

Research on Measurement and Coupling Coordination of Land Intensive Utilization and New Urbanization

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Abstract. This paper constructs an intensive land use system from the perspective of land input, output and sustainable development, constructs a new urbanization system from the perspectives of ecology, population, economy and society, and applies entropy weight method to 31 provinces, municipalities and autonomous regions. Based on the model of coupling degree and coordinated development degree, this paper divides the types of the two coupled and coordinated development stage by using intensity levels and a new type of urbanization.

1. Introduction

Land intensive utilization is the modern agricultural mode which not only maximizes profits, returns, and agricultural crop yields on smaller land areas, relying on advanced agricultural modern high-tech and management methods and investing in the same elements of production materials and labor force, but also guarantees and pays attention to land maintenance and sustainable development. New-type urbanization refers to the integration of urban and rural areas and the urban-rural integration as its development characteristics. It aims to promote social and economic development and achieve common prosperity. Ultimately, it is an important national development strategy to achieve a harmonious, stable, and sustainable innovation and development trend among population, economy, society, and ecological urbanization.

Research on land intensive use in academic is mostly focused on the evaluation of land intensive use, the relationship between land intensive use and urbanization, and the coordinated development of land intensive use and economy. [1, 2, 3] This paper constructs an evaluation index system for land intensive use and a new urbanization evaluation system. The entropy weighting method was used to measure the weights of various indicators, land intensive use and the intensity of new urbanization development, and to establish a harmonized development stage type of both the coupling degree and the coordinated development degree model division. This will provide a certain reference for clarifying and understanding the status of land intensive utilization and new urbanization in different provinces, municipalities and autonomous regions, and for the relevant land planning departments to formulate policies and regulations according to different provinces, municipalities and autonomous regions.



Table 1. Intensive Utilization of Land and New-type Urbanization Indicator Attributes and Their Weights

Target layer	Criteria layer	Indicator layer	Attributes	Weights
Intensive use of land	Land input intensity and utility	The number of laborers in the built-up area (Person/km ²)	positive	0.011
		The proportion of urban construction land in urban area (%)	positive	0.014
		Total crop area sown (Thousand hm ²)	positive	0.027
		Agricultural electricity (Ten thousand kwh)	positive	0.049
		Total agricultural water use (Billion m ³)	positive	0.032
	Land output benefits	Per capita food production (kg)	positive	0.023
		Unit Land Area Public Finance Revenue (Ten thousand yuan /km ²)	positive	0.080
		Total land area Retail sales of consumer goods (Ten thousand yuan)	positive	0.041
		Unit land area real estate development investment (Ten thousand yuan)	positive	0.035
		Unit land area year-end financial institutions Various deposit balances (Ten thousand yuan)	positive	0.05
	Sustainable land development capacity	Green area (hm ²)	positive	0.039
		Fertilizer application amount for agriculture (Ten thousand t)	negative	0.035
		Industrial SO ₂ emissions per unit area of land (t/km ²)	negative	0.029
		The amount of industrial wastewater discharged per unit area of land (Ten thousand t/km ²)	negative	0.033
		Industrial land smoke area dust emissions per unit area (t/km ²)	negative	0.042
New urbanization development level	Eco-urbanization	Every million people own a bus (Vehicle)	negative	0.005
		Built-up area green coverage area (hm ²)	positive	0.026
		Drainage pipe length (km)	positive	0.032
	Population urbanization	Tertiary industry employee at the end of the year (person)	positive	0.021
		Number of Basic Pensions, Medical and Unemployment Insurance for Urban Employees (Person)	positive	0.039
		Number of college students per 10,000 students (Person)	positive	0.015
	Economic urbanization	Per capita GDP (Yuan)	positive	0.024
		Total wages of employees on the job (Ten thousand yuan)	positive	0.043
		Total fixed and liquid assets of industrial enterprises (Ten thousand yuan)	positive	0.034
		Total output value of foreign-invested enterprises (Ten thousand yuan)	positive	0.084
	Social urbanization	Number of hospitals and hospitals(Pieces)	positive	0.021
		Internet broadband access users (Ten thousand)	positive	0.033
		Number of post offices at the end of the year(Pieces)	positive	0.023
		Mobile phone number of users at the end of the year (Ten thousand)	positive	0.028
		Real City Road Area at the End of the Year (Ten thousand m ²)	positive	0.029

2. Index system and research method

2.1. Intensive Utilization of Land and Construction of New Urbanization Index System

When selecting indicators, this paper ensures that the indicators can fully and objectively reflect the actual development of 31 provinces, municipalities, and autonomous regions in mainland China, and constructs an evaluation index system for land intensive utilization and new urbanization as shown in Table 1.

