

Evolution Mechanism of the Urban System Spatial Structure in Qinba Mountain Area

Taking Shanyang County as an Example

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Abstract—Taking Shanyang County in the south of Qinling Mountains in Shaanxi Province as an example, this paper elaborates the evolution mechanism of the urban system spatial structure in the county. It is found that it has experienced three main development stages: dual core structure, single center structure and point-axis spatial structure. Furthermore, the dominant factors of this evolution are analyzed, including traffic conditions, government policies, and resource and environmental carrying capacity. Finally, the future spatial development trend of Shanyang County is predicted to be a new dual-core structure, and corresponding policy recommendations are proposed.

Keywords—regional dual core structure; evaluation of resource and environmental carrying capacity; southern Shaanxi immigrants; ecological compensation

I. INTRODUCTION

According to statistics, China's urbanization rate has reached 56%, and urbanization has entered a period of overall acceleration. As the living and production costs in large cities continue to rise, the concentration of population in the east, especially in large cities, has gradually slowed down. Due to the influence of gradient transfer, the urbanization speed in the west is gradually accelerating, which bears the heavy responsibility of urbanization of the population especially in small towns in the county. The gathering of population and the increasingly rich urban functions have made the urban system spatial pattern in county also face reconstruction. In recent years, China has paid great attention to the spatial development and governance of the land by compiling a nationwide land use planning, urban system planning and main functional area planning. The delimitation and implementation of the main functional regionalization completely change the past GDP-based development pattern.

The county, one of the administrative divisions of China, began to appear in the Spring and Autumn Period. When First Emperor of Qin unified China, he implemented the county system, which was the beginning of the formal establishment of the county system [1]. By 2018, there were

1,347 counties in China, including 895 mountainous counties. The topography is complex and external connections are inconvenient in mountainous counties. They also face the most stringent environmental protection management policies in China's history. It can be said that the conditions for economic development are very bad. In the future, various regions will continue to establish an early warning mechanism for ecological and resource environmental carrying capacity. Therefore, in the process of selecting the spatial pattern of land use and urban construction, mountainous counties will be subjected to more restrictions.

Qinba Mountain Area belongs to one of the 14 contiguous poverty-stricken areas in China, including 76 counties (districts). The research area of this paper, Shanyang County of Shaanxi Province, is included in it, and it is also one of the pilot areas of new urbanization construction. The evolution process of the spatial structure of urban systems is sorted out to find the dominant factors at different stages, in order to provide a reference for the study of spatial development in similar areas.

II. OVERVIEW OF THE STUDY AREA

Shanyang County is located in the south of the Qinling Mountains, the north-south geographical boundary of China. The mountains are interlaced and the gullies cross there. The three major mountains are distributed in east-west direction, forming the ridge-valley pattern of "three mountains with two rivers". The vertical and horizontal Juan ridge links the northern Liu ridge with the central Hu ridge to form a complex terrain with high central and north sides and low east, west and south sides [2]. The county has a total area of 3,535 square kilometers, of which 2898 square kilometers are mountainous, accounting for 82.6%; water surface is 296 square kilometers, accounting for 3.3%; cultivated land is 320 square kilometers, accounting for 9.1%, so there is the saying "eight parts of mountains, one part of water and one part of field". Shanyang has a mild climate since the ancient times, with abundant precipitation and abundant natural resources, especially forests and minerals. Before the Qing Dynasty, due to the geographical location that is vulnerable

to war, the population has been relatively scarce. In the middle of the Qing Dynasty, the Jianghuai people entered the mountains to reclaim wasteland, and the population soared by more than 100,000. Since then, artificial forest destruction has begun. Since then, immigrants have become more prosperous. In the north of Hu ridge, there are mainly immigrants from Shanxi, while the south of Hu ridge is dominated by Jianghuai immigrants, thus forming concentrated areas with their respective cultural characteristics.

