

Analysis on the Coupling Coordination of Land Space in the Northern Metropolitan Area of Leshan City

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Abstract

In this study, the coupling and coordination evaluation index system of “Production-living-ecological” system was constructed for the northern Leshan metropolitan area, and the spatial production function, living function and ecological function of the metropolitan area were identified and evaluated. At the same time, according to the data of Leshan Statistical Yearbook and the statistical yearbook of each district and county of Leshan City, the measurement model of the coupling coordination degree of the spatial function of “Production-living-ecological” in Leshan Lebei metropolitan area was constructed.

Keywords

“Production-Living-Ecological” Function, Metropolitan Area, Space-Time Evolution, Coupling Coordination

1. Research Background

In May 2019, China formally proposed the establishment of a territorial spatial planning system, taking it as a guide for national spatial development, a spatial blueprint for sustainable development, and a basic basis for various development, protection and construction activities. In the past, the main functional zone planning, land use planning and urban and rural planning will be integrated into unified territorial spatial planning, realizing the “multiple plans into one”, and strengthening the guiding and binding role of territorial spatial planning on all special plans. At the same time, the collaborative study by the famous German theoretical physicist Hermann. Hakon was founded in the 1970s. Collaborative science is a cross-sectional science spanning natural science and social

science, studying the laws and characteristics of the system transformation from disorder to order. Leshan city is an excellent tourist city in China, with many tourist attractions in the city. In 2018, the Third Plenary Session of the 11th Sichuan Provincial Party Committee proposed to “support Leshan to build a major tourist destination in the world”. Although in the regional development strategy, superior planning, give Leshan high positioning, but the comprehensive analysis of urban and tourism development status, Leshan geographical location, urban economic growth, population contraction, tour contradiction, urban tourism industry space, global tourism lack of system support, scenic spots and urban development, urban landscape features to be promoted. At the same time, the proportion of inbound tourists in Leshan city is small, and the target gap with the world’s important tourist destinations is large. Facing the gap between the development goal and the reality, it is necessary to have scientific planning to lead the coordinated and rapid development of cities (Sun et al., 2022).

2. A Model of Coupling Coordination Measurement Based on “Production-Living-Ecological”

2.1. Scope of Study

The northern metropolitan area of Leshan City refers to the combination of Leshan central urban area (Central District, Shawan, Wutongqiao), Emeishan urban area, Jiajiang County, Qianwei County, and Jingyan County. It is the core urban area radiating the whole city. In recent years, the central urban area of Leshan, Mount Emei and Jiajiang began to show a trend of continuous and combined urban development. Its economic scale and growth rate are ahead of other regions (Chakraborty et al., 2021).

2.2. Construction of Index System

2.2.1. Construction of Evaluation Index System for “Production-Living-Ecological” System Coupling and Coordination in Leshan Northern Metropolitan Area

The identification and evaluation of “Production-living-ecological” functions is an important prerequisite for scientific delimitation of “Production-living-ecological” space and optimization of land space development. On the basis of previous studies, combined with the “Production-living-ecological” space theory of land space planning, the paper takes the northern metropolitan area of Leshan City as the research object, and will identify and evaluate the production function, living function and ecological function of the metropolitan area space. Based on the comprehensive consideration of the development status of the northern metropolitan area of Leshan City and the scientificity and operability of the selection of evaluation indicator factors, 35 indicators were selected to preliminarily construct the “Production-living-ecological” system coupling and coordination evaluation indicator system, including 10 production function indicators, 12 living function indicators and 13 ecological function indicators (see **Table 1** below). The entropy

Table 1. Evaluation index system of “production-living-ecological” system coupling and coordination.