2.2. Intensive Utilization of Land and Measurement of New Urbanization Level

Firstly this paper constructs a 30*31 judgment data matrix, of which 30 are 30 horizontal intensive land use and new urbanization evaluation indicators and 31 are the vertical portraits of 31 provinces, cities, and autonomous regions of China's mainland. The entropy method is used to measure the judgment matrix. The steps for calculating the entropy method are as follows:

- (1) The proportional swap of land intensive use and new urbanization indicators: $Q_{ij} = x_{ij} / \sum_{i=1}^n x_{ij}$;
- (2) The information entropy of intensive land use and new urbanization indicators: $e_j = -k \sum_{i=1}^n Q_{ij} \ln Q_{ij}$;
- (3) The redundancy of land intensive use and new urbanization indicators: $d_j = 1 - e_j$;
- (4) The weight of land intensive use and new urbanization indicators: $w_j = d_j / \sum_{j=1}^m d_j$;
- (5) The intensity of intensive land use and Intensive use of land and new urbanization: $W_i = \sum_{j=1}^m (w_j * X_{ij})$;

Explanation: m is the number of land intensive utilization and new urbanization evaluation indicators; n is the number of provinces, municipalities and autonomous regions; k is adjustment factor, k is calculated as $k = 1/\ln n$; X_{ij} is the standardized value of the jth index of the ith province, municipality and autonomous region x_{ij} is the initial value of the jth index of the th province and municipality, The

X_{ij} calculation method is: when x_{ij} is positive, $X_{ij} = \frac{x_{ij} - x_j \min}{x_j \max - x_j \min}$; when x_{ij} is negative,

$$X_{ij} = \frac{x_j \max - x_{ij}}{x_j \max - x_j \min} .$$

2.3. The Division of Coordinated Stages of Intensive Land Use and New Urbanization

This paper constructs an evaluation model of the degree of coupling and coordinated development of land intensive utilization and new urbanization applicable to this paper, where the formula for coupling as follows:

$$C = \left[(W_1 * W_2) / (W_1 + W_2)^2 \right]^{1/2}$$

W_1 and W_2 are the integrated intensity of land intensive utilization and new urbanization development in 31 provinces, municipalities and autonomous regions respectively, C is the degree of coupling between the two. C standard is as follows: $C \in [0, 0.3)$ belongs to low level coupling; $C \in [0.3, 0.5)$ belongs to antagonistic coupling; $C \in [0.5, 0.8)$ belongs to running-in coupling; $C \in [0.8, 1.0]$ belongs to high level coupling

At the same time, in order to avoid that the average level of intensive land use and new-type urbanization from a certain province is relatively low, but the degree of coupling is higher, which does not meet the objective reality, this paper introduces the degree of coordinated development based on the

coupling degree formula, and truly measures and reflects the coordinated development status and trend of the two. The formula for harmonizing the degree of development is as follows:

$$D = \sqrt{C * T} \quad T = \alpha U_1 + \beta U_2$$

D is the degree of coordinated development between the two, T is Comprehensive coordination coefficient. α And β are the contribution coefficients of land intensive use and new urbanization. This article believes that the two are in equal status and are of a very important degree and influence each other, promote each other, and contain each other.

3. Intensive Utilization of Land and the Development Level

This article categorizes 31 provinces, cities and autonomous regions in mainland China according to their geographical locations: Western China, Central China, Northeast China, Eastern China, etc. According to Table 2, presently, the new urbanization in the eastern region is ahead of the intensive use of land, the new urbanization in the western region is relatively balanced with the development of land intensive use, while the new urbanization in the central and northeast regions lags behind the development of intensive land use. The rank of land intensive utilization is as follows: Eastern Region (0.151)> Central Region (0.142)> Northeast Region (0.111)> Western Region (0.063). The order of new urbanization intensity is as follows: Eastern Region (0.184)> Central Region (0.115)> Northeastern Region (0.099)> Western Region (0.063).

