Evaluation of Economical and Intensive Use of Construction Land in a County Town: A case study of Wan'an County, Ji'an City

YU Zhijie
(Jiangxi Normal University, Nanchang, Jiangxi 330022, China)

Abstract Taking the changes of construction land in Wan'an County over the years as the research object, the quantity and spatial characteristics of construction land in Wan'an County were analyzed, and the overall situation and regional differences of construction land utilization in Wan'an County were revealed. From the aspects of main influencing factors such as land use structure, land use intensity, land input intensity and output benefit, an evaluation indicator system was established to evaluate the economical and intensive use level of construction land in Wan'an County. The results show that the score of the economical and intensive use level of construction land in Wan'an County was 56.92, which was the lowest among all the districts and counties in Ji'an City. Based on the evaluation results, the corresponding economizing and intensive strategies were put forward, and the safeguard measures for its implementation were explored. The purpose is to provide some support for the preparation of territorial spatial planning, the delineation of urban development boundaries, and the potential exploitation of construction land stock, hoping to improve the utilization efficiency and benefit of construction land in Wan'an County, and promote the economic growth of Wan'an County to the stage of high-quality development.

Keywords Construction land; Economical and intensive utilization; Evaluation
DOI 10.16785/j.issn 1943-989x.2024.1.012

The 20th National Congress of the Communist Party of China put forward the new development concept and the requirements of high-quality development. Under the new development concept, the utilization mode, efficiency and quality of territorial space need to be further transformed. Strengthening the conservation and efficient utilization of land is of great significance to optimize the territorial space pattern of Wan'an County and promote high-quality development.

In May 2022, the General Office of the Central Committee of the Communist Party of China and the General Office of the State Council issued the *Opinions on Promoting Urbanization Construction with County Seats as an Important Carrier*[1], in which it is clearly pointed out that county seats are an important part of China's urban system and a key support for the integrated development of urban and rural areas. It is necessary to guide the transformation and development of county seats with population loss, strictly control the increase of urban construction land, revitalize the stock, and promote an appropriate concentration of population and public service resources. In this study, Wan'an County, Ji'an City, Jiangxi Province was taken as an example to evaluate the economical and intensive use of construction land in the county town.

1 General situation of the study area

1.1 General situation of Wan'an County

Wan'an County is located at the eastern foot of the Luoxiao Mountains, in south-central Jiangxi Province, on the southern edge of Ji'an City, and on the east and west bank of the upper reaches of the Ganjiang River. It borders Xingguo in the east, Nankang of Ganxian County in the south, Suichuan in the west, and Taihe in the north. It is a mountainous county and an integral part of the Jitai Basin. The county is surrounded by mountains in the east, south and west. All the rivers belong to the Ganjiang River system, and are distributed in the shape of trees. The main river Ganjiang River runs through the middle of the county from south to north. The terrain is high in the south and low in the north, and there are mountains, hills and plains from south to north. It has a typical hilly landform of Jiangnan, and the terrain is mainly low and middle mountains and hills. According to the landform, the area of mountains, hills, low hilly land and plains accounts for 34%, 30%, 35%, and only 1% of the total area, respectively.

Wan'an County has outstanding ecological advantages and is an ecological economic belt and "two mountains" transformation demonstration area in the middle reaches of the Ganjiang River. In recent years, it has been awarded as a beautiful livable demonstration county in Jiangxi Province and a model city for livable industries in China. The population and land use are highly concentrated in the central urban area. Single center structure is obvious, and it lacks the support of a large and medium-sized town. The urban system structure is still at a low level of homogeneous distribution. Except for the central urban area, most towns in the county are built on a small scale.

The current construction land in the county is 103.96 km^2, and the permanent population is 251,000. The per capita construction land indicator is relatively large, and the urbanization rate is 44.53%. The population has continued to flow out in the past 10 years.

1.2 Current situation of land use in Wan'an County

According to the survey and update results of land change in Wan'an County in 2020, the total land area of Wan'an County in 2020 was 203,809.59 hm^2, including 185,710.13 hm^2 of agricultural land, 8,364.42 hm^2 of construction land, and 9,735.05 hm^2 of unused land, accounting for 91.12%, 4.10% and 4.78% of the total area of the county, respectively. That is, the proportion of agricultural land was the largest, followed by the proportion of unused land, while the proportion of construction land was the smallest.

From the classification of construction land, the area of urban and rural construction land was the largest, up to 6,895.83 hm^2, accounting for 82.44% of the total area of construction land. The area of regional infrastructure land was 1,289.64 hm^2, accounting for 15.42%. The area of other construction land was 422.32 hm^2, accounting for 5.05%.

