

RESEARCH ARTICLE

Basic Research on the Spatial Evolution of Rural Settlements under the Mountain-Water-Field System in Mountainous Area in the Middle of Shandong Province

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Abstract: Mountainous area in the middle of Shandong province is located in the south-central part of Shandong Province, including six cities and nineteen counties in Shandong Province. It has outstanding physical and geographical features and profound cultural accumulation. The function and structure of settlement space have distinct regional and humanistic characteristics. Based on literature review, field investigation, this paper obtains information and data about the nature, history, economy, ecology, policy and other aspects of the study area, summarizes and analyzes the natural environment conditions and humanistic environment foundation of rural settlement space formation in this area, and grasps the basic state of rural settlement space evolution in this area. It is found that the foundation of rural settlement space evolution in mountainous area in the middle of Shandong province is mainly the natural ecological background of mountains, water and fields, prominent and active rural economy and beautiful and fragile ecological environment. This study can provide reference for the optimization and reconstruction of settlement table space.

Keywords: rural settlements; evolution; mountainous area in the middle of Shandong province

1. Introduction

As an important agricultural base, water conservation land and ecological barrier in Shandong Province, in the long-term development process, mountainous area in the middle of Shandong province has become the key area and key node in the strategy of ecological protection and high-quality development in Shandong Province, forming a mountain-water-field symbiotic natural and ecological system. The distribution pattern, evolution characteristics, driving mechanism and optimization path of rural settlements have distinct regional and humanistic characteristics (Pan, 2020). The development, expansion, shrinkage and extinction of rural settlements have their own development laws. Understanding the evolution basis of settlements is the basis for the formulation of various development and intervention policies in rural areas (Zhou et al., 2011). At present, some rural areas of mountainous area in the middle of Shandong province blindly implement settlement space integration measures (Guo et al., 2012) that do not follow the development laws, such as demolishing villages and merging towns and so on, resulting in a series of problems such as idle settlement space and waste of land resources. In view of this, it is extremely necessary to analyze the spatial evolution basis of rural settlements in the mountainous area in the middle of Shandong province.

1. Research area and data source

Mountainous area in the middle of Shandong province is located in the south-central part of Shandong Province, mainly including 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 area of Tai'an City (*except Dongping County*), and the east of Linyi City (*Yinan county, Yishui County and Mengyin*).

The analysis data in this paper mainly includes land use and cover image data and regional development attribute data. Among them, the land use and cover data are mainly taken from Landsat TM/ETM/OLI series images (resolution 30m). The data of regional development attributes are mainly based on the *Statistical Yearbook of Shandong Province* (1999-2021).

2. Results and analysis

3.1 Natural ecological background of mountain-water-field

Based on the analysis of the background of land use and topography in the study area, it is found that the land use in the mountain area of middle Shandong Province has formed the structural characteristics of mainly dry land, supplemented by forest and grassland, and once again urban and rural construction land and water body. The mountain-water-field system directly affects the natural background of rural settlement land (Table 1). The overall elevation of mountain area in the middle of Shandong Province is between 18-1,406 meters, and the high area ratio of middle and low elevation mountains is the outstanding feature of this area (54%). The Yellow River and its tributaries, Mount Tai and Yimeng Mountain, and the alluvial plains in front of the mountains and intermountain basin have jointly shaped the natural foundation of mountain area in the middle of Shandong Province.

To sum up, for a long time, the natural ecological background of mountain-water-field has been formed in the middle mountain area of Shandong Province, which directly affects the pattern and evolution of rural settlement space.

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Land use type	area	percentage
plough	14932.93	56.65
woodland	3756.56	14.26
lawn	3219.23	12.22
water body	752.91	2.86
Urban land use	1177.64	4.47
Rural residential area	2176.11	8.26
Other land use	341.71	1.29

Table 1 Area and proportion of land use types in mountainous area in the middle of Shandong province in 2020

3.2 Highlight the active rural economy

From 2000 to 2020, the rural economy in mountainous area in the middle of Shandong province developed rapidly,

study area, while the per capita growth rates of farmers in Linqu, Changqing, Mengyin and Pingyi counties in the east and west of the study area were lower. Compared with the previous period, from 2010 to 2020, the growth rate of per capita net income of farmers in the study area decreased. The growth rate of 12 counties and cities located in the midwest of the study area, such as Licheng District, Changqing District and Feicheng City, was lower than the average level of the whole area, while that of Linqu County, Yinan county and Sishui county located in the east of the study area was higher than the average level of the whole area.

