environment Welfare Performance; Coupling Coordination; Coordinated Development of Regions.

1. Introduction

The Yellow River Basin is a key ecological security barrier and a core economic development area in China, and its ecological protection and high-quality development have become a major national regional strategy. Urban agglomerations are the core carriers of population and industrial agglomeration in the basin. They are not only the main spatial form of new urbanization, but also the main areas bearing the pressure of the ecological environment. New urbanization focuses on the core of "people-oriented, green and low-carbon", while ecological environment welfare performance integrates environmental governance and people's wellbeing into a unified framework. The coupling and coordination of the two is the key to the high-quality development of the basin. At present, the development of urban agglomerations in the Yellow River Basin shows obvious regional differences: the upper reaches have fragile ecology, the middle reaches face slow industrial transformation, and the lower reaches suffer from uneven distribution of ecological welfare. Existing studies mostly focus on the dual coupling of urbanization and ecological environment, and lack comprehensive consideration of ecological environment welfare performance. This paper analyzes the coupling and coordination mechanism of the two, explores the coupling development characteristics of urban agglomerations in the Yellow River Basin, and puts forward differentiated countermeasures, providing theoretical support for the basin to resolve the contradiction between development and protection.

2. A Review of Domestic and International Research

Foreign research on the relationship between urbanization and ecological environment started early and formed a theoretical system with the Environmental Kuznets Curve as the core. Later studies incorporated welfare performance into ecological evaluation, pointing out that urbanization has both supportive and restrictive impacts on ecological environment welfare. Scholars also explore the coupling mechanism of the two at the scale of urban agglomerations and put forward development models such as compact cities and ecological cities. However, foreign research pays little attention to specific basins such as the Yellow River Basin, and the adaptability of the conclusions to the national conditions of China's basin development still needs to be verified.

Domestic relevant research has been continuously deepened with the advancement of national regional strategies, and the coupling and coordination of new urbanization and ecological environment has become a research hotspot. Scholars generally believe that there are obvious spatial differences in China's regional coupling levels. In the research on the Yellow River Basin, Cui et al. (2020) measured the temporal and spatial coupling characteristics of the basin's ecological environment and high-quality development, and found that its coupling level presented a gradient differentiation pattern. Fang (2020) and Ma et al. (2020) focused on the spatial pattern and high-quality development of urban agglomerations in the basin, confirming that urban agglomerations are the core carriers of basin development. Gong et al. (2024) and Shi et al. (2021) explored the coupling and coordination relationship between new urbanization and ecological environment in the Yellow River Basin, revealing their temporal and spatial

differentiation characteristics. Han et al. (2023) and Sun et al. (2026) also incorporated rural revitalization into the coupling framework, enriching the research dimensions of basin coordinated development.

At the same time, the evaluation of ecological environment welfare performance and the methods of coupling models have been constantly improved. Xiang et al. (2024) constructed an evaluation system for the development quality of new urbanization, and Wang et al. (2021) corrected the application misunderstandings of the coupling coordination degree model, providing methodological support for coupling research. However, there are still deficiencies in existing studies. First, there is insufficient attention to the ecological environment welfare performance of the Yellow River Basin, and there is no in-depth coupling analysis between it and new urbanization. Second, most studies focus on a single urban agglomeration or local areas, and the research on the spatial correlation and dynamic evolution laws of the coupling development of urban agglomerations in the whole basin is not systematic. Third, the research on the radiation and driving effect of core cities is insufficient, which is difficult to support the practice of cross-regional coordinated development in the basin. In addition, although Guo (2023) and Si (2020) carried out research from the perspectives of carbon emissions and environmental regulation, they have not formed a complete research system for the coupling of ecological environment welfare performance and new urbanization, and relevant research still needs to be further deepened.

