Rural Restructuring Characteristics and Problem Area Identification in Agro-Pastoral Regions of Northern China: A Case Study of the Inner Mongolia Section of the Yellow River Basin (Post-print)

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Abstract

Scientific and orderly reconstruction constitutes an important pathway for modernizing agricultural and pastoral areas and achieving national rural revitalization. This study selects the Inner Mongolia section of the Yellow River Basin—a typical northern agricultural-pastoral region—and employs rural development indicators and econometric models to investigate the characteristics of rural reconstruction and identify problematic areas. The findings indicate: (1) From 1990 to 2020, all dimensions of rural development in the study area exhibited varying degrees of improvement, with the overall hierarchy being economic development > spatial utilization > social development. (2) During 1990–2020, rural economic reconstruction in the study area initially intensified before weakening, spatial reconstruction consistently strengthened, while social reconstruction remained overall lagging. The comprehensive rural reconstruction demonstrated a general pattern of higher in the south and lower in the north, higher in the east and lower in the west. Economic reconstruction displayed relatively minor regional disparities; social reconstruction showed a south-high, north-low pattern; spatial reconstruction was particularly pronounced in the Hetao Plain. The coupling and coordination degrees of rural economic-social-spatial reconstruction from 1990 to 2020 first increased then decreased, manifesting an east-high, west-low spatial distribution. (3) Problematic counties for rural development and reconstruction totaled 11 counties across 6 categories, distributed to the west of the Yellow River and north of the Yinshan Mountains within the study area, reflecting the combined effects of interacting factors including geographical environment, resource endowments, location and transportation, economic foundations, and regional policies, necessitating targeted policy measures based on local conditions.

Full Text

Abstract

Scientific and orderly restructuring represents a crucial pathway toward modernization in agro-pastoral areas and national rural revitalization. This study examines the Inner Mongolia section of the Yellow River Basin—a typical northern agro-pastoral region—to investigate rural restructuring characteristics and identify problematic areas using rural development indicators and econometric models. Results indicate that: (1) From 1990 to 2020, all dimensions of rural development in the study area improved to varying degrees, with economic development consistently outpacing spatial utilization and social development. (2) During this period, the economic restructuring intensity in the study area first increased then decreased, spatial restructuring intensity continued to strengthen, while social restructuring lagged considerably. The comprehensive restructuring pattern showed higher intensity in the south and east, lower in the north and west. Economic restructuring exhibited relatively minor spatial variation, whereas social restructuring displayed a clear north-south gradient (higher in the south, lower in the north). Spatial restructuring was particularly intense in the Hetao Plain region. The coupling and coordination degrees between economic, social, and spatial restructuring initially rose then fell, with higher coordination in eastern areas and lower coordination in western areas. (3) The study identified 11 counties classified as problematic areas, primarily distributed west of the Yellow River and north of the Yinshan Mountains. These areas reflect the combined effects of geographical environment, resource endowments, location and transportation, economic foundations, and regional policies, requiring targeted strategies based on local conditions.

Keywords: rural development level; rural restructuring; coupling coordination degree; Inner Mongolia section of the Yellow River Basin

1 Study Area Overview

The Inner Mongolia section of the Yellow River Basin is located in central-western Inner Mongolia, bordered by Gansu Province to the west, Shaanxi Province and Ningxia Hui Autonomous Region to the south, Xilingol League of Inner Mongolia to the east, and Mongolia to the north (Fig. 1). Covering a land area of 52.3$\times10^{4}$ km^2 (52.3% of Inner Mongolia's total), it includes all counties of Wuhai, Bayannur, Ordos, Baotou, and Hohhot cities, plus portions of Alxa League and Ulanqab City, comprising 42 counties (banners, districts) in total. The region features a temperate continental climate with abundant sunlight and heat but limited precipitation. The Yellow River's main channel runs east-west through the area, which contains diverse landforms including alluvial plains, mountains, hills, and plateaus, with widespread distribution of cropland, grassland, forestland, and desert. Rich in fossil energy resources (coal, petroleum) and mineral resources (iron, rare earths), these unique natural conditions have long fostered diverse rural spatial patterns of agriculture, pastoralism,

and agro-pastoral mixed systems.

