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Valley Density Evaluation and Typical Development Pattern in Mountainous Areas of Beijing

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Abstract Based on geographical differences and space differentiation, valley economy is a new pattern and new perspective for the development of mountainous areas, integrating ecological protection, industrial nurture, and village integration. On the basis of natural and geographical differentiation of valley, we give an overview of the spatial distribution of valley in mountainous areas of Beijing and spatial difference in valley density, and sum up the typical development pattern of valley economy, using DEM data. The results show that the spatial distribution of valley presents an asymmetric shape of inverted V or branch; Miyun, Yanqing, and Changping have high valley density, while Pinggu, Fangshan and Mentougou have low valley density; there is a significant positive relationship between valley density and the spatial distribution of river and reservoir. The development pattern of valley economy is divided into five types: leisure and high-end upgrade-based pattern, ecological development and transition demonstration-based pattern, folk culture and creation-driven pattern, scenic spots-driven and valley-linked pattern and leisure agriculture and specialty-led pattern.

Key words Mountainous areas of Beijing, Valley density, Valley economy, Typical pattern

1 Introduction

Mountain, as the three-dimensional highland with significant undulation and slope on the earth's land surface, is subject to the combined effects of a variety of power systems^[1]. The comprehensive development of mountainous areas is imperative^[2–5]; valley economy is a new perspective of the development of mountainous areas, a development pattern for mountainous areas in line with the characteristics of the times, and an extension of the study of issues on agriculture, rural areas and farmers in mountainous areas, "production, ecology and life"^[6–7]. Since Beijing is in a period of rapid development, population transfer, investment projects and capital is a major problem at present. In a new round of development, mountainous areas are gradually becoming new growth room and new growth pole. The entry point for the development of mountainous areas in Beijing is valley, which is the gathering area of material flow, energy flow, and people flow in mountainous areas, and the suitable development area. Valley economy is the extended or demand-driven ecological economy and mountainous economy, formed due to the propulsion of urban development in Beijing.

Man-mountain geographical system is the core of mountainous science research^[8]. Valley is the tie or blood linking four key elements (population, resources, environment and development) in mountainous areas, and also an effective way

to coordinate the integrated development of regional resources, industry and population. Based on DEM data, we extract the valley in mountainous areas of Beijing, evaluate the valley density, and summarize the typical development pattern of valley economy, in order to provide reference for the development of valley economy in mountainous areas of Beijing and even mountainous areas of the whole country, innovate upon the mechanism and path of balanced regional development from the microscopic valley perspective.

2 Valley density evaluation

The mountainous areas in Beijing are composed of the northern and western mountainous areas. The northern mountainous areas are part of the Yanshan Mountains, with an area of 7 031.72 km², approximately accounting for 69.79% of the city's total area of mountainous areas. It is mainly constituted by the fold and fault inlaid into several intermountain basins and block mountains. The mountains are dispersed, and mostly run from east to west, showing the characteristics of the ring structure. The western mountainous areas are part of the Taihang Mountains, with an area of 3 044 km², accounting for 31.21% of the city's total area of mountainous areas. It is mainly constituted by a series of folded mountains, which are high with steep slopes, showing ordered layered arrangement features from the southeast to the northwest. The western mountainous areas include 7 districts and counties (Mentougou, Pinggu, Huairou, Yanqing, Miyun, Fangshan, Changping).

Based on the hydrological analysis functions of ArcGIS platform, after conducting depression filling, flow direction extraction and flow accumulation calculation on the original DEM data, we get the map of valley in mountainous areas. At the

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same time, based on ETM remote sensing image, we adjust some pseudo valleys with wrong topology relationship inconsistent with the actual situation, and conduct simulation analysis of the valley density in accordance with flow accumulation in different scenarios. The mathematical expression is as follows:

$$V_s = \frac{\Sigma L}{A} \quad (1)$$

where V_s is valley density; ΣL is the total length of valley in the region (km); A is the area of the region (km^2).