III. THE EVOLUTION PROCESS OF THE URBAN SYSTEM SPATIAL STRUCTURE IN SHANYANG COUNTY

From the historical study of Shanyang County, it is found that the evolution of the urban system spatial structure has gone through three stages:

A. The Prototype of the Dual-core Structure

In the study of regional development issues, the domestic scholar Lu Dadao proposed the famous "point-axis system" theory in the 1980s. Based on this, Lu Yuqi (1998) first called the port city and the regional central city and its connected area the dual-core spatial structure, and believed that this combination of the regional central city and the port city can be regarded as the primary form or the first form of dual-core structure. The combination of the regional central city and the fringe city is regarded as the secondary form or the second form [3]. The regional dual-core structure is common in China's coastal areas, along the Yangtze River and even along the border areas. Based on this standard, is there a similar dual-core structure in the provincial boundary zone? The answer is yes. Although the size of the county areas cannot be compared with the regional central city, the principle is the same. Studies have shown that the other condition for core is the requirement for foreign trade and communication. Due to the limited traffic conditions in mountainous areas, it is more convenient to transport bulk cargo by waterways. Especially for areas with large differences, the requirements for goods communication are higher. As the volume of trade increases and the population gathers, the core along the edge is gradually formed. Shanyang County has developed a sub-small town Manchuanguan based on the flood and dry docks in the southeast of the county, which is a typical endogenous spatial polarization model.

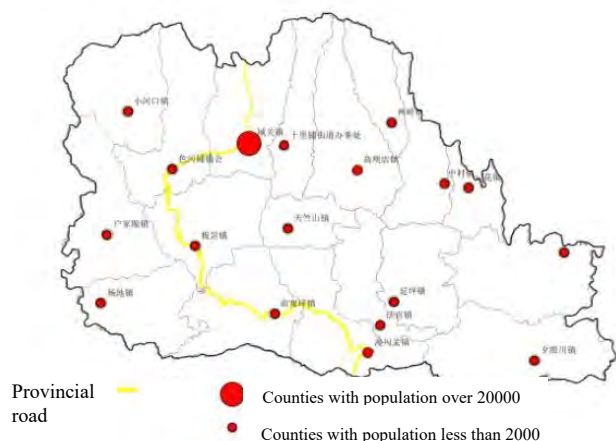
Manchuanguan is a long-established ancient frontier town in Shanyang. From the Ming and Qing Dynasties to the early years of the Republic of China, due to the development of water transport, Manchuan became a major north-south trade center on the Han River water transport. Especially after the Opium War, the Westernization Movement rose, the Han River waterway flourished, and Manchuanguan became the water and land transportation center "connecting Qinjin in the north and connecting Wuchu in the south", which plays the role of port city in the dual-core structure [4].

Chengguan Town (replaced as Chengguan Subdistrict Office in 2015) has been the location of the county government since the Ming and Qing Dynasties, as the political center of the county. The two small towns with clear division of functions and important status together constitute the early dual-core spatial structure of Shanyang.

