

Evaluation on the Sustainable Development of County in the Hilly Area of Northwest Sichuan from the Perspective of Niche

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Abstract: The construction of sustainable development system is an important basis for the scientific evaluation of coordinated development of urban economic, social and environmental conditions. Mianyang (2 District 6 County 1 city) is the representative of hilly northwestern county town in the underdeveloped level. Through the construction of niche suitability model, the sustainable development evaluation system of 18 indicators of the three subsystems of economy, society and environment is established, and comprehensive evaluation of ecologically sustainable and coordinated development of counties in Mianyang is conducted. The results show that the economic niche is the best in the central plain area, and the ecological niche is the best in hilly and mountainous areas, while the comprehensive niche of the Fucheng and Jiangyou cities is higher than that of other counties. The suitability level of the comprehensive niche has been growing gradually. Based on the comparison of time and space evolution of the three systems and the comprehensive niche suitability of each county town, this paper tries to put forward suggestions to promote the coordinated development of the county towns.

1. Introduction

City is the most concentrated area of human activity. County-level regions account for more than 90% of the total area in China [1]. City niche fitness is a major indicator, which represents the conformance level of the real niche and the best niche, reflecting the harmony degree of urban ecosystem, the strength of urban competitiveness and the ability of sustainable development.

At present, the rapidly developing cities are paid more attention currently, while the underdeveloped urban agglomerations in county-level are less concerned. Especially the county region towns in the hilly grounds of western mountains. This paper aims to provide a theoretical basis for the strategy and system of city's sustainable development.

2. Study Area and Pretreatment of Data Source

Mianyang City is located in the hilly area of northwestern Sichuan with the total land area of 20,248.4 square kilometers, covering from 31 degrees 16 minutes to 31 degrees 48 minutes of north latitude, and from 104 degrees 29 minutes to 104 degrees 50 minutes of east longitude [2]. The topography of Mianyang slopes from northwest to southeast. The western part of this city is a transitional zone from the Qinghai-Tibet Plateau to the Sichuan Basin; the southeastern part is hilly regions of Sichuan Basin, with rolling hills accounting for about 75% of the area [3].

The statistics of the proposed indicator system come from "Statistical Yearbook of Mianyang from 2012 to 2016", which includes statistics of Mianyang from 2011 to 2015. According to the niche fitness theory, the suitability of regional habitat condition is measured by the regional niche fitness, and the ecological niche fitness of economic, social and environmental subsystems as well as the comprehensive ecological niche fitness are selected as evaluation indicators which are screening and normalized later.

3. Research Method

Aiming at the 3 districts, 5 counties and 1 city in Mianyang City, a specific indicator system of sustainable development evaluation in the county region is constructed in this study. After factor analysis and principal component screening of the related indicators, social and environmental subsystems are obtained, besides, the county normalization is carried out.

The standardized values of ecological indicators needed for the development are recorded as X1, X2.....Xn [4-5]. Appropriate amendments are made based on the summary of the previous studies, and the calculation model of urban niche fitness is determined as equation (1):

$$F_i = \sum_{j=1}^m \beta_j \frac{\min\{|x_{ij} - x_{aj}\} + \frac{1}{2} \times \max\{|x_{ij} - x_{aj}\}\}}{|x_{ij} - x_{aj}| + \frac{1}{2} \times \max\{|x_{ij} - x_{aj}\}\}}$$

In addition, the comprehensive niche fitness is calculated by the niche fitness and corresponding weight of each indicator.

3.1 Calculation indicator and niche fitness model

The weight and the optimal niche of each ecological factor β_j are determined with AHP [6], the weight of niche fitness for each factor is determined by the entropy weight method. Related indicators and the weight are shown in Table 1.