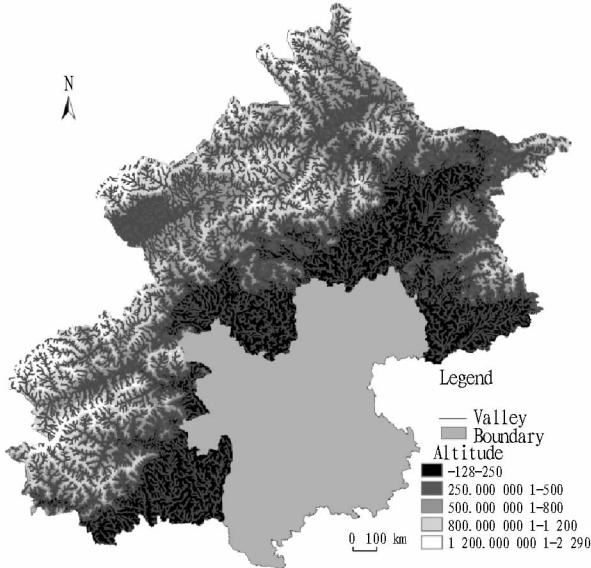


Fig.1 Spatial distribution of valley network

Table 1 Spatial variation of valley density

Name	Valley length km	Mean	Standard deviation	Area km^2	Valley density
Fangshan	1 924.33	0.046	0.044 9	2 019	0.953 11
Mentougou	1 414.96	0.043	0.033	1 455	0.972 481
Changping	1 406.62	0.047	0.048	1 343.5	1.046 982
Yanqing	2 107.49	0.045	0.043	1 993.75	1.057 048
Huairou	2 135.08	0.043	0.042	2 128.7	1.002 997
Miyun	2 380.46	0.047	0.064	2 229.45	1.067 734
Pinggu	1 001.31	0.049	0.069	1 075	0.931 451
Mean	1 767.179	0.046	0.049	1 749.2	1.004 543

Under the influence of water, climate, topography, lithology, vegetation and other factors, the valley in mountainous areas in Beijing is basically in line with the Davis stochastic simulation process, that is, after random flow, convergence and cutting, eventually an asymmetrical inverted V shape will appear. There is a significant positive relationship between valley density and the spatial distribution of river, reservoir.

3 The development pattern of valley economy

The development pattern of valley economy in mountainous areas in Beijing is an economic development idea and way derived based on the comprehensive understanding and bal-

anced consideration of various factors, which is conceived, generated and developed in the special region of mountainous area, on the basis of natural background of valley, both having the characteristics of path dependence, and having the characteristics of innovation of non-linear path. The development of valley economy is inseparable from the selection of pattern; suitable building model and development path directly determine the development level of valley economy.

By coupling the structural features of valley ecology and economy, and geographical differentiation characteristics, we analyze the degree of coordination of valley economy, classify the valley type, and generalize different development valley patterns. Valley economy is in the category of regional economy, attached to given geographical space, with distinctive regional characteristics. It also blends with geographic conditions, history and culture, particular resources, forming distinctive industrial chain, resulting in huge economic effect.

(i) Leisure and high-end upgrade-based pattern. Leisure and vacation tourism is the combination of leisure travel and vacation travel. This pattern mainly relies on rich tourism resources in the valley, to develop leisure and eco-tourism, vacation travel and other travel products.

The resources within the valley are rich, and the characteristic brands or entertainment and holiday elements are taken as the attraction, to accelerate the flow of people, material flow, information flow, and capital flow within the valley, forming the trend of gathering of high-end consumers. This pattern is representative in mountainous areas in Beijing, but not with strong universality. A typical representative is Yanqi Sleepless Valley in Huairou District.

(ii) Ecological development and transition demonstration-based pattern. Through the protection and restoration of ecological environment in the valley, this pattern takes advantage of the advantage of the natural resources to attract investment, seek the maximum economic and social benefits, and achieve sustainable development on the basis of ensuring the ecological benefits.

Transformation demonstration can be also called ecological redevelopment, using better ecological environment to select the appropriate type of alternative industries and form new industrial chain based on ecological restoration in the mountainous areas. A typical representative of this pattern is Damo Valley in Mentougou District.

(iii) Folk culture and creation-driven pattern. Relying on folk culture in the valley, this pattern causes the tourist's cultural tourism motivation by cultural differences; generates the vision, reverie of different cultures, and other cultural involvement impulses, thereby stimulating innovative thinking, changing the people's current consumer attitudes, ways and means; actively expands the cultural connotation of the valley through the development of creative industries, to enhance the cultural value; relies on natural, historical and cultural resources to develop cultural and creative industries, create a new economic growth point, and promote sustainable development of valley economy. A typical representative of this pattern