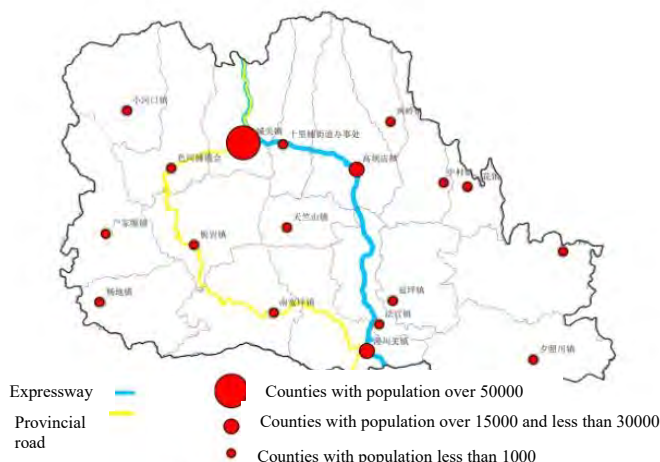
B. Single Center Structure

The single center structure is based on the classical theory of geography — central place theory, which was proposed by German urban geographer W. Christaller and German economist Alosch in 1933 and 1940 respectively. It became popular in English-speaking countries in the 1950s and then was spread to other countries. Being considered as one of the most important contributions of human geography in the 20th century, it is one of the basic theory for studying urban agglomeration and urbanization. [4]. In Shanyang County at the end of the Qing Dynasty and the beginning of the Republic of China, the war was frequent, and the people's livelihood was withered. After the founding of the People's Republic of China, with the restoration of government of Shanyang County, production and economic development were gradually resumed. However, because the channel connecting Shaanxi and South China was changed to pass through Shangnan County, the commercial function of Manchuanguan has shrunk and it gradually declined. The county took Chengguan Town as the single core, which is not only the administrative center but also the county center where industrial and commercial industry gather and public services are provided.

During this period, the economic development was slow with the low per capita GDP level and the urbanization rate less than 10%. Until 2007, the urban population of Chengguan Town was just over 20,000. In other towns, the population usually did not exceed 1,000, and that of Manchuanguan and Shilipu with more population was also less than 2,000 people, as shown in "Fig. 1". Assuming that the entire Shanyang County is an economic area, Chengguan Town is the only first-level central area, and other townships can be regarded as secondary central areas. However, due to the large fluctuation of the topography and the non-uniformity, the first-level central area is not the geometric center of the area, and the transportation relationship with the secondary central area is inconvenient — the traffic conditions in the county are relatively poor, with only one provincial road running through the north and the south. There is no road in the most of villages, let alone public transportation, so people go to neighboring towns and villages mainly by walking, and then walk from the town government to the county government, which frequently takes two or three hours of commuting time. The external transportation can only rely on the long-distance bus station in the county, resulting in a low level of compactness throughout the region, and it is also on the edge of the region at higher level, so the development is very slow.



Distribution map of county scale in Shanyang County in 2007



Distribution map of county scale in Shanyang County in 2016

Fig. 1. Schematic diagram of the urban scale of Shanyang County.

^a. Source: painted by the author.

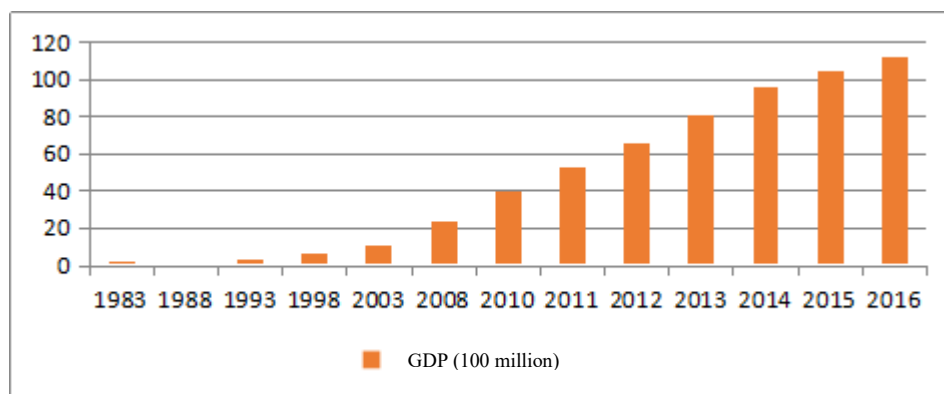


Fig. 2. Gross national product of major years in Shanyang County.

C. Point-axis Spatial Structure

The "point-axis" space structure system, proposed by Chinese geographer Lu Dadao, is an extension of the growth pole theory. From the process of regional economic development, it can be seen that the economic center is always concentrated in a few areas with good condition, which are distributed in spots. This kind of economic center is called the point in point-axis development model. The point is the central city that drives the economic development of the sub-level region while the axis is a relatively dense population and industrial belt formed by connecting several central towns of different levels in a certain direction, also known as the "exploiting axis" or "development axis" [5]. Therefore, point-axis development can be regarded as the development from large and small economic centers (points) in developed areas to the underdeveloped areas along the transportation lines.

