

Study on Spatial Evolution Characteristics and Model of Rural Settlements in Mountainous Area of Central Shandong

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Abstract: Based on the interpretation results of remote sensing images in central Shandong mountainous area from 2000 to 2020, this paper comprehensively uses the methods of rural settlement land dynamics, landscape pattern index, land use transfer matrix and principal component analysis to analyze the spatial evolution characteristics, influencing factors and change mode of rural settlement land in central Shandong mountainous area in the past 20 years. Conclusions: (1) the rural settlement land in Zhongshan District of Shandong Province shows a continuous expansion trend. With the evolution of time, the distribution density of rural settlement land patches continues to decline. In recent years, the effectiveness of rural settlement land planning and governance in Zhongshan District of Shandong Province is gradually prominent; From 2000 to 2020, the scale of rural settlement land in Zhongshan District of Shandong Province showed a trend of orderly improvement, and the settlement patch showed a spatial layout trend of "relocation integration". The temporal and spatial distribution differences of rural settlement land gradually became prominent, and the order and rationality of the layout gradually increased. (2) From 2000 to 2020, the spatial distribution and dynamic change potential of rural settlement land within different altitude levels in central Shandong mountainous area are different. The middle and low altitude area (18-246m) is the main distribution area of rural settlement land in the study area. With the evolution of time, the elevation level of rural settlement spatial distribution has increased slightly. (3) From 2000 to 2020, the mutual transformation trend between rural settlement land space and other land types in Zhongshan District of Shandong Province was obvious. The new rural settlement land was mainly transferred from flat cultivated land and widely distributed in all counties and regions in the central and southern part of the study area, while cultivated land and urban land were the primary and secondary transfer sources of rural settlement land. (4) The factors affecting the spatial evolution of rural settlements in Lushan District can be divided into two categories: regional economic development level factors and regional agricultural production status factors. With the evolution of time, the role of regional economic development level factors in the spatial evolution of rural settlements in Lushan District is gradually strengthened, while the

influence of regional agricultural production status factors is gradually weakened. (5) During the study period, there are significant differences in the spatial distribution and change of rural settlement land in Zhongshan District of Shandong Province, mainly showing five types of models: the fading impact of urbanization, the integration and relocation of ecological planning, the expansion caused by traffic trunk lines, the derivative of industrial transformation and stability.

Keywords: Rural settlements; Evolution characteristics; Influencing factors; Mode analysis; mountainous area of central Shandong

1. Introduction

Since the reform and development, with the development of social economy, the construction of rural areas in China has changed with each passing day and has made remarkable achievements. The scale, layout and form of rural settlement land have changed significantly. However, relevant studies have found that although the development speed of rural areas in China is amazing, its quality is not optimistic, and problems such as extensive and hollow rural land persist [1-3]. It is found that foreign scholars' research on rural settlement land mainly relies on 3S technology platform and uses mathematical methods such as change matrix to build a spatial model [4-6] to measure and monitor the spatial change of rural land. Domestic scholars mostly use maximum likelihood analysis and Ca simulation to analyze the characteristics, modes and stages of spatial change of rural settlement land. Based on the existing research findings, the research of domestic and foreign scholars is lack of analysis on the rural settlement land closely related to human activities in the rural land, and there is a lack of research on the mountainous area of central Shandong, which has distinctive regional and cultural characteristics and is the key area and key node in the ecological protection and high-quality development strategy of Shandong Province [7-10].

In view of this, this paper takes the rural settlement space under the "mountain water field" system in Zhongshan District of Shandong Province as the research object, analyzes the characteristics and mode of the evolution of rural settlement space in this area under the

collision and integration of agricultural civilization, industrial civilization and ecological civilization, and explores the evolution track of rural settlement space in this area under the joint influence and constraints of China's urbanization in the middle and late stage and the construction of ecological civilization, It is expected to provide reference for enriching the research theory of regional development and promoting the process of "Rural Revitalization" in the mountainous areas of central Shandong.