3. The Coupling and Coordination Mechanism of New Urbanization and Ecological Environment Welfare Performance

New urbanization and ecological environment welfare performance form a complex system of mutual promotion and restriction, and form a dynamic coupling relationship through factor flow, policy regulation and industrial interaction. Systematicness, spatiality and dynamics are its core characteristics. New urbanization has dual driving and restrictive effects on ecological environment welfare performance from five dimensions: economy, society, ecology, population and space. The driving effect is reflected in providing financial and technical support for ecological governance through industrial optimization and technological innovation, improving the supply efficiency of environmental welfare by perfecting infrastructure, and optimizing resource allocation through agglomeration. The restrictive effect comes from unreasonable development models, such as the asynchrony between rapid population agglomeration and infrastructure construction, the heavy industrial structure of some urban agglomerations, and the uneven supply of urban and rural public services.

Ecological environment welfare performance is an important foundation and restrictive condition for the high-quality advancement of new urbanization. Good ecological environment welfare can improve living quality, enhance the attraction of cities to population and industries, promote the green transformation of industries and boost urban-rural integration. At the same time, its improvement forces urbanization to abandon the scale-expansion mode and turn to green and intensive development, and promote the integration of urban and rural ecological infrastructure. On the contrary, low ecological welfare performance will restrict urban carrying capacity, aggravate the contradiction between environment and economic development, and hinder the sustainable progress of urbanization.

4. The Research Design Framework of Coupling and Coordinated Development in Urban Agglomerations of the Yellow River Basin

The Yellow River Basin mainly includes seven urban agglomerations, namely Lanzhou-Xining, Ningxia Yellow River Coast, Hohhot-Baotou-Ordos-Yulin, Jinzhong, Guanzhong Plain, Zhongyuan and Shandong Peninsula. According to hydrological characteristics, it is divided into three major regions: the upper reaches, the middle reaches and the lower reaches. The upper reaches have fragile ecology and a weak foundation for urbanization. The middle reaches have a high proportion of resource-based industries and great pressure of ecological governance. The lower reaches have a solid economic foundation and a high level of urbanization, being the core growth pole of the basin's development. The differences in natural endowments and development foundations of the three regions determine the regional characteristics of coupling and coordination between the two systems.

Following the principles of systematicness, scientificity and pertinence, this paper builds a multi-dimensional evaluation index system for the two systems. The index system of new urbanization is set around the five core connotations of "population, economy, society, ecology and space". The index system of ecological environment welfare performance is constructed around the four dimensions of "environmental welfare, ecological welfare, governance welfare and people's wellbeing welfare", which fully reflects the regional characteristics of the basin such as the large urban-rural gap.

This paper adopts three core research methods, which form a complete and mutually supportive method system. The Improved Entropy Method avoids subjective interference through objective weight assignment and enhances the dynamic adaptability of weights by introducing time variables. The Revised Coupling Coordination Degree Model optimizes the traditional formula, solves the problems of uneven distribution and insufficient discrimination of coupling degree, and quantifies the interaction degree and coordination level of the two systems. Spatial Autocorrelation Analysis includes global and local analysis, which can judge the overall spatial agglomeration effect and identify different agglomeration types, thus accurately locating the spatial highlands and depressions of coupling development.

5. The Theoretical Characteristics of Coupling and Coordinated Development in Urban Agglomerations of the Yellow River Basin

5.1. Temporal and Spatial Evolution Characteristics: Coexistence of Fluctuating Improvement and Gradient Differentiation

In the temporal dimension, the overall coupling and coordination level shows a fluctuating upward trend. With the advancement of relevant national strategies, each urban agglomeration has optimized its development mode and increased investment in ecological governance. The coordination of the two systems has been enhanced, and the coordination level has evolved from imbalance to coordination. However, affected by factors such as industrial transformation, policy connection and external shocks, the improvement process is nonlinear with a slight decline in some stages.