In the late 1990s, with the rapid development of the economy across China, the economic development of Sanyang, a poverty-stricken county in the west, began to accelerate. The main driving force was the production and processing using mineral resources and the cultivation and extraction of turmeric based on saponin production. However, with the launch of the South-to-North Water Diversion Project in 2004, more and more chemical companies have been shut down due to the ecological protection requirements for the Danjiangkou Reservoir water storage source, which has made the environment in the water source area of southern Shaanxi better, but the economic development has fallen behind the whole province and China and people's lives are even poorer. The government and people of southern Shaanxi have made major sacrifices to protect water sources and have undertaken huge environmental protection costs. Therefore, the inevitable trend of water source safety in the mid-line project in "South-to-North Water Diversion" is to promote local

economic development and increase economic income through ecological compensation for southern Shaanxi [6]. A series of ecological compensation mechanisms have certain impact, such as ecological migration projects. Relying on the natural and geographical conditions of southern Shaanxi, they can give play to the advantages of Chinese medicine towns, and focus on the industrial development planning of developing Chinese medicine industry, green recycling industry and rural tourism industry, so that the economy has made considerable progress, as shown in "Fig. 2".

The urban system spatial structure has also been reconstructed. First of all, because the original transit provincial road was built along the river valley due to the restriction of terrain, and the west line was taken, so the road was narrow with more bends and the traffic speed was relatively slow, which did not form a significant development axis. However, in 2009, when Fuyin Expressway in Shaanxi Province, Shangman Expressway was completed and opened to traffic, the situation has been greatly improved. The designed speed of expressway is 80 km/h, and it shortens the distance by crossing the mountain and building the bridge. It takes only one hour from Chengguan Town to Manchuanguan Town. At the same time, the history and culture of Manchuanguan is excavated and utilized to build the cultural tourism characteristic town of Shanyang County, making the economic and population center gradually move eastward. In addition, in May 2010, the Shaanxi Provincial People's Government launched a 10-

year investment project with an investment of more than 100 billion yuan, covering 2.4 million people in three cities in southern Shaanxi. The scale is twice that of the immigrants in the Three Gorges Reservoir Region, which is called "the biggest migration" in the history of New China. The population quickly concentrated in the town. In 2007, the urban population of the county was only 37,600. The combined effect of ecological immigrants, disaster immigrants and poor immigrants has made nearly 130,000 people move to cities and towns up to the immigration relocation plan in 2016. By 2017, the urbanization rate in term of permanent resident population has reached 45%.

In February 2015, Chengguan Town and Shilipu Town were changed into the subdistrict offices, and the central city of the county gradually showed a pattern of banded groups. In the future, the Gaobadian town in the east will be cancelled at the appropriate time and changed to a subdistrict office. Thus, the three groups of Chengguan, Shilipu and Gaobadian formed a band group along the main traffic axis, as shown in "Fig. 1". The Manchuanguan and Gaobadian along the Fuyin Expressway are listed as national key towns, and Hujiatun along the Shanzha Expressway in the construction of Tianzhushan Town River is listed as a municipal key town, as shown in "Table I". In this way, the urban system spatial pattern of the county extends southward, and it is connected with the other core of the early dual-core structure, Manchuanguan Town, forming a point-axis spatial structure.

TABLE I. FUNCTIONAL DIVISION OF TOWNS ALONG THE EXPRESSWAY OF SHANYANG COUNTY

| Name | Nature | Industry | Travel Resources | Key town |
|-------------------------|-------------------------------|--------------------------------------|---------------------|------------------|
| Tianzhushan Town | | | AAAA scenic spot | Municipal level |
| Chengguan Street Office | Political and economic center | comprehensive | | |
| Manchuanguan Town | National characteristic town | Green cycle | AAAA scenic spot | Provincial level |
| Hujiayuan Town | | plantation | | Municipal level |
| Shilipu Street Office | | Chinese medicine and food processing | | Provincial level |
| Gaobadian Town | | Cultivation | | |
| Faguan Town | | Green cycle | Qinlingyuan Village | |

a. Source: Painted by the Author.