2. Study Area

The mountainous areas in central Shandong mainly include six cities and 19 counties in Shandong Province, namely, the south of Zibo City (Boshan District and Yiyuan County), the southwest of Weifang City (Linqu County), the south of Jinan City (Pingyin County, Changqing District, Licheng District, Laiwu district and Gangcheng District), most areas of Tai'an City (except Dongping county), the east of Linyi City (Yinan County, Yishui County, Mengyin County, Fei County and Pingyi County), and Jining City (Sishui county). As an important agricultural base, water conservation area and ecological barrier in Shandong Province, in the long-term development process, this area has become a key area and key node in the ecological protection and high-quality development strategy of Shandong Province, forming a "mountain water field" collaborative symbiotic natural and ecosystem. The distribution pattern, evolution characteristics, driving mechanism and optimization path of rural settlements have distinct regional and cultural characteristics [11].

3. Research Method

3.1. Dynamic Degree of Rural Settlement Land

The dynamic index of rural settlement land can reflect the proportion of the average annual new settlement land in the study unit in its own land area. The calculation formula is: $I = \frac{U_{ij}}{T_j \cdot TLA_i}$, where I is the change intensity index of settlement land [12].

3.2. Landscape Pattern Analysis

Referring to the research of scholars, combined with the development status of mountainous areas in central Shandong, starting from the scale and distribution of rural settlements, this paper selects indicators such as total patch number (NP), total patch area (CA) and patch density (PD) to analyze the landscape pattern of rural settlement land in Zhongshan District of Shandong from 2000 to 2020 [13].

3.3. Land Use Transfer Matrix

This study extracts the transfer matrix of land use types from 2000 to 2020, and analyzes the transformation relationship between land use types in different periods in central Shandong mountainous area. The formula is:

$$C_{ij} = \begin{bmatrix} C_{11} & C_{12} & \Lambda & C_{1n} \\ C_{21} & C_{22} & \Lambda & C_{2n} \\ M & M & M & M \\ C_{n1} & C_{n2} & \Lambda & C_{nn} \end{bmatrix}$$

Where C_{ij} refers to the space area of land use type J at the end of the study from the land use type i at the initial stage of the study [14].

3.4. Principal Component Analysis

Principal component analysis can simplify multiple indicators into a few comprehensive indicators from the internal structural relationship of the index system, reflect most of the information of the original index system as much as possible, ensure the mutual independence of the comprehensive indicators, and fully measure the impact of different driving factors on the temporal and spatial evolution of rural settlements [15]. The formula is:

$$F = \frac{\lambda_1}{\sum_{K=1}^p \lambda_K} F_1 + \frac{\lambda_2}{\sum_{K=1}^p \lambda_K} F_2 + \dots + \frac{\lambda_i}{\sum_{k=1}^p \lambda_k} F_i$$

4. Spatial Evolution Characteristics of Rural Settlements in Zhongshan District of Shandong Province

4.1 Study and Analyze the Spatial Evolution of Rural Settlements in the Whole Region

Based on the interpretation results of remote sensing images in Lushan District from 2000 to 2020, the scale and distribution characteristics of rural settlement land in Lushan District are extracted by GIS Technology (Fig1). It is found that with the evolution of time, the rural settlement land in Zhongshan District of Shandong province continues to expand, and the rural settlement land area from 2000 to 2020 is 1845.85km², 2130.65km² and 2176.11km². Over the past 20 years, the rural settlement land has expanded by 18%, with an average annual growth rate of 16.51km².

Based on the feature to point module in ArcGIS 10.3 software, the rural settlement land patches are transformed into vector points, and the spatial distribution density of rural settlement land in Lushan District from 2000 to 2020 is analyzed. It is found that the distribution density of rural settlement land patches in Lushan District continues to decline with time, from 6.07/km² in 2000 To 5.43/km² in 2020, and the decline is mainly concentrated in 2000-2010, which reflects the effectiveness of rural settlement land planning and governance in Zhongshan District of Shandong Province in recent years.