In 2020, the region's GDP reached 76.3% of Inner Mongolia's total, with per capita GDP of 44.2% above the provincial average. Rural residents' per capita net income was 11.9% higher than the provincial average. County-level rural transformation and restructuring serve as crucial fulcrums for advancing the rural revitalization strategy and represent primary arenas for urban-rural integration. Therefore, this analysis employs counties as the basic unit. Based on 2020 administrative divisions and excluding municipal districts, the study encompasses 35 counties (banners).

2.1 Data Sources

This research examines spatiotemporal evolution patterns of rural development and restructuring in a typical northern agro-pastoral region from 1990 to 2020, with 1990, 2000, 2010, and 2020 as temporal breakpoints. Data sources fall into two categories: socioeconomic data reflecting rural development and restructuring indicators, and land use data for the same indicators. Socioeconomic data were obtained directly from the *China Statistical Yearbook for Regional Economy* (1991–2021) and *Inner Mongolia Statistical Yearbook* (1991–2021). Land use data, derived from Landsat TM/ETM remote sensing imagery interpreted by the Resources and Environmental Science Data Center of the Chinese Academy of Sciences (http://www.resdc.cn/), have a 30 m resolution. To eliminate price fluctuation effects, all economic data were converted to 1990 constant prices.

2.2.1 Rural Development Level

Rural development level reflects the state of rural development at a given time point and forms the basis for analyzing rural restructuring processes. Based on the connotation of rural restructuring, this study first constructs a rural development indicator system for northern agro-pastoral areas encompassing three dimensions—economic development, social development, and spatial utilization—aligned with local economic and social development planning objectives. Following existing research and considering indicator comparability, conciseness, and data availability, the study uses agro-pastoral economic level, agro-pastoral structure ratio, and farmer-herder income level to reflect rural economic development; agro-pastoral population ratio, road network density, communication facility level, and medical-sanitary conditions to reflect social development; and cropland use efficiency, grassland grazing intensity, rural settlement use efficiency, and ecological space optimization to reflect "production-living-ecological" spatial utilization status. Specific indicators and calculations are detailed in Table 1. Notably, due to the "vast territory with sparse population" characteristics of Alxa Left Banner, Wulate Rear Banner, and Wulate Middle Banner in the study area—which differ significantly from the population and economic agglomeration features

of the Hohhot-Baotou-Ordos urban agglomeration—this study considers it more reasonable to measure regional development differences using "total amount" rather than "per capita" for certain economic and social indicators. The Entropy Weight TOPSIS model, suitable for multi-indicator objective comprehensive evaluation, was employed to assess rural economic development level [RDL(e)], social development level [RDL(so)], spatial utilization level [RDL(sp)], and comprehensive development level (RDL = [RDL(e) + RDL(so) + RDL(sp)]/3) for each county in 1990, 2000, 2010, and 2020.

2.2.2 Rural Restructuring Intensity

Whether restructuring occurs within a certain period and its degree can be measured by comparing rural development levels at the beginning (T_1) and end (T_2) of the study period, with the degree of change representing rural restructuring intensity. This study calculates restructuring intensity using changes in each indicator within the rural development indicator system across study periods. For positive indicators (x), if $x(T_2)/x(T_1) > 1$, restructuring is considered to have occurred and intensity is calculated using the actual ratio; if $x(T_2)/x(T_1) \leq 1$, no restructuring is considered to have occurred and the value is recorded as 1. For negative indicators, the opposite applies. Using the Entropy Weight TOPSIS model, the study measures rural economic restructuring intensity [RRD(e)], social restructuring intensity [RRD(so)], spatial restructuring intensity [RRD(sp)], and comprehensive restructuring intensity (RRD = [RRD(e) + RRD(so) + RRD(sp)]/3) for different periods.

2.2.3 Coupling Coordination Degree of Rural Economic-Social-Spatial Restructuring

Based on restructuring intensity calculations, the coupling coordination degree model evaluates the coupling and coordination state among economic, social, and spatial restructuring. To avoid division-by-zero errors in coupling coordination calculations, the following formula is applied:

$$C = 2 \times [RRD(e) \times RRD(so) + RRD(so) \times RRD(sp) + RRD(e) \times RRD(sp)] / [RRD(e) + RRD(so) + RRD(sp)]^2$$

where C is the coupling degree ($0 \leq C \leq 1$), with higher values indicating stronger coupling.