3.1. Intensive use of land

The intensity of land input in the western region is ahead of the sustainable use of land, but the land output benefits lag behind; The intensity of land input in the central region is balanced with sustainable land use, and both are ahead of the land output benefits; Northeast China has the most balanced development in terms of land input, land output, and sustainable land use. In the eastern region, land input intensity lags behind sustainable land use, and land output benefits are the highest (Table 2). The order of land input intensity is as follows: Central (0.056)> Eastern (0.037) = Northeast (0.037)> Western (0.026), the order of land output benefits is as follows: Eastern (0.062)> Northeast (0.036)> Central (0.029)> Western (0.015), the order of sustainable land use is as follows: Central (0.057)> Eastern (0.052)> Northeast (0.038)> Western (0.022).

3.2. New urbanization development level

The development of social urbanization in the western, central and northeast regions is all ahead of the economic urbanization, the next rank is the development of ecological urbanization, and population urbanization is the most lagging behind. The development of economic urbanization in the eastern region ranks first, social urbanization temporarily ranks second, and both eco-urbanization and population urbanization are relatively weak and relatively balanced. (Table 2) The order of ecological urbanization is as follows: Eastern (0.027)> Central (0.020)> Northeast (0.017)> Western (0.011), the order of population urbanization is as follows: East (0.028)> Central (0.016)> Northeast (0.014)> West (0.010). The order of economic urbanization is as follows: East (0.075)> Middle (0.032) = Northeast (0.032)> West (0.015). The order of social urbanization is as follows: East (0.054)> Central (0.047)> Northeast (0.036)> West (0.027).