Table 1 Indicator weight

Assessment factor(β_i)	Single indicator	Weight of ecological factor
Economic development level 0.4013	Per capita GDP (RMB yuan)	0.2590
	Average salary of employed persons (RMB yuan)	0.1010
	Non-public economic added value (RMB ten thousand yuan)	0.2332
	Per capita fixed asset investment (RMB yuan)	0.2476
	Per capita financial income (RMB yuan)	0.1182
	Per capita financial expenditure (RMB yuan)	0.0410
Social living level 0.1678	Household electricity consumption (ten thousand kwh)	0.1342
	Number of Social Welfare Adoption Units (unit)	0.0980
	Number of health care institutions (unit)	0.2498
	Population density (person/ km ²)	0.1821
	Internet users (household)	0.2279
Resources and environment level 0.2893	Number of new rural cooperative medical insurance (person)	0.2080
	Forest area (hectare)	0.0420
	Sulfur dioxide emissions (tons)	0.2780
	Nitrogen oxide emissions (tons)	0.2972
	Smoke (powder) dust emissions (tons)	0.2618
	Number of sewage treatment plant (unit)	0.0456
	Annual rainfall (mm)	0.0753

3.2 Spatial Autocorrelation Analysis

Spatial autocorrelation analysis of GIS can be used to fundamentally improve the statistical analysis, and measure the spatial difference and pattern evolution between urban niches. In this paper, local spatial autocorrelation of niche fitness is analyzed with Getis-Ord G* [7].

4. Results and Analysis

Table 1 shows the weight of sustainable development indicators. The dominant indicators affecting economic niche fitness are GDP per capita; the dominant indicators affecting social niche fitness are household electricity consumption and population density; the dominant indicators affecting environmental niche fitness are sulfur dioxide emissions and smoke (powder) dust emission.

4.1 Temporal analysis of urban niche fitness

(1) From the perspective of time, as shown in Figure 1. The environmental niche fitness obviously fluctuates over time; economic niche fitness of Jiangyou has significantly increased; social niche fitness and environmental niche fitness of Fuchen district have significantly increased. Part of the reasons for this situation is that during the expansion process of the city.



Fig.1 Administrative divisions of Mianyang City

(2) From the perspective of space, the distribution characteristics of niche fitness of urban sustainable development are analyzed, as shown in Figure 1. For economic and social niche fitness, cities in central plain area are obviously with a higher one, the southeast hilly areas are in the middle, northwest mountain area is with a lower one, Beichuan is weaker than Pingwu.

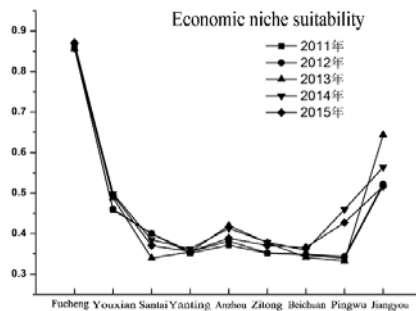


Fig.2 Economic niche suitability of Mianyang City, district and county in 2011-2015

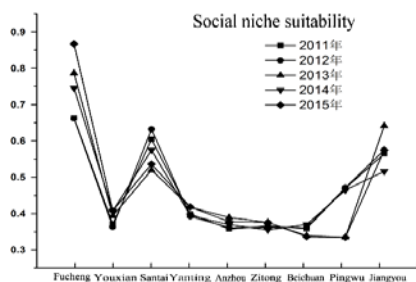


Fig.3 Social niche suitability of Mianyang City, district and county in 2011-2015

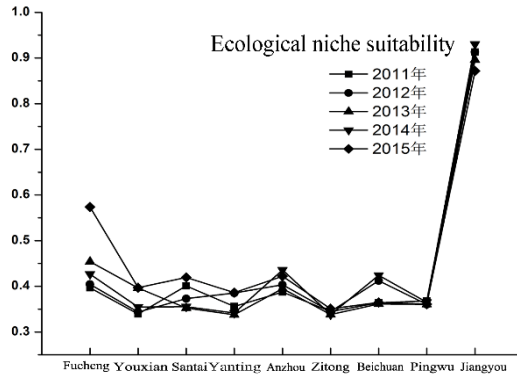


Fig.4 Ecological niche suitability of Mianyang City, district and county in 2011-2015

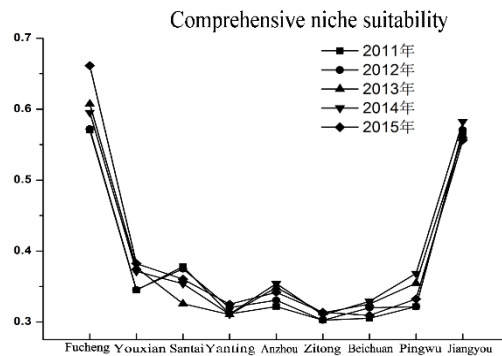


Fig.5 Comprehensive niche suitability of Mianyang City, district and county in 2011-2015