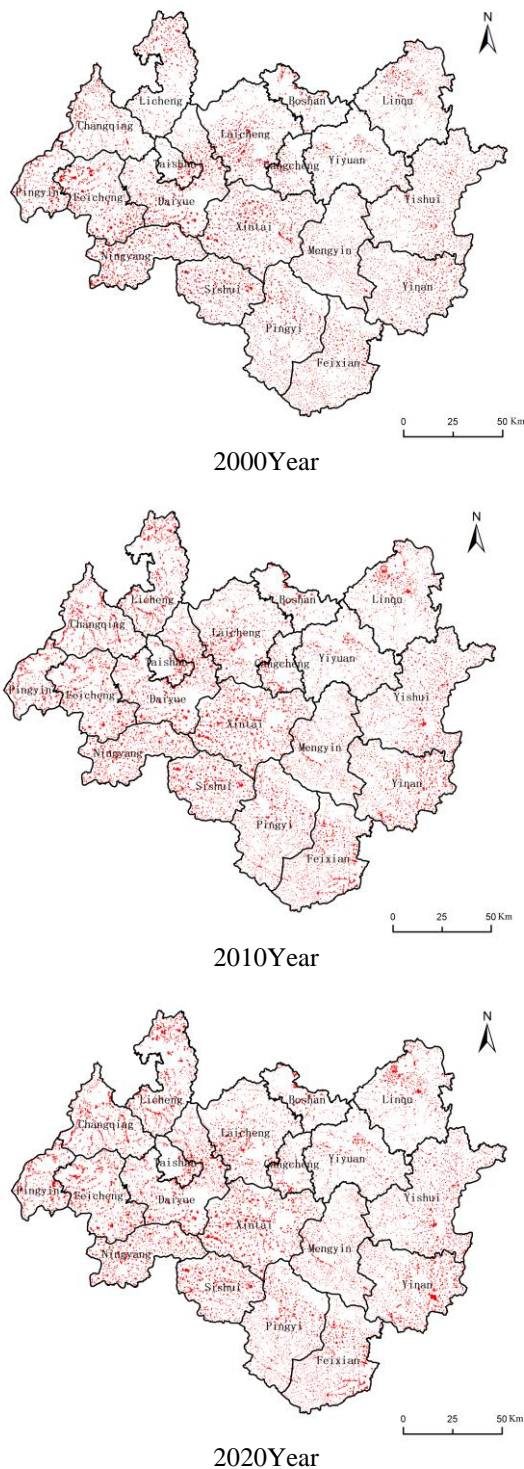


Figure 1. Distribution of rural settlement land in Zhongshan District of Shandong Province from 2000 to 2020

4.2 Analysis on Spatial Evolution of Rural Settlements at County Scale

Through comparison, it is found that with the evolution of time, the spatial differentiation of rural settlement land within each component unit in central Shandong mountain area has gradually become prominent. The spatial overlay analysis based on ArcGIS 10.3 extracts the spatial data of rural settlement land in

19 counties and urban areas of Zhongshan District of Shandong Province from 2000 to 2020. Discovery:

(1) From the perspective of land use scale, the overall scale of rural settlement land in counties and urban areas of Lushan District increased from 2000 to 2020, but the temporal and spatial differences in distribution and change are significant. During the study period, the scale of rural settlement land in Xintai City, Feicheng City, Daiyue district, Feicheng City, Yishui County, Yinan county and Fei County, which are located in the central and Western Tai'an section and the eastern Linyi section of the central Shandong mountainous area, is significantly higher, while the scale of rural settlement land in Taishan District, Boshan District and Gangcheng District, which are under the municipal jurisdiction, is significantly lower. In different periods, the change range of rural settlement land in the study area and regional differences are significant. From 2000 to 2010, the increase of settlement land in Licheng District, Changqing District, Xintai City, Yishui County, Yinan county and Fei County was significantly higher (> 20%), while the increase of rural settlement land in Taishan District, Boshan District, Yiyuan County and Pingyin County was significantly lower (< 5%). It is worth noting that the area of rural settlement land in Feicheng City and Ningyang County decreased during this period; Compared with the previous period, the growth rate of rural settlement land in the study area decreased significantly from 2010 to 2020, and the high-value areas are mainly concentrated in a few counties and regions such as Pingyin County, Feicheng City, Yinan county and Yiyuan County, which reflects that the implementation of policies such as new industrialization and Urban-Rural integration in recent years has changed the scale and structure of rural settlement land in Lushan District to a certain extent.

(2) In terms of distribution density, the spatial distribution density of rural settlements in Linyi section in the southeast of central Shandong mountainous area during the study period was continuously higher than that in other counties, which also reflected the high degree of fragmentation of the spatial distribution of rural settlements in Linyi section of Zhongshan District from 2000 to 2020. With the evolution of time, the spatial distribution density of rural settlements in various counties in the mountainous area of central Shandong is significantly different. From 2000 to 2010, the spatial distribution density of rural settlements in Boshan District, Ningyang County, Feicheng City, Laicheng district and Yiyuan County in the central and western part of the study area increased, while that in other counties and regions decreased, especially in Linyi section in the East and south; In contrast, from 2010 to 2020, the spatial distribution density of rural settlements in all counties and urban areas of the study area decreased as a whole and the variation range was lower than that from 2000 to 2010. The high-value areas with decreased density were scattered in a few counties and regions such as Feicheng City, Pingyin County and Yinan county.