From the perspective of land classification, residential land occupied the largest proportion of construction land in Wan'an County, with an area of 5,536.86 hm^2, accounting for 66.20%.

Received: December 15, 2023 Accepted: January 18, 2024

The second was the transportation land, with an area of 1,387.13 hm^2, accounting for 16.58%. The area of other land was the smallest, only 4.26 hm^2, accounting for 0.05%.

Seen from spatial distribution, the construction land was mainly distributed in Furong Town, Wufeng Town and Luotang Township in the middle of the county, followed by Yaotou Town, Gaopi Town and Jiantou Town in the north, while it was less in Xiazao Town, Danqian Township, Jiantian Township, Baoshan Township and Wushu Township in the south. The north-south difference was related to the topography and geomorphology characteristics of Wan'an County. Compared with the northern towns, the southern towns have higher terrain slope and more limited flat space, so the development and construction are relatively backward.

2 Overall evaluation of economical and intensive use of construction land

2.1 Evaluation indicator system and weight

The selection of evaluation indicators follows the principles of scientificity, representativeness, stratification and operability, and takes into consideration the principles of prospectivity. Four factors of land use structure, land use intensity, land input intensity and land output benefit were selected by referring to the *Operation Manual for Evaluation of the Economical and Intensive Use of Urban Construction Land in China* and the *Assessment Methods for the Economical and Intensive Use of Land in Jiangxi Province*, including a total of 7 evaluation factors[2-3]. Through Delphi method, relevant experts were invited to score the importance of the participating indicators and determine the weight of each indicator.

By calculating the entropy of land use structure, the mixing degree of land use was evaluated, and the formula is as follows:

$$H(x) = -\sum_{i=1}^{n} P_i \log P_i$$

In the formula, $H(x)$ is the entropy value of land use structure in year x; P_i is the proportion of land i in construction land. The greater the H value, the greater the mixing degree of land function. The smaller the H value, the smaller the mixing degree of land function.

2.2 Data sources

The data of land use came from the survey and update results of land change in Ji'an County in 2020. The scale and spatial distribution of various construction land were analyzed by GIS, and the information entropy and per capita construction land factor were comprehensively calculated by the data of the seventh population census. Based on the statistical yearbooks of Ji'an City and Wan'an County in 2021, various economic and social data were determined. For demographic data, based on the data of the seventh population census published by the state, the relevant per capita area and labor force population were calculated.

2.3 Evaluation method

The linear proportion standardization method and weighted sum method were used to calculate the economical and intensive use level of construction land. Firstly, the linear proportional standardization method was used to adopt two formulas according to the difference of positive and reverse indicators. For positive indicators, the formula was $X' = X/X_{max}$ ($X \geqslant 0$); for reverse indicators, the formula was $X' = X_{min}/X$ ($X > 0$).

Secondly, on the basis of single factor evaluation, the comprehensive evaluation results were obtained by weighted summation method. The formula is as follows:

$$I = \sum_{i=1}^{n} N_i W_i$$

In the formula, I is land economical and intensive use level index (i.e. the total score of comprehensive evaluation); N_i is the standardized score of indicator i; W_i is the weight of indicator i ($0 \leqslant W_i \leqslant 1$, $\sum W_i = 1$); n is the number of evaluation indicators. The value of I reflects the level of land economical and intensive use. The larger the value of I, the higher the level of land economical and intensive use.

2.4 Evaluation results

Based on the above methods, the original and standardized data and scores of evaluation indicators of the overall economical and intensive use level of construction land in the 13 districts and counties of Ji'an City in 2020 were obtained (Table 2−3).

By calculating the product of the standard value and weight of each indicator, the score of each evaluation indicator and the final total score of each district and county in Ji'an City were obtained (Table 4).

SPSS software was used to cluster the evaluation scores, and they were divided into three categories: relatively intensive, generally intensive and relatively unintensive. The evaluation results are shown in Table 5.

According to Table 5, the degree of conservation and intensive use of construction land in all districts and counties of Ji'an City was generally intensive. Among them, there were 3 relatively intensive districts and counties located in the central urban area and the northeast of the city, namely Jizhou District, Xin'gan County and Yongfeng County. There were 7 general intensive districts and counties located in the north and south of the city, including Suichuan County, Qingyuan District, Jinggangshan City, Xiajiang County, Jishui County, Anfu County and Ji'an County. There were three relatively unintensive districts and counties, which are located in the middle of the city, namely Taihe County, Yongxin County and Wan'an County.

In general, the level of economical and intensive use of construction land in Wan'an County was the lowest among all the districts and counties in Ji'an City, but the gap with other districts and counties was small.