4.2 Spatial pattern evolution of urban niche fitness

As shown in Fig. 6 to Fig. 8, the hot spots of the comprehensive niche fitness are clustered in the central plains, and the cold spots are mainly distributed in the southeast hilly areas and the northwest mountainous areas with relatively backward economy and low living environment. Cold spots decreased year by year, with a transformation to the sub-cold zone and sub-hot zone. Comparing the spatial association pattern of comprehensive niche fitness, it is clear that the comprehensive development level of county region towns in Mianyang is gradually increasing.

5. Suggestions on Sustainable Development of Hilly counties in Norwestern Sichuan

Based on the above conclusions, two suggestions are proposed for the sustainable development of Mianyang county regions:

(1) The economic niche fitness in the central plain area is better, the environmental niche fitness in the hilly and mountainous area is better, the social niche fitness of all county region towns is in the similar level. Therefore, the same city construction of Mian (Fucheng and Youxian District) to Jiang (Jiangyou City) to an (Anzhou District) to Bei (Chuan) should be fully utilized, establish an interregional cooperation mechanism in the hilly area of northwest Sichuan, and promote the interdependent, mutual integrated and complementary cooperation, achieving the common development of the county region towns.

(2) Santai, Zitong, Yanting, Pingwu and Beichuan County are located in the hilly and mountainous area far away from the center of Mianyang City. Although the polarization effect of their growth pole cannot be exerted, each of them has own featured resources and superior environmental ecological factor. As a result, their similarities in natural resource, transport and location condition should be combined, and the common featured resource should be regionally co-ordinated planned and integrated. In this way, the disorder competition among counties can be suppressed, and the comprehensive competence of county region towns can be improved.

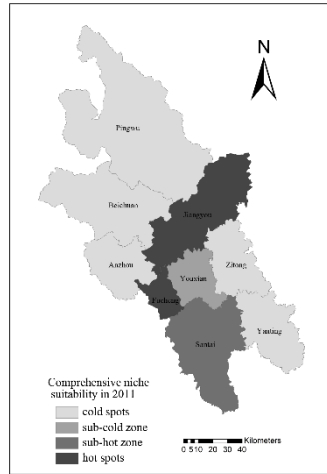


Fig.6 Comprehensive niche Spatial association pattern of Mianyang City, district and county in 2011

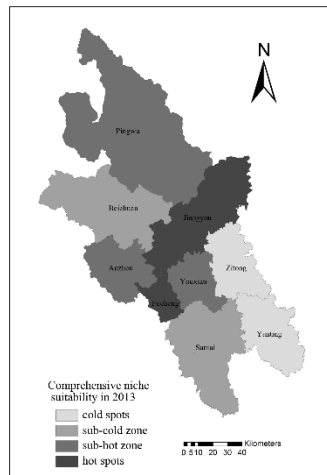


Fig.7 Comprehensive niche Spatial association pattern of Mianyang City, district and county in 2013

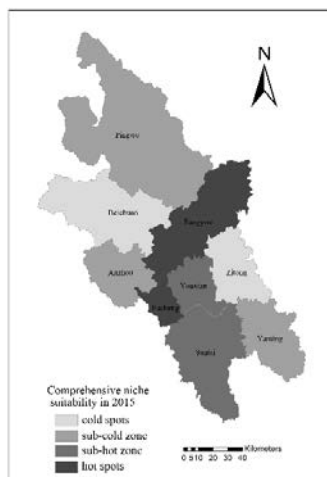


Fig.8 Comprehensive niche Spatial association pattern of Mianyang City, district and county in 2015

6. Conclusion

This paper analyzes the spatial and temporal evolution of the niche in west Sichuan hilly

counties and finds out the problems existing in the urban development, a case study of Mianyang City. For each city, reasonable and phased plan and implementation should be completed according to its own characteristics and advantages, achieving a coordinated and sustainable development of economy, society and ecology. Urban economic development and social progress must be based on a good ecological environment, and the laws and regulations related to sustainable development are necessary to be strengthened.

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