IV. DEVELOPMENT TREND OF THE URBAN SYSTEM SPATIAL PATTERN OF SHANYANG COUNTY

A. The Dominant Factors Affecting the Evolution of Urban Spatial Pattern in Shanyang County

It can be seen from the evolution of the spatial structure of Shanyang County that the natural geographical conditions laid the foundation, and transportation, especially external transportation and government policies, are the two dominant factors. Two important turning points in history have emerged due to changes in external traffic conditions. The first time was the replacement of water transport by road transport, resulting in the rapid decline of Manchuanguan and the disintegration of the dual core structure. The second time was the construction of the expressway. Once again, the Manchuanguan was pulled into the track of rapid

development. Of course, the historical and cultural advantage of the ancient trade town is the core competitiveness. The government's immigration policy has accelerated the process of urbanization. Although in initial period, population has not yet achieved real urbanization and citizenization, this thrust cannot be underestimated. In the future, these new immigrants will play an important role in the development of cities and towns.

B. Development Trends — New Dual-core Structure

It can be clearly observed from the urban population size distribution map in 2016 that the current urban population is mainly concentrated in two cores. One is the northern core based on Chengguan Town, of which the main functions are administrative center and industrial park, and another is the southern core based on Manchuanguan, of which the main function is to develop tourism, health and ecological

breeding. The urban population of these two groups has accounted for nearly 70% of the total urban population. In accordance with the ideas of industrial cluster development and the policy orientation of the three centralities, industrial enterprises are also concentrated in these two core industrial parks. In the future, the urban system spatial structure of Shanyang County is likely to develop into a new dual-core structure — that is, within the county, the Chengguan group and the Manchuanguan group is the cores. Although the status of Manchuanguan is not the border town based on commerce and trade, it has become a business card of Shanyang because of the construction of the characteristic town, and its popularity is far greater than that of the county government location. (In terms of Baidu search ranking). Its function is not repeated with the city-level group, so it has the potential to form a dual-core structure.

At present, China attaches great importance to the relationship with the environment during the process of exploiting and utilizing the land. Since the Wenchuan earthquake, it is necessary to consider the bearing pressure of resources and environment for areas with geological and other disaster risks, and the main compiling points of provincial-level land planning issued by the Ministry of Land and Resources in 2017 has clearly stated to make the evaluation of resource and environmental carrying capacity and given detailed indicators. The main compiling point

mentions that it is necessary to analyze the influence of factors such as elevation, slope, land that is hard to use, mountain flood disaster, landslide and debris flow, land subsidence, active fault, karst collapse, water and soil loss, water resources quantity, important ecological land, planned prohibited construction areas, basic farmland, and grades of agricultural land on land development according to the resource and environmental factors such as natural and environmental conditions, life safety, ecological security, food security and so on [8], and screen elements based on the degree of impact and data acquisition. The author selects suitable elements for Shanyang County to evaluate the resource and environmental carrying capacity, determines the suitable land use scope, and combines the ecological red line range determined by the provincial ecological protection requirements. It is found that most of the two are coincident, and the rest available land for development and construction is only 590 square kilometers, which is relatively scattered, as shown in "Fig. 3". The suitable construction land for the two core groups in the north and the south is only 61 and 66 square kilometers respectively, which is not plentiful. Therefore, there are already projects for cutting mountains to make land, indicating that although the cost of building land is higher; it is still acceptable compared with the location advantage. Now not only is population and land, but capital is also rapidly concentrating toward two cores.