Target layer	Subsystem	Index layer	Weight	
Evaluation of “Production-living-ecological” system coupling and coordination	Production function	The GDP of the secondary industry	0.0816	
		The GDP of the tertiary Industry	0.1226	
		Value added of private economy	0.0862	
		Investment in fixed assets	0.0851	
		Total industrial output value above designated size	0.0818	
		Total retail sales of consumer goods	0.1163	
		Actual cultivated land area at the end of the year	0.0841	
		Added value of agriculture, forestry, animal husbandry and fishery	0.0875	
		Balance of loans of financial institutions at the end of the year	0.1609	
		Employees	0.0939	
		Production function	The size of the permanent population	0.0772
			Urban population size	0.0929
	Rural population		0.0692	
	Urbanization rate		0.0797	
	Highway mileage		0.0686	
	Fixed phone users		0.0974	
	Mobile phone users		0.0994	
	Number of primary schools		0.0891	
	Primary school students		0.0913	
	The number of ordinary middle schools		0.0762	
	Number of medical and health beds		0.0954	
	Urban and rural per capita disposable income		0.0636	
	Ecology function	Cultivated area	0.0497	
		Woodland area	0.0749	
		Grass area	0.1648	
		Water area	0.0771	
		Per capita forest area	0.1289	
		Per capita water resources	0.0634	
		percentage of forest cover	0.0805	
		Landscape fitness (LAI)	0.0774	
		Highway mileage	0.0527	
		Fertilizer application intensity	0.0632	
Industrial development intensity		0.0509		
Landscape sensitivity (LSI)		0.0560		
Landscape vulnerability (LVI)	0.0603			

Note: P represents production function, L represents living function; Or P represents production function, L represents ecological function; Or P for living function, L for ecological function.

method is used to calculate the weight of each index.

1) Production space. According to the “Production-living-ecological” space theory of land space planning, production space refers to the regional space mainly providing agricultural products, industrial products and service products, as the place where people engage in production and business activities. The indicators are selected on the basis of reference to relevant literature research, taking into account the development status of the northern metropolitan area of Leshan City and the operability of data collection. The GDP of the secondary industry, added value of private economy and other indicators are selected to characterize the production space of industry and service products in the northern metropolitan area of Leshan City, which are positive indicators; The actual cultivated land area at the end of the year, the added value of agriculture, forestry, animal husbandry and fishery and other indicators are selected to characterize the agricultural production space in the northern metropolitan area of Leshan City (Liu & Zhou, 2021).

2) Living space is the place used by people in their daily life activities, providing necessary space conditions for people’s living and public activities. It mainly includes urban living space and rural living space (Gonçalves & Ferreira, 2015).

3) Ecological space refers to the regional space that plays an important role in ecological protection and has an important impact on maintaining regional ecological security and sustainable development, and can provide ecological services and products. It is the guarantee of human production and life, an area that must be strictly controlled and maintained, mainly including important ecological space and general ecological space. The LAI, LSI and LVI indexes are calculated by Fragstats4.2. The detailed calculation of the indexes refers to the research results of Zhang Lifang et al., and will not be repeated here (Zhang et al., 2020).

2.2.2. The Coupling and Coordination Model of the “Production-Living-Ecological” System in the Northern Urban Circle of Leshan City

The measurement model of the spatial function coupling coordination degree of “Production-living-ecological” in the northern metropolitan area of Leshan City is constructed. The specific calculation formula is as follows:

$$C = 3\left\{\frac{P \times L \times E}{P + L + E}\right\}^{\frac{1}{3}} \quad (1)$$

Among them, C is the coupling degree of the “San Sheng” spatial function subsystem in the northern metropolitan area of Leshan City, with a value range of [0, 1]. The larger the value, the stronger the interaction between subsystems. P , L and E are respectively the comprehensive evaluation values of production function, living function and ecological function in the “Production-living-ecological” spatial function system of the northern metropolitan area of Leshan City (Daunt et al., 2021).

In order to further analyze the interaction between the “Production-Living” function, “Production-Ecology” function and “Living-Ecology” function of the northern metropolitan area of Leshan City, the coupling degree model can evolve as follows:

$$C_1 = 2\left\{\frac{P_i \times L_i}{P_i + L_i}\right\}^{1/2} \quad (2)$$

$$C_2 = 2\left\{\frac{P_i \times E_i}{P_i + E_i}\right\}^{1/2} \quad (3)$$

$$C_3 = 2\left\{\frac{L_i \times E_i}{L_i + E_i}\right\}^{1/2} \quad (4)$$

Although the degree of coupling can reflect the degree of interaction between the functions of Leshan Global Tourism Spatial Collaborative Planning System, it cannot indicate whether the functions promote each other at a high level or restrict each other at a low level. Therefore, the coupling coordination index is introduced to build the functional coupling coordination model of Leshan Global Tourism Spatial Collaborative Planning System. The specific calculation formula is as follows:

$$D = \sqrt{C \times T}, T = \alpha P \times \beta L \times \chi E \quad (5)$$

In the formula: C coupling degree of the “Production-living-ecological” spatial function subsystem in the northern metropolitan area of Leshan City; D is the coupling and co scheduling of the “Production-living-ecological” spatial function subsystem in the northern metropolitan area of Leshan City; P, L, E are the evaluation values of production, living and ecology of Leshan City respectively; α, β, χ are respectively the undetermined coefficients of production, living and ecology. On the basis of referring to the opinions of relevant experts, the undetermined coefficients are determined as $\alpha = 0.4, \beta = 0.3$ and $\chi = 0.3$; Similarly, formula (5) can be used to obtain the coupling and co scheduling between the two functions of Leshan Global Tourism Spatial Collaborative Planning System. The calculation formula is as follows:

$$D = \sqrt{C \times T} \quad (6)$$

Among them, T is: $T_1 = \alpha P \times \beta L$ or $T_2 = \alpha P \times \chi E$ or $T_3 = \beta L \times \chi E$

The D values corresponding to three different T values can be shown in **Table 2** as the synergistic relationship between production and life.

2.2.3. Data Source

The data required for this study mainly include long-term statistical data, including social economic data and ecological environment index data in 2010, 2015 and 2018. The social economic data are mainly from the Statistical Yearbook of Leshan City and the statistical yearbooks of districts and counties in Leshan City published by China Statistics Press in 2011, 2016 and 2019. The ecological environment data is mainly the land use data of the third period from

Table 2. Analysis on the “Production-Living” Coordination of Production-living-ecological Space in the Northern Metropolitan Circle of Leshan City.

Coordination degree D	category	Subcategory	Subsystem comparison	Coordinate characteristics
$0 < DP-L \leq 0.2$	Unmatched	Serious unmatched	$f(P) - f(L) > 0.1$	Lagging of living Function
			$ f(P) - f(L) \leq 0.1$	Synchronous
$0.2 < DP-L \leq 0.4$	Transformation and development	Basically uncoordinated	$f(L) - f(P) > 0.1$	Production function lags behind
			$f(P) - f(L) > 0.1$	Lagging of living function
$0.4 < DP-L \leq 0.6$	Coordinated development	Basically coordinated	$ f(P) - f(L) \leq 0.1$	Synchronous
			$f(L) - f(P) > 0.1$	Production function lags behind
$0.6 < DP-L \leq 0.8$	Coordinated development	Moderately coordinated	$f(P) - f(L) > 0.1$	Lagging of living function
			$ f(P) - f(L) \leq 0.1$	Synchronous
$0.8 < DP-L \leq 1$	Highly coordinated	Highly coordinated	$f(L) - f(P) > 0.1$	Production function lags behind
			$f(P) - f(L) > 0.1$	Lagging of living function
			$ f(P) - f(L) \leq 0.1$	Synchronous
			$f(L) - f(P) > 0.1$	Production function lags behind

Note: P represents production function, L represents living function; Or P represents production function, L represents ecological function; Or P for living function, L for ecological function.

2010 to 2018, which is from the Data Center of Resources and Environment Science, Chinese Academy of Sciences (<http://www.webmap.cn/main.do?method=index>). According to the research methods of Zhang et al. (2020), Tian et al. (2019), Xu et al. (2018) and others, 6 types of cultivated land, grassland, forest land, water area, construction land and unused land were obtained.

3. Summary

This paper mainly discusses the coupling collaborative measurement model based on “Production-living-ecological” and the construction of coupling coordination evaluation index system of “Production-living-ecological” system in Lebei metropolitan area. This paper provides a policy reference for the coupling and coordination development of Leshan northern metropolitan circle, and also provides reference for the coupling and coordination of metropolitan circle in other provinces (cities). In the future, we will further strengthen the in-depth research on the comparison of “Production-living-ecological” functions among various regional types and the optimization of urban “Production-living-ecological” functions (Xing et al., 2021).

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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