In the spatial dimension, there is a gradient differentiation decreasing from east to west, with the obvious characteristic that the upper reaches fall behind and the middle and lower reaches take the lead. The Shandong Peninsula and Zhongyuan urban agglomerations in the lower reaches rank first in the basin in coupling level due to their economic and governance advantages. The Jinzhong and Guanzhong Plain urban agglomerations in the middle reaches have a medium coordination level and insufficient stability due to the restriction of resource-based industries. The Lanzhou-Xining and Ningxia Yellow River Coast urban agglomerations in the upper reaches have a long-term low coupling level because of fragile ecology and weak foundation. At the same time, the strengthening of cross-regional cooperation in the basin has continuously reduced the scope of unbalanced areas, and a coordinated development pattern is gradually taking shape.

5.2. Spatial Correlation Characteristics: Obvious Positive Spatial Correlation and Polar Agglomeration

The coupling coordination degree has a significant positive global spatial correlation. Urban agglomerations with high coordination level are adjacent to high-value areas, and low-value areas agglomerate with each other. This is due to the regional correlation of natural endowments and industrial structures in the basin and the spatial flow of factors. However, restricted by administrative and development barriers, the efficiency of cross-regional factor flow is not high, which limits the improvement of spatial agglomeration effect.

The local spatial correlation presents a polar agglomeration pattern, with "high-high" and "low-low" as the main agglomeration types, and "high-low" and "low-high" distributed sporadically. The "high-high" agglomeration area is stably located in the Shandong Peninsula Urban Agglomeration in the lower reaches, with a significant radiation and driving effect of core cities. The "low-low" agglomeration area is mainly located in the Lanzhou-Xining Urban Agglomeration in the upper reaches and some areas of the Guanzhong Plain, with fragile ecology and insufficient radiation of core cities. The "high-low" agglomeration areas are mostly core cities of urban agglomerations, with a high level themselves but lagging surrounding areas. The "low-high" agglomeration areas are very few, reflecting the insufficient ability of low-value areas to undertake factors from high-value areas.

5.3. Dynamic Evolution Characteristics: Obvious Path Dependence and Club Convergence

The coupling and coordinated development has obvious path dependence characteristics. Each urban agglomeration has a high probability of maintaining its own development state, and it is difficult to achieve cross-level leaps. This is because coupling development is restricted by factors such as development foundation and industrial structure, and the adjustment of development mode requires long-term policy support and factor accumulation.

At the same time, there is a phenomenon of club convergence. Urban agglomerations at different coordination levels form their own development clubs, and the gap between high and low levels is difficult to narrow quickly. The high-value areas in the lower reaches form a positive cycle of "high-quality urbanization development - ecological welfare improvement", while the low-value areas in the upper reaches fall into a low-level cycle of "lagging urbanization - low ecological welfare". In addition, the development level of surrounding urban agglomerations has a significant impact on the local area. Areas around high-value areas are likely to improve their development level through factor flow and technological diffusion, while areas around low-value areas will strengthen club convergence.

6. Conclusion

The coupling and coordinated development of new-type urbanization and ecological environment welfare performance is a core task for the high-quality development of the Yellow River Basin. The two interactive systems form a complex relationship of mutual promotion and restriction, with significant dual effects. Their core coupling features lie in systematicness, spatial heterogeneity, and dynamic evolution.

Overall, the coupling coordination level of the two systems in the Yellow River Basin's urban agglomerations has risen with fluctuations. It shows a clear east-to-west gradient decline—upper reaches lagging, and middle/lower reaches leading. The coupling coordination degree features significant positive spatial correlation, forming "high-high" and "low-low" polar agglomerations. However, the radiation and driving effects of core cities remain underutilized. Meanwhile, the coupled development shows obvious path dependence and club convergence, making cross-level leaps difficult for each urban agglomeration.

To promote their high-quality coupling and coordinated development, policies should align with the Yellow River Basin's regional characteristics: implementing differentiated strategies for upper, middle, and lower reaches; comprehensively strengthening ecological environment welfare supply; breaking spatial barriers to advance cross-regional collaboration; and establishing long-term mechanisms to escape low-level path dependence. Future research can combine empirical data to quantitatively identify key influencing factors of coupling coordination, and explore effective ways to enhance core cities' radiation effects. These efforts will provide more precise theoretical and practical

support for the coordinated development of urban agglomerations in the Yellow River Basin.

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