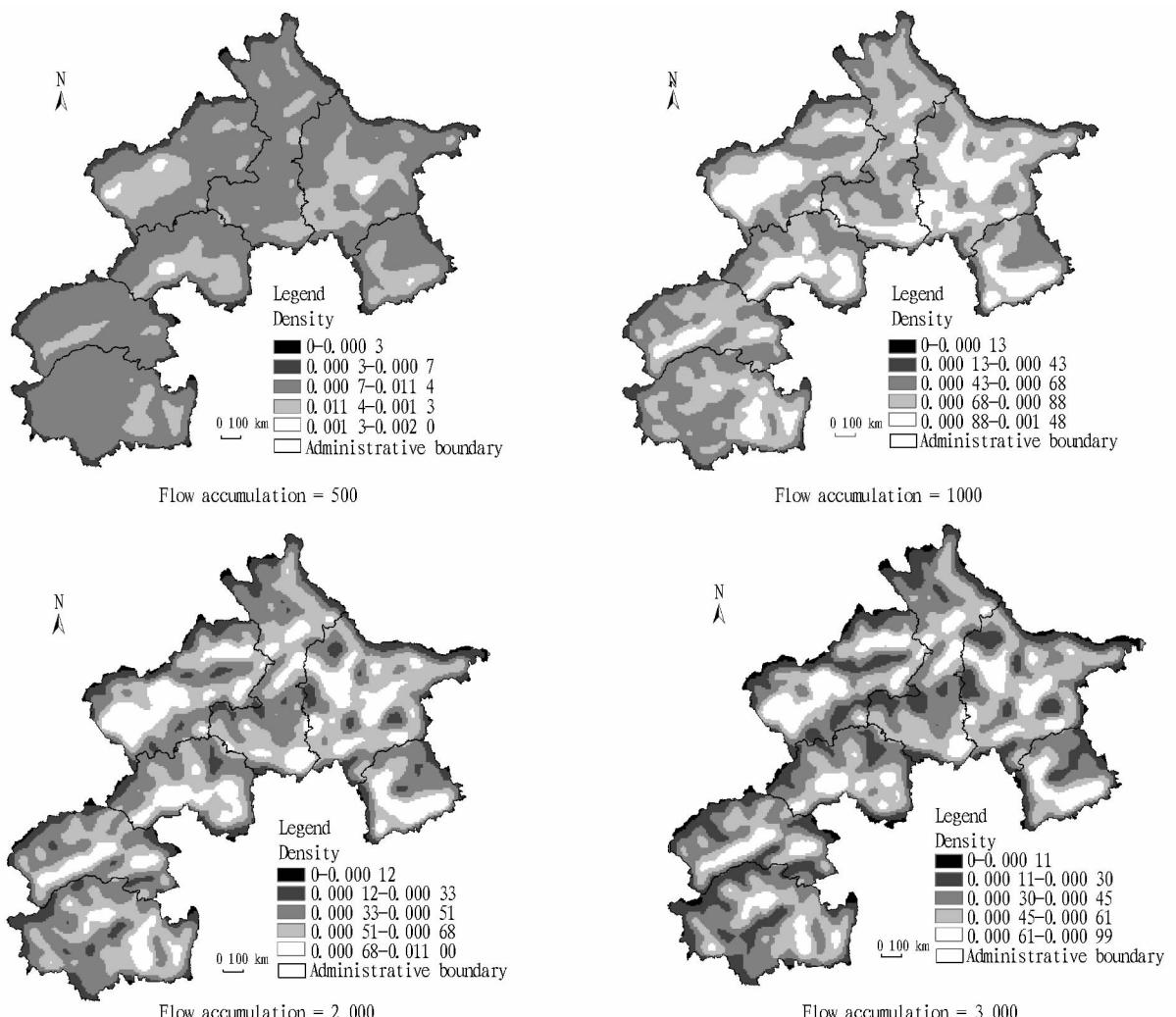


Fig.2 Valley density scenario simulation in mountainous areas of Beijing

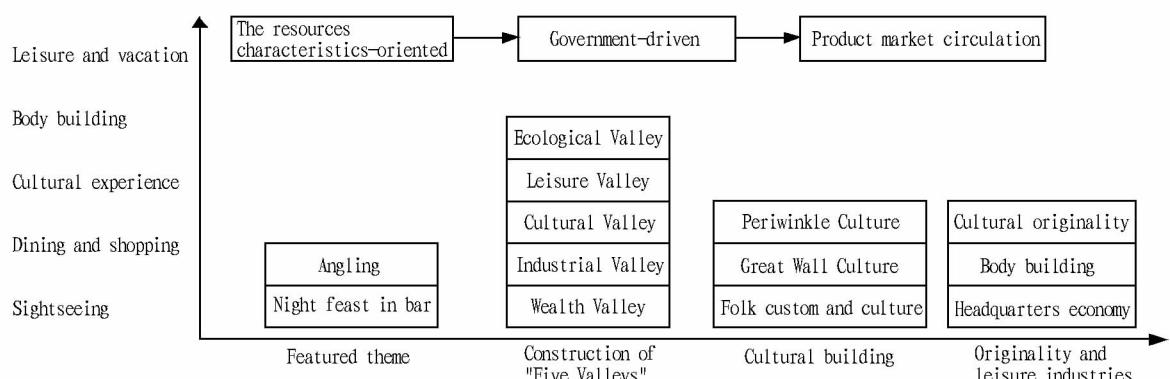


Fig.3 Development pattern of "sleepless valley"

is Tanghe Valley in Miyun County.

(iv) Scenic spots-driven and valley-linked pattern. This pattern mainly relies on large leading scenic spots to drive linkage development of valley. The development layout should be based on the famous scenic spot. For cross-valley or cross-regional scenic spots and landscape belt, we can implement corridor-style development, to intensify the leading role of scenic

spots. This pattern has strong characteristics of dependence, that is, the villages in the valley greatly depend on the neighboring scenic spots.

Therefore, the development and construction should be combined with rural tourism, include rural tourism into the range of regional tourism for coordinated planning, take the leading scenic points within the valley as the core to drive the industrial