Table 2. Intensive use of land and the intensity of new urbanization development

		Intensive use of land					New urbanization development level					
		Land input intensity	Land output benefits	Sustainable land	Comprehensive intensive use	order	Eco-urbanization	Population urbanization	Economic urbanization	Social urbanization	Integrated urbanization	order
Western Region	Guangxi	0.034	0.011	0.031	0.075	22	0.015	0.010	0.023	0.033	0.081	21
	Ningxia	0.007	0.011	0.013	0.031	30	0.006	0.003	0.006	0.011	0.027	27
	Xinjiang	0.075	0.015	0.015	0.105	14	0.004	0.009	0.008	0.005	0.026	29
	Xizang	0.004	0.004	0.004	0.012	31	0.001	0.006	0.000	0.000	0.007	30
	Inner Mongolia	0.036	0.026	0.035	0.098	18	0.015	0.008	0.028	0.029	0.079	22
	Chongqing	0.015	0.021	0.019	0.055	26	0.019	0.025	0.021	0.031	0.096	16
	Sichuan	0.035	0.021	0.030	0.086	20	0.024	0.023	0.040	0.078	0.164	5
	Guizhou	0.019	0.020	0.030	0.068	23	0.010	0.005	0.008	0.029	0.053	25
	Yunnan	0.028	0.015	0.022	0.064	25	0.010	0.008	0.010	0.022	0.050	26
	Gansu	0.028	0.009	0.011	0.048	27	0.009	0.006	0.014	0.034	0.063	24
	Qinghai	0.004	0.012	0.030	0.046	28	0.002	0.001	0.001	0.003	0.006	31
	Shanxi	0.023	0.017	0.027	0.067	24	0.013	0.015	0.025	0.045	0.097	15
	Average	0.026	0.015	0.022	0.063		0.011	0.010	0.015	0.027	0.063	
Central Region	Hunan	0.084	0.029	0.067	0.180	4	0.019	0.017	0.026	0.048	0.110	13
	Henan	0.079	0.045	0.093	0.217	3	0.022	0.023	0.043	0.065	0.153	6
	Jiangxi	0.032	0.023	0.046	0.101	17	0.016	0.011	0.022	0.036	0.085	20
	Shanxi	0.065	0.022	0.056	0.142	9	0.012	0.012	0.023	0.041	0.088	18
	Hubei	0.040	0.029	0.040	0.108	12	0.021	0.019	0.041	0.045	0.127	11
	Anhui	0.039	0.025	0.042	0.106	13	0.027	0.014	0.036	0.049	0.125	12
	Average	0.056	0.029	0.057	0.142		0.020	0.016	0.032	0.047	0.115	
North-east area	Heilongjiang	0.057	0.027	0.020	0.104	15	0.015	0.012	0.021	0.039	0.087	19
	Jilin	0.024	0.032	0.030	0.085	21	0.014	0.010	0.021	0.024	0.069	23
	Liaoning	0.031	0.050	0.063	0.144	8	0.023	0.020	0.055	0.044	0.143	8
	Average	0.037	0.036	0.038	0.111		0.017	0.014	0.032	0.036	0.099	
East area	Beijing	0.022	0.092	0.012	0.126	10	0.019	0.031	0.053	0.024	0.127	10
	Tianjin	0.021	0.043	0.023	0.088	19	0.017	0.014	0.036	0.026	0.093	17
	Shanghai	0.026	0.207	0.058	0.292	1	0.020	0.025	0.075	0.023	0.143	7
	Zhejiang	0.027	0.045	0.046	0.119	11	0.027	0.032	0.072	0.064	0.195	4
	Guangdong	0.064	0.046	0.069	0.179	5	0.051	0.061	0.166	0.117	0.395	1
	Jiangsu	0.049	0.044	0.069	0.163	7	0.053	0.034	0.161	0.081	0.328	2
	Shandong	0.067	0.030	0.067	0.164	6	0.044	0.038	0.106	0.102	0.290	3
	Hebei	0.061	0.053	0.125	0.239	2	0.018	0.018	0.036	0.058	0.130	9
	Fujian	0.022	0.034	0.046	0.101	16	0.014	0.013	0.043	0.038	0.108	14
	Hainan	0.009	0.022	0.005	0.037	29	0.005	0.016	0.002	0.003	0.026	28
	Average	0.037	0.062	0.052	0.151		0.027	0.028	0.075	0.054	0.184	

4. The Coupling of Land Intensive Use and New Urbanization

According to Table 3, the degree of coupling between land intensive use and new urbanization in 31 provinces, cities and autonomous regions in China is between 0.3 and 0.5, which is affiliated with antagonistic coupling levels. In order to further distinguish antagonistic differences within these provinces, municipalities and autonomous regions, this article further divides them into the following parts within the interval of antagonistic coupling: (1) High-grade antagonistic coupling (C between 0.49-0.5);(2) Low-grade antagonistic coupling (C between 0.46-0.47);(3) Mid-grade antagonistic coupling (C between 0.47-0.48);(4) Low-grade antagonistic coupling (C between 0.46-0.47);(5) Low-grade antagonistic coupling (C less than 0.46). At present, the land intensive use and the new urbanization in the northeastern and central regions are both coupled at a high level of antagonism, the eastern region is a medium and high grade antagonistic coupling, and the western region has the lowest degree of coupling, manifested as intermediate-grade antagonistic coupling. The land intensive use and new urbanization in most provinces, municipalities and autonomous regions are at a high level of antagonism coupled level, However, there are also some cases of “false high-level coupling” in Ningxia and Gansu (low intensity of land intensive use and new urbanization), Therefore, this paper introduces the harmonized development degree D to divide the coordinated development of land intensive use and new-type urbanization, so as to make up for the deficiency of “false high-level coupling”.