3.3 Beautiful and fragile ecological environment

As an important support for the survival and development of rural settlements, the mountainous area of mountainous area in the middle of Shandong province is widely distributed, with 5A-level scenic spots such as Mount Tai and Yimeng Mountain. Dawen River and Beijing-Hangzhou Grand Canal flow through this area, and the ecological environment is beautiful and diverse. However, after long-term development, the ecological

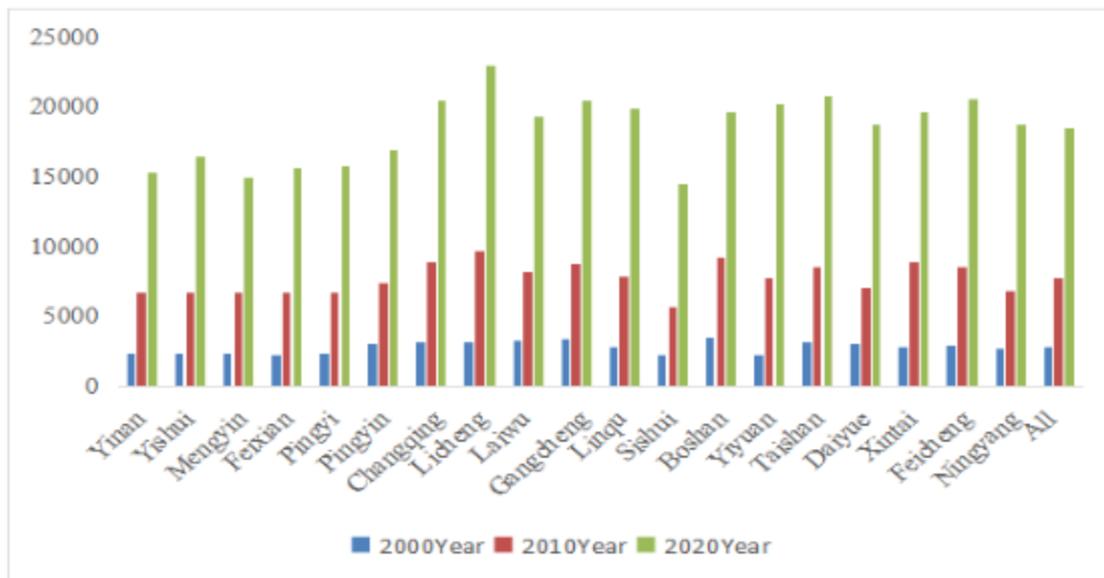


Figure 1 Net income per capita of farmers in mountainous area in the middle of Shandong province from 2000 to 2020 (yuan)

the social and economic system became more and more perfect, and the social and economic foundation of rural settlement land changed actively and significantly.

As the direct embodiment of rural residents' production and living standards, the per capita net income of farmers has become an important indicator to measure rural economic activity. As can be seen from Figure 1, in general, the per capita net income of farmers in mountainous area in the middle of Shandong province increased significantly from 2000 to 2020, and the rural economic activity increased significantly. Specifically, the increase of farmers' per capita net income in different time periods and regions in the study area is different, and the spatial and temporal differences of rural economy are prominent. From 2000 to 2010, the per capita net income of farmers in all counties and cities in the study area more than doubled. Among them, the growth rates of Daiyue district, Pingyin, Ningyang, Sishui county, Laicheng, Boshan, Gangcheng and Taishan district in the middle of the study area were lower than the average level of the

declining. Therefore, this paper refers to the relevant scholars' research (Liu et al., 2017), introduces the index of land use status (formula 1), and analyzes the ecological background of rural settlements in mountainous area in the middle of Shandong province from the perspective of sustainable development.

The Land Use Status Index (LCSI) refers to the proportion of the total area of the study area by the sum of the areas of three types of land use, such as water, forest, shrub and grassland, which have good ecosystem comprehensive functions (Chen & Zhao, 2009). The higher the index, the stronger its ecological comprehensive functions, and vice versa^[194]. The formula is

$$LCSI = \left(\sum_{i=1}^3 \frac{C_i}{TLA} \right) \times 100\% \quad (1)$$

where LCSI is the index of land use status, C_i is the area of water body, woodland and grassland, and TLA is the area of study area.

According to the statistics, from 2000 to 2020, the index of land use in mountainous area in the middle of Shandong province fluctuated significantly, showing a trend of first decreasing and then rising, and the LCSI index in the three years was 32.61%, 29.2% and 29.32% respectively. The ecological background of rural settlement development and support in the study area was continuously weakened.

3. Conclusion

Based on literature review and on-the-spot investigation, the analysis data of remote sensing images and social economy in mountainous area in the middle of Shandong province were obtained, and the natural environment conditions and humanistic environment foundation of rural settlement space in this area were summarized and analyzed. By grasping the basic state of rural settlement space evolution in this area, it was found that the foundation of rural settlement space evolution in mountainous area in the middle of Shandong province was mainly characterized by natural ecological background between mountains, water and fields, prominent and active rural economy and beautiful and fragile ecological environment. Analyzing the evolution mode of rural settlements and exploring the path of settlement space optimization will be the follow-up research focus of this paper.

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Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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