Since coupling degree alone cannot reflect coordination levels, the coordination degree is calculated as:

$$D = \sqrt{(C \times RRD)}$$

where D is the coordination degree and RRD is the comprehensive restructuring intensity.

3.1 Spatiotemporal Characteristics of Rural Development Level

From 1990 to 2020, comprehensive rural development in the Inner Mongolia section of the Yellow River Basin evolved from low-level homogenization to higher-level heterogenization (Table 2). Spatially, high-level areas in 1990 were concentrated in Alxa Left Banner, Bayannur municipal districts, and areas near the Hohhot-Baotou-Ordos urban agglomeration. By 2020, the overall level improved significantly, with high-level areas becoming more concentrated around Bayannur municipal districts and the Hohhot-Baotou-Ordos urban agglomeration (Fig. 2). Different dimensions exhibited distinct spatiotemporal evolution characteristics. Rural economic development level was generally high and improved rapidly, with county averages increasing from 0.17 in 1990 to 0.56 in 2020. High-level areas in 1990 were few, mainly concentrated in Jungar Banner and Otog Banner of Ordos City; by 2020, high-level areas expanded to Uxin Banner, Ejin Horo Banner, and Alxa Left Banner (Fig. 2a). This likely relates to abundant energy and mineral resources in these areas, forming industrial strong counties dominated by coal power generation and steel smelting. Simultaneously, Ordos City's extensive grasslands and pastures promoted light processing of agricultural and livestock products and grassland tourism industries.

Rural social development improved slowly and remained relatively lagging, with county averages increasing only from 0.17 in 1990 to 0.30 in 2020. In 1990, high-level areas were distributed in Alxa Left Banner, western Bayannur City, and some counties in Ulanqab City; by 2020, high-level areas gradually concentrated near Bayannur municipal districts and the Hohhot-Baotou-Ordos urban agglomeration, primarily due to accelerated urbanization during this period, which substantially reduced the proportion of rural population engaged in traditional agriculture and animal husbandry while improving rural infrastructure through urbanization's radiation effects (Fig. 2b).

Rural spatial utilization level increased steadily, but regional disparities gradually widened over time (Table 2). In 1990, high-level areas were mainly distributed in the Hetao Plain along the Yellow River and nearby regions; by 2020, high-level areas increased rapidly in Ordos City and Ulanqab City (Fig. 2c). The former benefits from flat terrain, abundant water resources, and favorable ecological conditions conducive to intensification and large-scale agricultural development, while the latter's large-scale resource development and secondary industry growth promoted residential space concentration.

3.2.1 Spatiotemporal Characteristics of Rural Restructuring Intensity

Overall characteristics: From 1990 to 2020, the average comprehensive restructuring intensity in the study area showed an initial increase followed by a decrease, with values of 1.17, 1.25, 1.27, and 1.19 across the four periods. Eco-

nomic restructuring intensity followed a similar pattern (1.16, 1.27, 1.29, 1.14), while spatial restructuring intensity increased continuously (1.15, 1.20, 1.25, 1.31), surpassing economic restructuring intensity after 2010. Social restructuring intensity remained consistently low (1.20, 1.27, 1.27, 1.12), reflecting weak rural infrastructure and inadequate social services (Table 3).

Spatial distribution characteristics: From 1990 to 2020, comprehensive restructuring exhibited a pattern of higher intensity in the south and east, lower in the north and west (Fig. 3). Temporally, high-value areas in the 1990s were mainly distributed along and north of the Yellow River; in the early 21st century, restructuring in Alxa Left Banner and Ordos City accelerated significantly, shifting high-value areas southward; after 2010, overall regional restructuring weakened, with high-value areas concentrating in southern Ulanqab City and Ordos City (Fig. 3d).

Economic restructuring intensity showed relatively minor spatial variation. In the 1990s, restructuring was stronger along the Yellow River and in parts of Ordos City; after 2000, overall restructuring intensity weakened while peripheral county restructuring increased (Fig. 3a), primarily due to urbanization's radiation effects.

Social restructuring intensity displayed a north-south gradient (higher in the south, lower in the north) (Fig. 3b). In the 1990s, restructuring was stronger north of the Yellow River; after 2000, the pattern reversed, with the most intense restructuring occurring in Ordos City counties, likely related to the local government's implementation of the Grain for Green Project and encouragement of family ranching in the early 21st century, which alleviated desertification and soil erosion while improving livestock production efficiency.