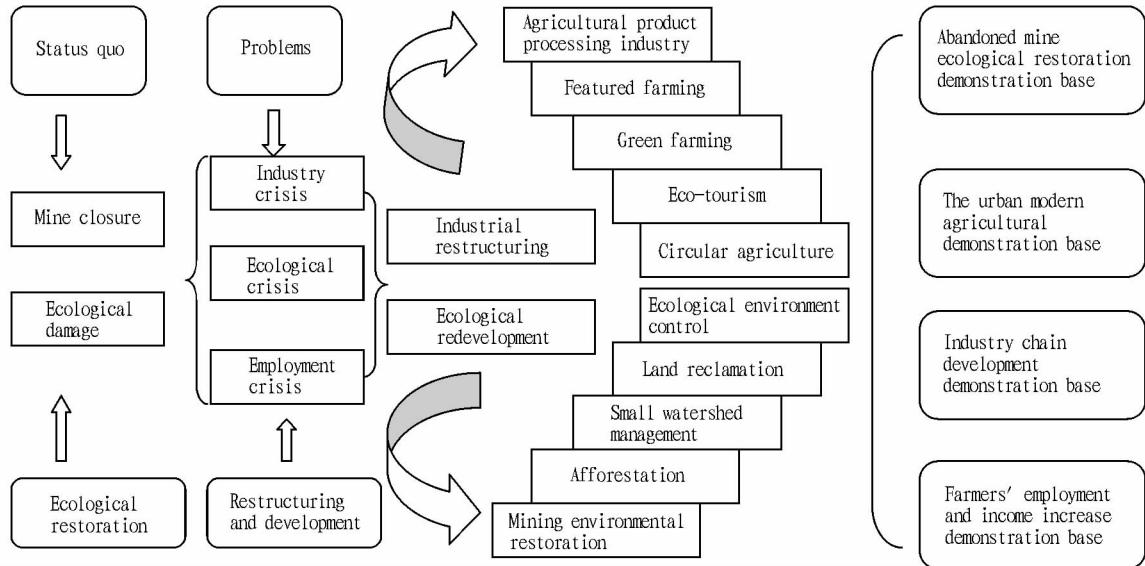


Fig.4 Development pattern of Damo Valley

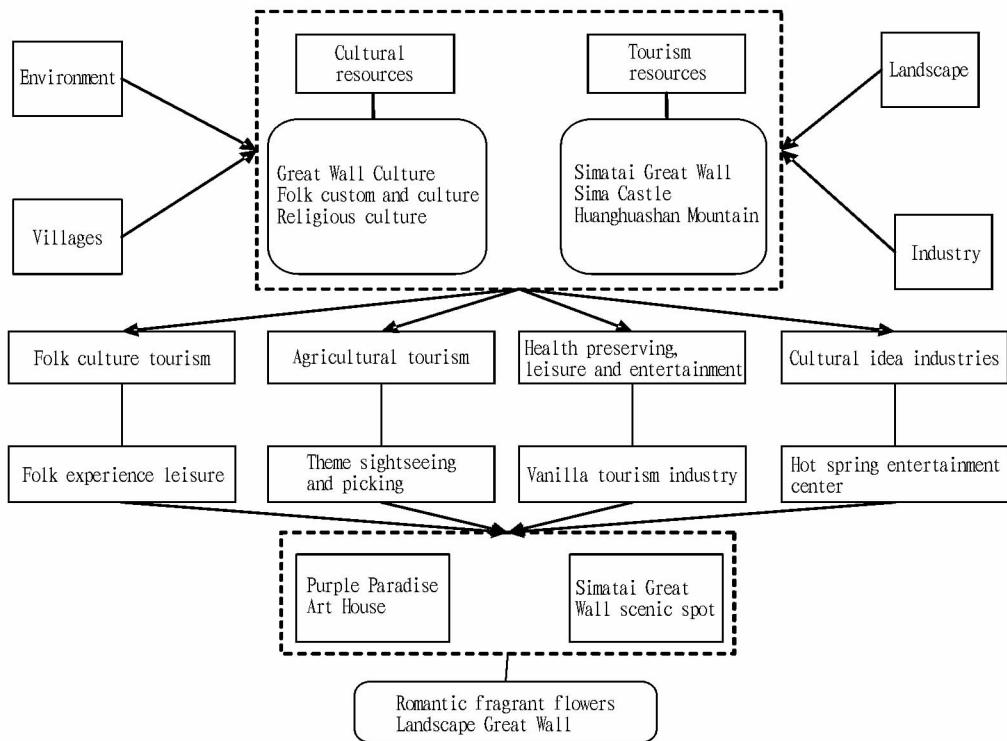


Fig.5 Development pattern of Tanghe Valley

development of the surrounding areas, break the administrative boundary of valley, and form large economic region. A typical representative of this pattern is Ming Tombs Valley in Changping District.

(v) Leisure agriculture and specialty-led pattern. This pattern uses the existing characteristic pillar industry resources, coupled with leisure agriculture, to develop environment-friendly eco-industries with the connotation of technology, green and health, extend the industrial chain, enhance the overall competitiveness of industry, develop special industries, and the de-

velopment of modern urban mountain farming (specialty fruit industry, leisure agriculture and agricultural science and technology park).

Through the effective linking and integration of agriculture, arts, culture, agriculture, tourism and folklore, the culture and the arts are turned into creative