To sum up, it is found that from 2000 to 2020, with the development of "Rural Revitalization" and Urban-Rural Coordination and integration, the scale of rural settlement land in Lushan District showed a trend of orderly improvement, the settlement patch showed a trend of "relocation integration" spatial layout, the temporal and spatial distribution difference of rural settlement land gradually became prominent, and the order and rationality of the layout also gradually increased.

4.3 Analysis of Spatial Evolution of Rural Settlements based on Topographic Differences

As a typical mountainous area, topographic factors have a significant impact on the distribution and change of rural settlement land in the study area. Based on DEM data with 30m resolution in central Shandong mountain area, arcgis10.0 is used. The elevation of the mountainous area in central Shandong is divided into four categories and superimposed with the patches of rural settlement land from 2000 to 2020. The distribution and change of rural settlement land at different elevation levels can be calculated.

From 2000 to 2020, the spatial distribution and dynamic change potential of rural settlement land within different altitude levels in Zhongshan District of Shandong Province were different. The middle and low altitude area (18-246m) was the main distribution area of rural settlement land in the study area. With the evolution of time, the altitude level of rural settlement spatial distribution increased slightly; In addition to the areas with an altitude of 18-146 meters, the patch fragmentation of rural settlement land within each altitude level is also gradually increasing.

In 2000, the rural settlement land in Zhongshan District of Shandong Province was mainly distributed in the middle and low altitude range of 18-246m, accounting for more than 85% of the total area of rural settlement land in the study area. In comparison, the distribution scale of rural settlement land in the middle and high altitude range of 246-551m was small, accounting for 14.7%. During this period, the rural settlements in the high altitude area of 551m were relatively rare, accounting for only 0.1% of the total area of rural settlement land in Zhongshan District of Shandong Province. In 2010, the area distribution and scale of rural settlement land within various altitude levels in the mountainous area of central Shandong changed, and the altitude range of 18-246m is still the main distribution area of rural settlement land in the study area (81.9%); Compared with 2000, in the range of 18-146 meters above sea level, the area of rural settlement land and the number of patches have increased, but the proportion in the study area has decreased; The elevation grade range of 146-246m is the primary expansion area of rural settlement land area from 2000 to 2010, indicating that the spatial distribution and elevation of rural settlement land have increased as a whole from 2000 to 2010; In contrast, the 246-371m altitude area is the area with the most significant increase

in the proportion of rural settlement land area and patch number from 2000 to 2010. It is worth noting that the spatial distribution of rural settlements in the high altitude area is still significantly less. Similar to 2010, there are also significant topographic differences in the scale and distribution of rural settlement land in the study area in 2020. The area with an altitude of 18-246m is the main distribution area of rural settlement land, and more than 75% of the new rural settlement land is concentrated in the low altitude range of 18-146m, which reflects that the impact of mountain ecological protection and planning on the spatial distribution and location selection of rural settlements in this period is gradually prominent.

4.4 Analysis of Spatial Evolution of Rural Settlements based on Land use Transfer Matrix

In the process of rural settlement land change, it will inevitably occupy or transform into other types of land, which will lead to the change of the overall land use structure. In view of this, based on env5 2 and arcgis10 1 and other software, extract the land change information of central Shandong mountainous area from 2000 to 2020, calculate the land use transfer matrix in the research period, and then analyze the transformation trend of rural settlement land area and structure in central Shandong mountainous area.

From 2000 to 2020, the mutual transformation between rural settlement land space and other land types in Zhongshan District of Shandong Province was obvious. In the past 20 years, the changing area of rural settlement land in Lushan District has reached 1649.43km². The stable land area of rural settlement is 1186.2, indicating that the spatial change of rural settlement land in the study area is more active in this period. Among them, the new rural settlement land is mainly transferred from cultivated land with flat terrain, with an area and contribution rate of 826.91km² respectively and 83.54%, which are widely distributed in the central and southern counties of the study area; Under the guidance of rural planning and sustainable utilization, 86.12km² The conversion of grassland into rural settlement land is particularly significant in Linyi section in the east of the study area; The comparison shows that in the process of rural planning regulation and reconstruction, a small amount of urban land and forest land have been converted to rural settlement land, and their contribution rates to the new rural settlement land are basically the same, both about 3%. Such areas are mainly concentrated in Jinan and Tai'an sections in the Midwest of the study area; In comparison, the contribution rate of water and other land to the new rural settlement land is low, less than 1%.