3 Conclusions and suggestions

3.1 Conclusions

3.1.1 Unreasonable structure of construction land. From the scores of various evaluation

Table 1 Evaluation indicator system of overall economical and intensive use of construction land

Destination layer	Criterion layer	Indicator layer	Indicator description	Indicator attribute	Indicator weight
Overall intensive utilization level of construction land	Land use structure	Information entropy	See below	Positive correlation	0.1
	Land use intensity	Per capita construction land area	Total area of construction land/total population	Negative correlation	0.2
	Land input intensity	Number of labor force per construction land	Number of labor force/total area of construction land	Positive correlation	0.15
		Fixed asset investment per construction land	Investment in fixed assets of the whole society/total area of construction land	Positive correlation	0.2
	Land yield benefit	Total output value per construction land	Total output value/total area of construction land	Positive correlation	0.15
		Fiscal revenue per construction land	Total fiscal revenue/total area of construction land	Positive correlation	0.1
		Retail sales of consumer goods per construction land	Total retail sales of consumer goods/total area of construction land	Positive correlation	0.1

indicators in Wan'an County, it can be seen that the evaluation score of land use structure in Wan'an County was penultimate among all districts and counties, indicating that the structure of construction land in Wan'an County was not reasonable. Based on the specific analysis of various types of land use, it is found that the proportion of residential land in the construction land of Wan'an County was relatively high, and the proportion of green land and square land in construction land was relatively low. In the future, it is vigorously develop the tertiary industry and adjust and optimize the spatial layout of construction land according to the development strategy of Wan'an County.

3.1.2 There is some room for improvement of land use intensity. The score of per capita construction land indicator in Wan'an County ranks medium among all counties, showing that there is still some room for improvement of land use intensity in Wan'an County. In the future, the index of construction land increment is extremely limited, so it is needed to invigorate the stock based on the connotation mining. The evaluation score of land input intensity was the lowest, and the evaluation score of land output benefit was penultimate, so Wan'an County should enhance the efforts to introduce foreign capital, improve the quantity and quality of labor force, and increase the output benefit of land in the future.

3.2 Strategies for optimizing the economical and intensive use of construction land

3.2.1 Improving the management and operation mechanism of construction land and promoting the scientific and reasonable structure of construction land. It is necessary to establish and improve the land use planning and regulation mechanism, prevent the convergence of land use structure, duplication of infrastructure construction, and invisible expansion of land use scale, make overall arrangements for all types and regions of land use, as well as for land development and utilization and ecological construction, establish and improve the government's land use behavior restriction mechanism, and restrict government behavior from specific operations, ensure the legitimacy, rationality and scientificity of land use by the government, and make a good lead for economical and intensive use of land. Besides, it is needed to establish and improve the operation efficiency mechanism of land market, promote the efficient allocation of

Table 2 Original data of evaluation indicators of economical and intensive use level of construction land in 13 districts and counties of Ji'an City in 2020

Administrative area	Land use structure	Land use intensity	Land input intensity		Land output benefit		
	Information entropy	Per capita construction land area//m^2	Number of labor force per construction land//km^2	Fixed asset investment per construction land $10^4/km^2$	Total output value per construction land//$10^4/km^2$	Fiscal revenue per construction land//$10^4/km^2$	Retail sales of consumer goods per construction land//$10^4/km^2$
Ji'an City	0.58	246	1,930	19,508	16,361	2,318	6,601
Jizhou District	0.67	243	2,747	25,732	26,499	2,176	13,407
Qingyuan District	0.61	264	2,386	15,247	20,728	1,842	7,438
Ji'an County	0.60	293	1,817	16,394	13,571	2,006	5,647
Jishui County	0.60	234	1,758	17,318	13,667	1,521	6,487
Xiajiang County	0.62	308	1,459	20,688	13,278	2,510	5,101
Xin'gan County	0.67	257	1,825	22,806	19,226	2,327	7,514
Yongfeng County	0.55	230	1,905	25,063	16,782	1,937	6,113
Taihe County	0.53	257	1,761	14,934	13,614	1,684	5,584
Suichuan County	0.46	186	2,516	18,130	14,807	1,494	5,747
Wan'an County	0.48	265	1,700	13,590	11,129	1,659	4,040
Anfu County	0.54	272	1,632	19,127	14,401	1,810	7,290
Yongxin County	0.50	212	1,938	15,045	10,319	1,146	5,359
Jinggangshan City	0.59	275	1,712	21,108	14,436	2,039	8,206

Table 3 Standardized data of evaluation indicators of economical and intensive use level of construction land in 13 districts and counties of Ji'an City in 2020