agricultural products, tourism cultural consumer goods; the agricultural products are invested with meaning, feature and value of landscape culture, offering spiritual enjoyment, which can effectively increase the value-added of agricultural products and promote the local develop-

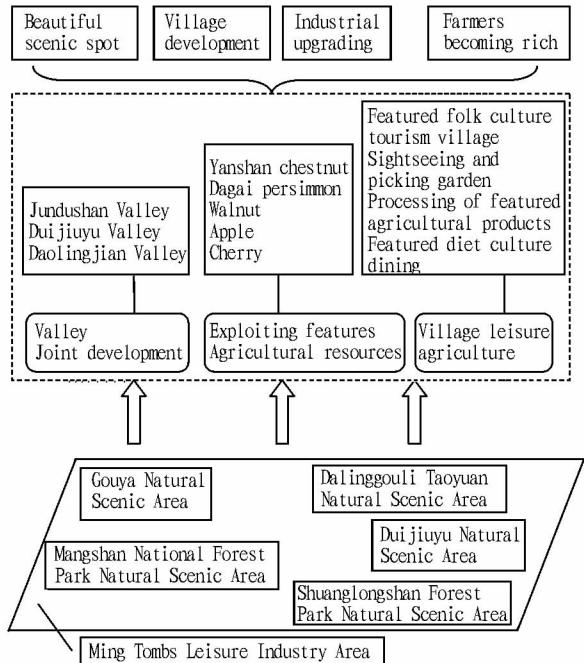


Fig. 6 Development pattern of Ming Tombs Valley

ment of rural tourism. This pattern is widespread in seven mountainous areas and a typical representative of this pattern is

Miaofengshan Valley in Mentougou District.

4 Conclusions and discussions

4.1 Conclusions The valley in mountainous areas in Beijing is basically in line with the Davis stochastic simulation process, that is, after random flow, convergence and cutting, eventually an asymmetrical inverted V shape will appear. Miyun, Yanqing, and Changping have great valley density, while Pinggu, Fangshan and Mentougou have small valley density. There is a significant positive relationship between valley density and the spatial distribution of river, reservoir.