By comparison, it is found that the transferred out area of rural settlement land in Zhongshan District of Shandong Province is lower than that newly added from 2000 to 2020, and the study area has 659.62km² in 20 years. Rural settlement land has been transferred to other land types, of which cultivated land is the primary transfer out source of rural settlement land (69.3%) and is mainly distributed in remote villages far away from the

urban area, which reflects that a series of problems caused by the "hollowing" and "centrifugation" of rural development in this region in recent years are gradually emerging; Urban land is the secondary transfer out source of rural settlement land (23.2%), which shows that the development of Urban-Rural Coordination and integration is gradually changing the form and scale of rural settlement land, and a considerable number of suburban villages are gradually turning into cities and towns; In contrast, the scale of rural settlement land transferred to forest land, grassland, water and other land during the study period is small, and the sum of the four accounts for less than 10% of the transfer out of rural settlement land.

Based on the above analysis, driven by rural revitalization, new rural construction and urban-rural coordinated and integrated development, the change of rural settlement land in Zhongshan District of Shandong Province showed a more active trend from 2000 to 2020, which also had a certain impact on the structural characteristics and form combination of land use in this area.

4.5 Analysis on Influencing Factors of Spatial Evolution of Rural Settlements

Combined with the development characteristics of mountainous areas in central Shandong and the research results of scholars, from the perspective of independence, comparability and hierarchy, this paper selects X1 gross national product (100 million yuan), X2 total social fixed asset investment (100 million yuan), X3 year-end balance of residents' savings deposits (100 million yuan), X4 total retail sales of social consumer goods (100 million yuan) and X5 urbanization rate (%) in mountainous areas in central Shandong from 2000 to 2020; X6 total output value of agriculture, forestry, animal husbandry and fishery (100 million yuan), X7 total output value of non-agricultural industries (100 million yuan), X8 per capita net income of farmers (yuan), and x9 total grain output (10000 tons); X10 total population (10000 people), X11 agricultural population (10000 people) and other 11 indicators, and build a principal component analysis model to analyze the influencing factors of the spatial evolution of rural settlements in Zhongshan District of Shandong [15].

Firstly, the data are standardized, and the common factors are extracted based on the eigenvalue. Based on SPSS statistics, it is found that the cumulative variance of the first two common factors has reached 87.21%, which can better explain all original variables, so two common factors are extracted. The correlation degree between the common factor and the original variable index is characterized by the factor load value. It is found that the first common factor has a large correlation with X1, X3, x4, X7 and X8, and the second common factor has a high correlation with x9, X10 and X11. Therefore, the factors affecting the spatial evolution of rural settlements in Lushan District can be attributed to two categories: regional economic development level factors and regional agricultural production status factors.

5. Analysis on Spatial Evolution Model of Rural Settlements in Zhongshan District of Shandong Province

Referring to the transformation characteristics between rural settlement space and other land types in Lushan District, and based on the spatial superposition function of ArcGIS software, this paper analyzes the spatial distribution vector map of rural settlement land in Lushan District from 2000 to 2020. It is found that there are significant differences in the temporal and spatial distribution and change of rural settlement land in Lushan District during the study period, mainly showing the types of fading impact of urbanization, integrated relocation of ecological planning, expansion caused by traffic trunk lines Industrial transformation, derivative type and stable type.

5.1 Regression of Urbanization Impact

Such areas are mainly distributed in the east-west direction in Pingyin County, Feicheng City and Gangcheng city in the central and western part of the study area. The main reason is that in recent years, driven by the strategy of becoming the capital of Jinan, the integration of Ji Lai and Ji Tai and other strategies, the urban land in this area has expanded significantly, the urbanization level has been continuously improved, and the occupation of rural settlement land is significant (the area from rural settlement land to urban land in the study area is mainly concentrated here), resulting in significant changes in the form, scale and function of rural settlement land in this area, And to a certain extent, it has led to the decline of rural settlement land in this area.