Table 3. The Coupling and Coordination Stage Types of Land Intensive Use and New Urbanization Development

		Coupling C	Coupling level	Coefficient T	D	Development stage	Order
Western Region	Guangxi	0.500	High grade	0.078	0.198	High Imbalance	21
	Ningxia	0.498	High grade	0.029	0.120	High Imbalance	29
	Xinjiang	0.398	Low Level	0.065	0.161	High Imbalance	27
	Xizang	0.483	Medium and high grade	0.009	0.067	Low imbalance	31
	Inner Mongolia	0.497	High grade	0.088	0.210	Medium imbalance	19
	Chongqing	0.481	Medium and high grade	0.075	0.190	High Imbalance	23
	Sichuan	0.475	Medium level	0.125	0.244	Medium imbalance	11
	Guizhou	0.496	High grade	0.060	0.173	High Imbalance	24
	Yunnan	0.496	High grade	0.057	0.168	High Imbalance	25
	Gansu	0.495	High grade	0.056	0.166	High Imbalance	26
	Qinghai	0.327	Low Level	0.026	0.093	Low imbalance	30
	Shanxi	0.491	High grade	0.082	0.201	Medium imbalance	20
	Average	0.470	Medium level	0.063	0.166	High Imbalance	
Central Region	Hunan	0.485	Medium and high grade	0.145	0.265	Medium imbalance	9
	Henan	0.492	High grade	0.185	0.302	Low imbalance	5
	Jiangxi	0.498	High grade	0.093	0.215	Medium imbalance	17
	Shanxi	0.486	Medium and high grade	0.115	0.237	Medium imbalance	14
	Hubei	0.498	High grade	0.117	0.242	Medium imbalance	12

North-east area	Anhui	0.498	High grade	0.116	0.240	Medium imbalance	13
	Average	0.493	High grade	0.128	0.250	Medium imbalance	
	Heilongjiang	0.498	High grade	0.095	0.218	Medium imbalance	16
	Jilin	0.497	High grade	0.077	0.195	High Imbalance	22
	Liaoning	0.500	High grade	0.143	0.268	Medium imbalance	8
	Average	0.498	High grade	0.105	0.227	Medium imbalance	
East area	Beijing	0.500	High grade	0.127	0.252	Medium imbalance	10
	Tianjin	0.500	High grade	0.091	0.213	Medium imbalance	18
	Shanghai	0.470	Medium level	0.217	0.320	Low imbalance	4
	Zhejiang	0.485	Medium and high grade	0.157	0.276	Medium imbalance	7
	Guangdong	0.463	Medium and low grade	0.287	0.365	Low imbalance	1
	Jiangsu	0.471	Medium level	0.246	0.340	Low imbalance	2
	Shandong	0.480	Medium and high grade	0.227	0.330	Low imbalance	3
	Hebei	0.477	Medium level	0.184	0.297	Medium imbalance	6
	Fujian	0.500	High grade	0.104	0.228	Medium imbalance	15
	Hainan	0.493	High grade	0.031	0.125	High Imbalance	28
	Average	0.484	Medium and high grade	0.167	0.274	Medium imbalance	

5. Conclusion

(1) In terms of land intensive use, western land investment is ahead of sustainable land use but land output lags behind relatively; Land input in the central region is balanced with sustainable land use, and both are ahead of land output; And northeast China has the most balanced land input, output, and sustainable use.

(2) In terms of new urbanization, the development of social urbanization in the west, central region and northeast are all ahead of the economic urbanization, ecological urbanization is the second, and population urbanization is the most lagging behind. And in eastern region, economic urbanization ranks first, social urbanization temporarily ranks second, ecological urbanization and population urbanization are relatively weak and relatively balanced.

(3) The pattern of spatial differentiation between land intensive use and new-type urbanization is not balanced, showing a situation of “lower in the east, higher in the north” and a downward trend in the east to west direction. The whole western part of the country except Xinjiang is in the low-value zone of land intensive use, especially in Ningxia, Gansu, Qinghai and Tibet. The high value of land intensive use is concentrated in the south with Hunan and Guangdong as the core and the east with Shanghai, Jiangsu, Shandong, Henan, Shanxi, Hebei, Beijing, and Liaoning as the core.

(4) The intensive use of land in the northeast and central areas is coupled with high-grade urbanization at a high level of antagonism, coupled with the middle-to-high-grade antagonistic coupling in the east and intermediate-grade antagonistic coupling in the west. Most provinces, municipalities, and

autonomous regions are at a high level of antagonism coupled, but there are "false high-level couplings" conditions in Ningxia and Gansu. Besides, the land intensive use and new-type urbanization in the east, central and northeast regions are moderately disordered, and the west is highly disordered.

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