Spatial restructuring intensity was particularly strong in the Hetao Plain region, while Alxa Left Banner showed notably low restructuring (Fig. 3c). Temporally, spatial restructuring was stronger north of the Yellow River in the 1990s, but the pattern reversed after 2000.

3.2.2 Coupling Coordination Degree Analysis of Rural Economic-Social-Spatial Restructuring

The coupling and coordination among economic, social, and spatial restructuring is crucial for stable urban-rural transformation and regional coordinated development. From 1990 to 2020, the average coupling degree among the three dimensions was 0.98, 0.99, 0.99, and 0.98, while the average coordination degree was 1.07, 1.11, 1.12, and 1.09, respectively. Both coupling and coordination degrees showed an initial increase followed by a decrease (Table 3).

Spatially, the coupling and coordination degrees exhibited an east-west gradient (higher in the east, lower in the west) from 1990 to 2020. In the 1990s, high-value areas were distributed along the Yellow River and nearby regions; in the early 2000s, they gradually expanded to northern counties in Ordos, Bayan-

nur, Baotou, and Ulanqab cities; after 2010, coupling and coordination degrees weakened in some of these counties, particularly in Baotou City (Fig. 5), possibly related to recent economic transformation bottlenecks. Alxa Left Banner's coupling degree was below 0.90, approaching dissonance, while other counties maintained coupling degrees above 0.95, achieving barely coordinated, primary coordinated, or moderately coordinated states.

3.3 Problem Area Identification

Scientifically identifying and revealing problem areas is essential for refining regional policies. This study identifies problem areas based on 2020 rural development levels, 1990–2020 restructuring intensities, and coupling coordination degrees. Counties are classified as problematic if any measured value falls below "mean - 0.5 × standard deviation."

Results show six types of problem areas across 11 counties:

1. **Low economic development type** includes Siziwang Banner, Chahar Right Middle Banner, Liangcheng County in Ulanqab City, and Hangjin Rear Banner and Wuyuan County in Bayannur City. Siziwang Banner, Chahar Right Middle Banner, and Liangcheng County suffer from weak industrial foundations, insufficient productivity, and fragile ecological environments, leading to economic underdevelopment. Hangjin Rear Banner and Wuyuan County are constrained by excessive traditional agriculture and animal husbandry with lagging industrial upgrading.

2. **Low social development type** includes Darhan Muminggan Joint Banner, Siziwang Banner, Guyang County, and Wuchuan County, mostly concentrated in the remote northeastern part of the study area with weak urbanization effects. These areas have high proportions of agricultural-pastoral populations and weak infrastructure. In 2020, rural population proportions in Guyang and Wuchuan counties reached 61.2% and 57.3%, respectively, while communication facility levels in Darhan Muminggan Joint Banner and Siziwang Banner were only 40.2% and 42.5% of the study area average.

3. **Low spatial utilization type** includes Alxa Left Banner, Wulate Middle Banner, and Darhan Muminggan Joint Banner. Wulate Middle Banner and Darhan Muminggan Joint Banner primarily show low utilization of grazing space, while Alxa Left Banner suffers from insufficient green ecological space, with its 2020 Normalized Difference Vegetation Index (NDVI) at 0.21, the lowest in the study area, related to its extensive deserts, Gobi, desert grasslands, and arid climate.

4. **Social restructuring lag type** includes Alxa Left Banner, Guyang County, and Zhuozi County. Alxa Left Banner shows low restructuring of rural population, while Guyang and Zhuozi counties reflect slow updating of facility support, likely due to their agriculture-pastoral dominated in-

dustries and slow economic development that weakens social service and facility improvements.

5. **Spatial restructuring lag type** includes only Alxa Left Banner. According to field investigations, aside from relatively strong farming space restructuring in 2020, grazing, ecological, and living space restructuring in Alxa Left Banner were all below the study area average, indicating insufficient development potential.

6. **Economic-social-spatial restructuring dissonance type** includes Alxa Left Banner and Guyang County. Alxa Left Banner's dissonance stems from lagging social and spatial restructuring (2020 intensities of 1.06 and 1.07, respectively), while Guyang County's dissonance relates to its lagging social restructuring (2020 intensity of 1.08).