Administrative area	Land use structure	Land use intensity	Land input intensity		Land output benefit		
	Information entropy	Per capita construction land area	Number of labor force per construction land	Fixed asset investment per construction land	Total output value per construction land	Fiscal revenue per construction land	Retail sales of consumer goods per construction land
Positive or negative	Positive	Negative	Positive	Positive	Positive	Positive	Positive
Weight	0.1	0.2	0.15	0.2	0.15	0.1	0.1
Jizhou District	1.000 0	0.764 5	1.000 0	1.000 0	1.000 0	0.867 1	1.000 0
Qingyuan District	0.915 9	0.705 2	0.868 5	0.592 6	0.782 2	0.734 1	0.554 8
Ji'an County	0.898 6	0.634 0	0.661 6	0.637 1	0.512 1	0.799 4	0.421 2
Jishui County	0.901 1	0.793 7	0.640 1	0.673 0	0.515 8	0.606 2	0.483 8
Xiajiang County	0.918 6	0.603 7	0.531 3	0.804 0	0.501 1	1.000 0	0.380 5
Xin'gan County	0.999 5	0.722 9	0.664 3	0.886 3	0.725 5	0.927 3	0.560 4
Yongfeng County	0.824 8	0.807 6	0.693 4	0.974 0	0.633 3	0.772 0	0.455 9
Taihe County	0.797 1	0.724 2	0.640 9	0.580 4	0.513 8	0.671 0	0.416 5
Suichuan County	0.684 3	1.000 0	0.915 9	0.704 6	0.558 8	0.595 2	0.428 6
Wan'an County	0.709 9	0.702 6	0.619 0	0.528 1	0.420 0	0.660 9	0.301 3
Anfu County	0.810 8	0.684 2	0.594 0	0.743 3	0.543 4	0.721 3	0.543 7
Yongxin County	0.749 7	0.874 9	0.705 5	0.584 7	0.389 4	0.456 6	0.399 7
Jinggangshan City	0.883 8	0.676 6	0.623 3	0.820 3	0.544 8	0.812 6	0.612 0

Table 4 Scores of evaluation indicators of economical and intensive use level of construction land in 13 districts and counties of Ji'an City in 2020

Administrative area	Land use structure	Land use intensity	Land input intensity		Land output benefit			Total score
	Information entropy	Per capita construction land area	Number of labor force per construction land	Fixed asset investment per construction land	Total output value per construction land	Fiscal revenue per construction land	Retail sales of consumer goods per construction land	
Jizhou District	10.00	15.29	15.00	20.00	15.00	8.67	10.00	93.96
Qingyuan District	9.16	14.10	13.03	11.85	11.73	7.34	5.55	72.76
Ji'an County	8.99	12.68	9.92	12.74	7.68	7.99	4.21	64.22
Jishui County	9.01	15.87	9.60	13.46	7.74	6.06	4.84	66.58
Xiajiang County	9.19	12.07	7.97	16.08	7.52	10.00	3.81	66.63
Xin'gan County	9.99	14.46	9.97	17.73	10.88	9.27	5.60	77.90
Yongfeng County	8.25	16.15	10.40	19.48	9.50	7.72	4.56	76.06
Taihe County	7.97	14.48	9.61	11.61	7.71	6.71	4.17	62.26
Suichuan County	6.84	20.00	13.74	14.09	8.38	5.95	4.29	73.29
Wan'an County	7.10	14.05	9.28	10.56	6.30	6.61	3.01	56.92
Anfu County	8.11	13.68	8.91	14.87	8.15	7.21	5.44	66.37
Yongxin County	7.50	17.50	10.58	11.69	5.84	4.57	4.00	61.68
Jinggangshan City	8.84	13.53	9.35	16.41	8.17	8.13	6.12	70.54

Table 5 Evaluation results of economical and intensive use of construction land in 13 districts and counties of Ji'an City in 2020

Administrative area	Evaluation results of economical and intensive use of construction land
Jizhou District	Relatively intensive
Qingyuan District	Generally intensive
Ji'an County	Generally intensive
Jishui County	Generally intensive
Xiajiang County	Generally intensive
Xin'gan County	Relatively intensive
Yongfeng County	Relatively intensive
Taihe County	Relatively unintensive
Suichuan County	Generally intensive
Wan'an County	Relatively unintensive
Anfu County	Generally intensive
Yongxin County	Relatively unintensive
Jinggangshan City	Generally intensive

land resources, and maximize the value of state-owned land assets[4].

3.2.2 Redeveloping existing, idle and inefficient urban land and improving the efficiency of land use. It is needed to strictly control land increment, take practical measures to revitalize the existing construction land, adopt different disposal countermeasures for different inefficient idle ways[5], promote the special urban renewal work of urban abandoned, idle and inefficient land redevelopment, and promote the economical and intensive use of land while improving the supporting facilities of urban functions and enhancing the carrying capacity of the city[6].

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