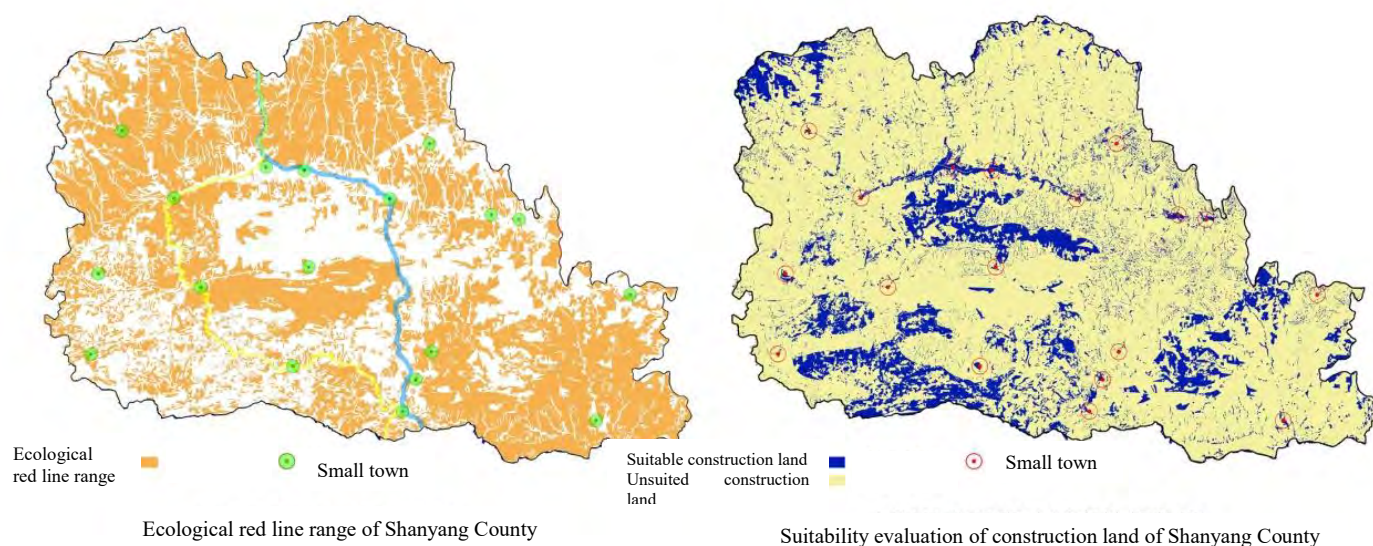


Fig. 3. The ecological red line and suitability evaluation of construction land in Shanyang County.

At the same time, the external traffic conditions of Shanyang County will also undergo major changes. The Xiwu high-speed railway, which will be constructed from 2019, has already determined to build two stations in Shanyang: Shanyang Station (located at Chengguan Subdistrict Office) and Manchuanguan Station (located in Manchuanguan Town). The establishment of stations in Manchuanguan Town can be said to be affirmation of the good social and economic development of Shanyang County in recent years. The establishment of these two high-speed railway stations will further strengthen the development

trend of Manchuanguan group to the second core and also increase the compactness of the county, which is conducive to the concentration of resources and forming a virtuous circle.

V. CONCLUSION

Compared with the traditional dual-core structure along the river and the border areas, the urban system spatial structure of counties between the inland provinces, especially the mountainous counties, can also have the characteristics

of a dual-core structure. Generally speaking, the county's convergence point is in the town where county government is located. Due to the small population density and the underdeveloped economy, the scale of the central town is small, and the support of the hinterland is limited (the destination of population migration will mainly be prefecture-level cities or provincial capitals). The concentration role of county is limited and the radiation capacity is limited. The spatial pattern of urban system is generally dominated by a county core, while other small towns are small in scale and single in function. However, for mountainous counties, urban construction is difficult to develop a homogeneous central structure due to the constraints of topographic conditions, and often needs to improve their accessibility relying on transit traffic conditions, so the dependence on transportation is stronger, and most of them expand along the river valley and traffic corridors. When the external traffic conditions and government policies changed greatly, the population quickly gathered to the potential core. For example, in Shanyang County, the research object of this paper, there are two core gathering points. Because there were the early dual-nuclear structure in the history of Shanyang County, and the other core has rich intangible cultural heritage and tourism resources, it smoothly revived in the orientation of government policies to develop characteristic small towns, and further develops toward the dual-core structure. This trend has in turn affected the improvement of the regional external traffic conditions (the Xiwu high-speed railway establishes two stations in Shanyang), which is a very worthwhile experience for the new urbanization process in mountainous counties.

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