In summary, problem areas in the Inner Mongolia section of the Yellow River Basin reflect the combined effects of geographical environment, resource endowments, location and transportation, economic foundations, and regional policies, revealing development and restructuring dilemmas faced by agro-pastoral areas with insufficient resource-environment carrying capacity, remote locations, and weak economic foundations during rapid industrialization, urbanization, and marketization. These 11 problematic counties, primarily distributed west of the Yellow River and north of the Yinshan Mountains (Fig. 6), include both single-type and multiple-type overlapping issues.

4 Discussion

Against the backdrop of China's comprehensive rural revitalization strategy, scientifically guiding rural modernization and restructuring in typical northern agro-pastoral areas is vital for maintaining national food and ecological security. This case study of the Inner Mongolia Yellow River Basin section provides important references for ecological, production, and living coordination and related planning practices in the Yellow River Basin. Compared with existing rural restructuring research, this study expands the distinctive agro-pastoral region type, with spatial restructuring indicators fully incorporating regional characteristics and analyzing from the "production-living-ecological" space perspective.

This study reveals the nonlinear complex development process of rural restructuring, consistent with existing research conclusions. However, the changing trends of economic and spatial restructuring intensity differ slightly from other studies, possibly because the relationship between economic development and ecological protection in northern agro-pastoral areas is more complex and mutually constraining than in traditional agricultural regions. For instance, grassland grazing must balance economic benefits with ecological conservation. The ecological consequences of excessively rapid early economic development often compel relevant actors to balance and compensate through strengthened spatial

governance and slowed economic growth in later stages, potentially creating seesaw effects. This aligns with Li et al.'s research findings.

Data limitations prevented the inclusion of culture and organizational governance in the rural development and restructuring indicator system, which should be supplemented in future research. Additionally, this study uses counties as the unit of analysis, which is relatively macro-scale; future research could explore micro-scales such as towns and villages.

5.1 Conclusions

This study measured county-level rural development levels, restructuring intensities, and their coupling coordination degrees in the Inner Mongolia section of the Yellow River Basin from 1990 to 2020, and identified problem areas. Main conclusions are:

1. Rural comprehensive development evolved from low-level homogenization to higher-level heterogenization, with economic development levels high and improving rapidly, social development improving slowly and lagging relatively, and spatial utilization levels increasing steadily but with widening regional gaps. Different dimensions showed distinct spatial evolution characteristics over time.

2. Economic and comprehensive restructuring intensities experienced a nonlinear evolution of initial strengthening followed by weakening. Spatial restructuring intensity increased continuously throughout the study period, surpassing economic restructuring in later stages, while social restructuring lagged overall. Comprehensive restructuring showed a pattern of higher intensity in the south and east, lower in the north and west. Economic restructuring had relatively minor spatial variation, social restructuring showed a north-south gradient, and spatial restructuring was particularly intense in the Hetao Plain. The coupling and coordination degrees among economic, social, and spatial restructuring initially increased then decreased, showing an east-west gradient.

3. The study area contains 11 counties with rural development and restructuring problems, mainly distributed west of the Yellow River and north of the Yinshan Mountains. These areas reflect the comprehensive impacts of interacting factors including geographical environment, resource conditions, location and transportation, economic foundations, and regional policies.

5.2 Recommendations

Problem areas in the Inner Mongolia Yellow River Basin section concern the modernization of northern agro-pastoral areas, high-quality Yellow River Basin development, and comprehensive national rural revitalization. Targeted strategies based on local conditions and problem types are essential:

1. **Low economic development type:** Continuously leverage traditional agro-pastoral production advantages by introducing agricultural product industry chains, developing deep processing of agricultural and livestock products in conjunction with industrial parks, and creating regional specialty brands. For counties with fragile ecological environments and weak economic foundations, actively cultivate ecological and clean industries such as grassland tourism services, wind power, and photovoltaic generation while maintaining ecological balance.
2. **Low social development type and social restructuring lag type:** Address both facilities and population. For counties with weak facility support, emphasize the important role of county towns in regional economic and social development, strengthen fiscal support for public infrastructure in education, healthcare, culture, and transportation, or introduce investment projects through public-private partnerships. For counties with large rural population proportions and slow urbanization, strengthen secondary and tertiary industries and urban construction to expand employment opportunities, while improving transportation to enhance urban-rural connectivity.
3. **Low spatial utilization type and spatial restructuring lag type:** Focus on "production-living-ecological" spaces. Strengthen ecological governance through Grain for Green and afforestation projects to mitigate soil erosion and desertification. For living spaces, moderately promote concentrated residence based on local geography and ethnic cultures. For production spaces, actively promote land transfer to facilitate large-scale cropland utilization while adhering to rotational grazing and grass-livestock balance, improving ecological compensation mechanisms, and encouraging stall-feeding and semi-stall-feeding to enhance livestock production specialization.
4. **Economic-social-spatial restructuring dissonance type:** Counties should prioritize coordinating economic development and spatial utilization while strengthening mutual feedback between economic and social development. For the former, coordinate agro-pastoral transformation with cropland and grassland use, including reasonable transfer and consolidation of idle farmland, rotational grazing, and grassland tourism development, while strengthening integration between secondary industry development and residential spaces to improve supporting facilities and enhance land multifunctionality. For the latter, guide industrial agglomeration to drive facility construction and improve economic benefits through market-oriented operations.

References

[1] Long Hualou, Tu Shuangshuang. Theoretical thinking of rural restructuring[J]. Progress in Geography, 2018, 37(5): 581-590.

[2] Long Hualou, Tu Shuangshuang. Rural restructuring: Theory, approach and research prospect[J]. Acta Geographica Sinica, 2017, 72(4): 563-576.

[3] Li Fanrong. Rural revitalization and rural functional optimization and transformation in China[J]. Scientia Geographica Sinica, 2021, 41(12): 2158-2167.

[4] Guo Yan, Tang Xinlei, Chen Kunlun, et al. Characteristics and influencing factors of spatial restructuring of rural settlements in Wuhan City[J]. Economic Geography, 2018, 38(10): 180-189.

[5] Yang Haijuan, Sun Laiding, Zhou Meijun, et al. Trade-off analyses of ecosystem services during the reconstruction of grain production space in Loess Plateau: A case of Yulin City[J]. Arid Land Geography, 2022, 45(1): 226-236.

[6] Tu Shuangshuang, Long Hualou, Zhang Yingnan, et al. Process and driving factors of rural restructuring in typical villages[J]. Acta Geographica Sinica, 2019, 74(2): 323-339.

[7] Ding Jianjun, Wang Zhang, Yu Fangwei, et al. Targeted poverty alleviation drives the process and mechanism of rural reconstruction: A case study of Shibadong Village[J]. Acta Geographica Sinica, 2021, 76(10): 2568-2584.

[8] Long Hualou, Tu Shuangshuang. Land use transition and rural vitalization[J]. China Land Science, 2018, 32(7): 1-6.

[9] Tu Shuangshuang, Zheng Yuhan, Long Hualou, et al. Spatio-temporal pattern of rural development and restructuring and regional path of rural vitalization in Guangxi, China[J]. Acta Geographica Sinica, 2020, 75(2): 365-381.

[10] Xi Xuesong, Gao Jungang, Hao Yuanyuan, et al. The construction of the Yellow River ecological belt from a multi-dimensional composite spatial perspective: A case study of Yellow River Basin within Inner Mongolia[J]. Journal of Natural Resources, 2023, 38(3): 721-741.

[11] Department of Ecological Environment of Inner Mongolia Autonomous Region. Ecological protection and high-quality development planning of the Yellow River Basin in the Inner Mongolia Autonomous Region[EB/OL]. [2022-03-01]. https://sthjt.nmg.gov.cn/sthjdt/ztzl/zyhjbhdczg/zcwj_{7840}/202203/t20220301_{2011133}.html.

[12] Huang Xianjin, Yin Haiwei, Li Shengfeng, et al. Comprehensive thematic study on territorial space planning and guidelines on space control of the Yellow River Basin in the Inner Mongolia Autonomous Region[R]. Nanjing: Nanjing University, 2021.

[13] Liu Tao, Zhuo Yunxia, Peng Rongxi, et al. Urbanization and the regional types evolution of China's rural population change from 1990 to 2020[J]. Acta Geographica Sinica, 2022, 77(12): 3006-3022.

[14] Long Hualou. Land consolidation and rural spatial restructuring[J]. Acta Geographica Sinica, 2013, 68(8): 1019-1028.