The development pattern of valley economy is an economic development idea and way derived based on the comprehensive understanding and balanced consideration of various factors, which is conceived, generated and developed in the special region of mountainous area, on the basis of natural background of valley, both having the characteristics of path dependence, and having the characteristics of innovation of nonlinear path. The development pattern of valley economy is divided into five types: leisure and high-end upgrade-based pattern, ecological development and transition demonstration-based pattern, folk culture and creation-driven pattern, scenic spots-driven and valley-linked pattern and leisure agriculture and specialty-led pattern. The typical pattern will play a role in leading the in-depth development of valley economy.

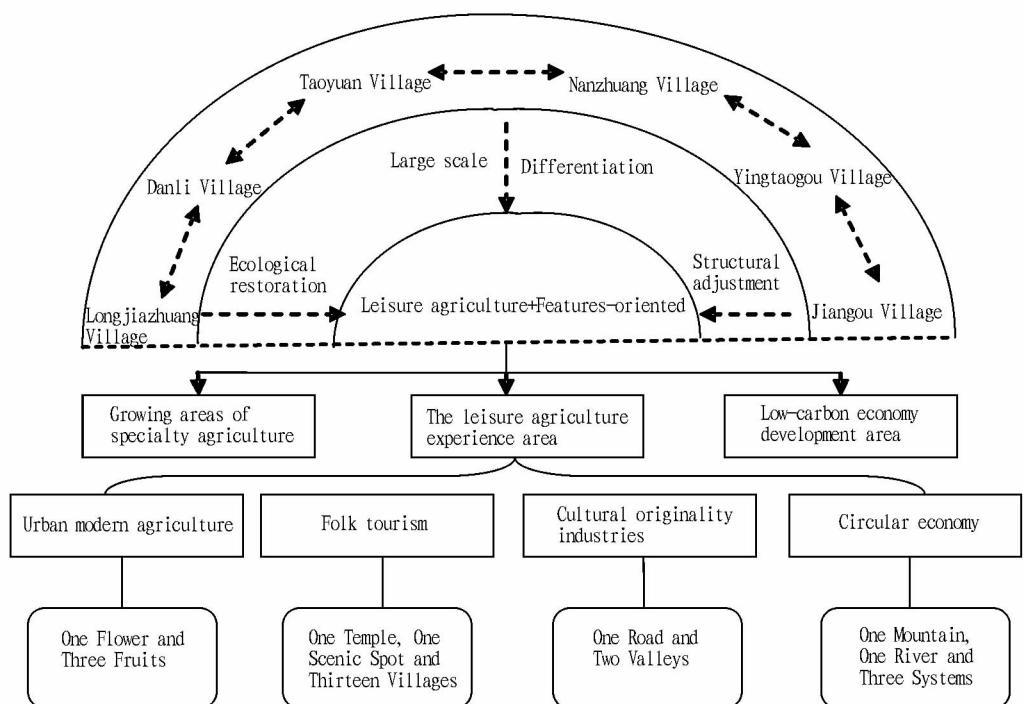


Fig. 7 Development pattern of Miaofengshan Valley

4.2 Discussions Based on geographical differences and space differentiation, valley economy is a new pattern and new perspective for the development of mountainous areas, integrating ecological protection, industrial nurture, and village integration. For in-depth study on valley economy, we should take into

account the natural and geographical conditions of valley, geographical differences, trend of economic development, development stage of valley economy and other dominant factors; quantitatively characterize the space differentiation and momentum

(To page 47)

variability, and complete the dynamic classification of land cover in Four-Lake Area during the period 2001–2007. The study shows that the area of arable land in Four-Lake Area is in the process of constant shrinking, while the area of cities and towns increases, indicating that this area is in the process of urbanization. The area of water body, woodland and grassland increases, indicating that the implementation of returning farmland to lakes, fishing and the development of forestry in recent years has achieved certain results, and the landscape ecological structure of the area takes a turn for the better. The resulting changes in the ecological environment are yet to be further studied.

The MODIS satellite revisit cycle is short, and the data acquisition is simple, without paying. The provided vegetation index data is given on the basis of completing several rounds of pretreatment. Based on the accuracy of land cover classification of MODIS satellite data, for a large area of arable land concentrated, it is acceptable^[18], so it can be expected that the application of MODIS satellite data products will be increasingly frequent. The EVI data are updated quickly, so the results of this study can be used for the fast tracking and monitoring of land cover change in this area. Of course, the above classification rules have to go through necessary on-site verification, and the identification accuracy needs to be better evaluated and analyzed, so as to lay a solid foundation for giving full play to the role of remote sensing data resources.

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(From page 36)

element of development of valley economy; sum up the mechanism and path of development of valley economy.

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