5.2 Integration and Relocation of Ecological Planning

Such areas are mainly scattered in counties and cities in Linyi section in the east of the study area and Changqing District and Licheng District of Jinan in the northwest. This is mainly affected by the planning strategies of Yimeng mountain ecological protection and the ecological protection and high-quality development of the Yellow River Basin. The rural settlement land space located in ecologically sensitive and vulnerable areas is integrated, optimized or relocated as a whole. The emergence of such areas can effectively reduce the human land conflict and contradiction, and promote the sustainable and high-quality development of rural settlement space in Lushan District.

5.3 Stable Type

This kind of area is mainly distributed in three counties and districts of Zibo section and Weifang section in the northeast of the study area. Compared with other counties and cities in Zhongshan District of Shandong Province, the stability of rural settlement land space in this area is stronger, the transformation between settlement space and other land types is relatively less, and the stability of land structure is stronger. The integration found that the main reason is that the region is located at the intersection of Shandong provincial capital urban agglomeration and Jiaodong Peninsula

urban agglomeration. The stability of the three industry structure is strong, and the change of farmers' livelihood is relatively small, which enhances the stability of rural settlement form and rural settlement space to a certain extent.

5.4 Extended Traffic Trunk Line

This kind of area is mainly distributed from northwest to Southeast in Licheng District to Xintai City. By comparison, it can be seen that this area is located along the Shandong section of Beijing Shanghai expressway. The construction of traffic trunk lines and the improvement of accessibility not only significantly enhance the location conditions of settlement spatial distribution, but also greatly change the distribution form and scale of rural settlements, and promote the expansion and spread of rural settlement space in this kind of area.

5.5 Industrial Transformation Derivative

Such areas are mainly distributed in Linyi section, Jinan section and southwest section of Tai'an City on the East and west sides of central Shandong mountain area, represented by Changqing District, Ningyang County and Yishui County. From 2000 to 2020, the industrial layout and structure of all counties and cities in the mountainous area of central Shandong have undergone significant transformation. The industrial transformation, especially the improvement and development of the primary industry, is inseparable from rural residents and space. Further integration found that in recent years, the planning and development of Rural Revitalization and rural tourism in such areas have greatly mobilized the enthusiasm of rural residents in production and life, And significantly promoted the scale and plot ratio of rural settlement land, and promoted the emergence of new rural settlement space represented by "farmhouse fun" and "family workshop".

6. Conclusion and Discussion

Based on the interpretation results of remote sensing images in central Shandong mountainous area from 2000 to 2020, the spatial evolution characteristics, influencing factors and change mode of rural settlement land in central Shandong mountainous area in the past 20 years are analyzed by comprehensively using the methods of rural settlement land dynamics, landscape pattern index, land use transfer matrix and principal component analysis. The following conclusions are drawn:

(1) With the evolution of time, the rural settlement land in Zhongshan District of Shandong province continues to expand, and the distribution density of rural settlement land patches continues to decline, which reflects that the effectiveness of rural settlement land planning and governance in Zhongshan District of Shandong Province is gradually prominent in recent years.

(2) From 2000 to 2020, with the development of "Rural Revitalization" and Urban-Rural Coordination and integration, the scale of rural settlement land in Zhongshan District of Shandong Province showed a

trend of orderly improvement, the settlement patch showed a trend of "relocation integration" spatial layout, the temporal and spatial distribution and regional differences of rural settlement land gradually became prominent, and the order and rationality of the layout also gradually increased.

(3) From 2000 to 2020, the spatial distribution and dynamic change potential of rural settlement land in different altitude levels in Zhongshan District of Shandong Province are different. The middle and low altitude area (18-246m) is the main distribution area of rural settlement land in the study area. With the evolution of time, the altitude level of rural settlement spatial distribution increases slightly.

(4) From 2000 to 2020, the mutual transformation trend between rural settlement land space and other land types in Zhongshan District of Shandong Province was obvious. The new rural settlement land was mainly transferred from flat cultivated land, with an area and contribution rate of 826.91km² and 83.54%, which are widely distributed in the central and southern counties of the study area; In contrast, cultivated land is the primary transfer out source of rural settlement land (69.3%) and mainly distributed in remote villages far away from urban areas, which reflects that a series of problems caused by "hollowing out" and "centrifugation" of rural development in this region are gradually emerging in recent years, while urban land is the secondary transfer out source of rural settlement land (23.2%), which indicates that the development of Urban-Rural Coordination and integration is gradually changing the form and scale of rural settlement land.