[15] Zhang Yida, Liu Xuelu, Fan Yahong, et al. Multi-functional evaluation on land use in Lanzhou City based on the improved TOPSIS method[J]. Arid Land Geography, 2019, 42(2): 444-451.

[16] Li Hengji, Qu Jiansheng, Pang Jiaxing, et al. Spatial-temporal synthetic measurement of coupling coordination and sustainable development of population-economy-society-resource-environment system in Gansu Province[J]. Arid Land Geography, 2020, 43(6): 1622-1634.

[17] Zhang Jie, Qin Fucang. Spatial distribution pattern and driving mechanism of desertification land in Alxa Zuoqi from 2009 to 2017[J]. Research of Soil and Water Conservation, 2020, 27(6): 174-179.

[18] Li Wenlong, Kuang Wenhui, Lü Jun, et al. Adaptive evolution mechanism of rural human-land system in farming-pastoral ecotone of northern China: Taking Damao Banner, Inner Mongolia as an example[J]. Acta Geographica Sinica, 2021, 76(2): 487-502.

[19] Liu Hehe, Qi Xiaohui, Qiao Guanghua, et al. Empirical research on the development planning of agriculture and animal husbandry industry in farming-pastoral ecotone counties: Taking Huade County, Inner Mongolia as an example[J]. Chinese Journal of Agricultural Resources and Regional Planning, 2022, 43(5): 113-121.

[20] Zhang Xuegang. Thinking on promoting construction of new infrastructure in Inner Mongolia[J]. Northern Economy, 2020(4): 21-25.

[21] Nelson P B. Rural restructuring in the American West: Land use, family and class discourses[J]. Journal of Rural Studies, 2001, 17(4): 395-407.

[22] Woods M. Rural geography: Processes, responses and experiences in rural restructuring[M]. London: Sage, 2005: 299-304.

[23] Fink M, Lang R, Harm R. Local responses to global technological change: Contrasting restructuring practices in two rural communities in Austria[J]. Technological Forecasting and Social Change, 2013, 80(2): 243-252.

[24] Hedlund M, Lundholm E. Restructuring of rural Sweden: Employment transition and out-migration of three cohorts born 1945—1980[J]. Journal of Rural Studies, 2015, 42: 123-132.

[25] Jain M, Korzhenevych A, Hecht R. Two decades of urban and rural restructuring in India: An empirical investigation along Delhi-Mumbai industrial corridor[J]. Habitat International, 2021, 117: 102444.

[26] Li Xinyu, Lu Aili. Discussion on comprehensive exploration and utilization of energy in Ordos Basin[J]. Natural Resource Economics of China, 2005(2): 10-12, 46.

[27] Jia Baoquan, Sun Pengsen, Wang Guozhu, et al. Spatial pattern changes of landscape in Ordos Plateau: Taking the Yijinhuoluo County as an example[J]. Arid Land Geography, 2003, 26(3): 202-207.

[28] Feng Yanwei, Zhen Jianghong. Eco-spatial security optimization in watershed of the Yellow River in Inner Mongnolia[J]. Chinese Journal of Agricultural Resources and Regional Planning, 2022, 43(10): 129-138.

[29] Liu Yan, Yang Mian. Inspection on Erdos model from the perspective of ecological civilization[J]. Journal of Arid Land Resources and Environment, 2011, 25(7): 222-226.

[30] Wu Qinyu, Yao Xijun, Liang Jie, et al. Spatial and temporal intensity of vegetation cover improvement and degradation in coal mining areas of Erdos City[J]. Journal of Arid Land Resources and Environment, 2022, 36(8): 101-109.

[31] Ning Xiaoli, Yu Jiasheng. The predictive analytics of economic development level in Baotou City[J]. Journal of Arid Land Resources and Environment, 2016, 30(2): 45-50.

[32] Zhang Peifeng, Hu Yuanman, Zhao Minghua. Study on the action mechanism of economic development and eco-environment in Ulanqab City[J]. Journal of Arid Land Resources and Environment, 2010, 24(3): 6-12.

[33] Lobley M, Potter C. Agricultural change and restructuring: Recent evidence from a survey of agricultural households in England[J]. Journal of Rural Studies, 2004, 20(4): 499-510.

Note: Figure translations are in progress. See original paper for figures.