(5) The factors affecting the spatial evolution of rural settlements in Zhongshan District of Shandong Province can be divided into two categories: regional economic development level factors and regional agricultural production status factors. With the evolution of time, the role of regional economic development level factor in the spatial evolution of rural settlements in Lushan District has gradually increased, while the influence of regional agricultural production status factor has gradually weakened.

(6) During the study period, there are significant differences in the temporal and spatial distribution and change of rural settlement land in Zhongshan District of Shandong Province, mainly showing five change modes: the fading impact of urbanization, the integration and relocation of ecological planning, the expansion caused by traffic trunk lines, the derivative of industrial transformation and stability.

On the basis of exploring the evolution process and characteristics of rural settlement space in Lushan District, this paper identifies the relevant factors affecting the evolution of settlement space, and puts forward the diversified evolution model of rural settlement in the study area, which can provide theoretical basis and practical guidance for the effective integration of rural settlement space and the smooth promotion of rural urbanization in the follow-up study area. Integrating and refining the optimization and

Reconstruction Path of rural settlement space is the focus of this paper.

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References

- [1] Zhao Shengnan, Ren Zhiyuan, Zhang Han, et al. Characteristics and benefit analysis of construction land expansion in Xi'an from 2000 to 2013 *Journal of Shaanxi Normal University (NATURAL SCIENCE EDITION)*, 2015,43 (4): 89-95
- [2] Yuan Jia, Shen Fei, Huang Weiwei, et al Analysis on urban spatial expansion and driving force of Wuhu City since reform and opening up *Human geography*, 2015 (3): 72-78
- [3] Li Qianguo, Shi Peiji, Wei Wei Oasis city expansion and driving mechanism in arid area - a case study of Zhangye City *Research on arid areas*, 2015,32 (3): 598-605
- [4] Liu Shenghe, Wu Chuanjun, Shen Hongquan Beijing urban land use expansion model based on GIS *Journal of geography*, 2000,55 (4): 407-416
- [5] Kuang Wenhui, Shao Quanqin, Liu Jiyuan, et al. Analysis on the characteristics and mechanism of land use spatial expansion in the main urban area of Beijing since 1932 *Journal of Earth Information Science*, 2009,11 (4): 428-435
- [6] Mundia C N, Aniya M. Analysis of land use/cover changes and urban expansion of Nairobi city using remote sensing and GIS. *International Journal of Remote Sensing*, 2005, 26(13):2831-2849.
- [7] Mu Xiaodong, Liu Huiping, Xue Xiaojuan Research on urban expansion of Beijing from 1984 to 2007 based on remote sensing monitoring *Journal of Beijing Normal University (NATURAL SCIENCE EDITION)*, 2012,48 (1): 81-85
- [8] Zhang Li, Lei Jun, Li Xuemei, et al. Characteristics and influencing factors of urban land expansion in China from 1997 to 2007 *Advances in Geographical Sciences*, 2011,30 (5): 607 - 614
- [9] Ye Yuyao, Zhang Hongou, Liu Kai, et al Analysis on the influence of geographical location factors on construction land expansion - Taking the Pearl River Delta as an example *Advances in Geographical Sciences*, 2010,29 (11): 1433-1441
- [10] Batisani Nnyaladzi, Yarnal Brent. Urban expansion in Centre County, Pennsylvania: Spatial dynamics and landscape transformations. *Applied Geography*, 2009(29):235-238.
- [11] Pan YanXu Research on public facilities space design of rural complex in Lushan District under the background of "beautiful village residence" *Shandong University of architecture*, 2020
- [12] Zhang Lei, Li Jun, Wu Youde, Li Cansong Analysis on the expansion characteristics and mode of urban settlement land in the area around Erhai Lake in Yunnan -- a case study of Xiaguan Town, Dali city *Soil and water conservation study*: 347-347, 2017
- [13] Liu Song, Guo Feifei Study on rural residential area layout optimization based on landscape pattern analysis *Journal of Northeast Agricultural University*, 2010, 41(11):42-46
- [14] Han huiran, Yang Chengfeng, song Jinping Characteristics and driving mechanism of land use change in Beijing *Economic geography*, 2015,35 (05): 148-154 + 197
- [15] Zhang Lei Analysis on the temporal and spatial evolution characteristics and layout optimization of rural settlements around Erhai Lake in Yunnan Province under the influence of social and economic changes *Yunnan Normal University*, 2016