Evaluation of Overall Coordination of Urban and Rural Land Use in Xiangtan City

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Abstract Based on regional characteristics of Xiangtan City and in line with relevant principle of overall coordination of urban and rural land use, this paper builds an evaluation system for overall urban and rural land use in Xiangtan City. With weight of each index determined by Analytic Hierarchy Process, it makes quantitative analysis of overall urban and rural land use of Xiangtan City in recent 8 years. Finally, it proposes feasible recommendations for overall coordinated development of urban and rural land use in Xiangtan City according to current land use situations.

Key words Xiangtan City, Urban and rural land, Overall and coordinated land use, Coordination degree

Currently, China has entered the rapid development stage of urbanization and urban and rural economy is in the key period of transformation. However, the long time urban and rural separation greatly widens the gap between urban and rural living, economic and social development. The *Report to the Sixteenth National Congress of the Communist Party of China* clearly states that overall planning of urban and rural development should be the top priority. Promoting coordinated urban and rural development has become a strategic mission to be accomplished in the course of China's reform and opening up, and also an important objective of strengthening and improving macro-control in the new period. As the essential material foundation of national economic development, overall land use plays a significant role in urban and rural construction and development.

1 Establishment of evaluation index system for overall and coordinated urban and rural land use

1.1 Principle for establishing the index system

1.1.1 Systematic principle. Coordinated land use is a systematic work including economic, social and environment subsystems. When designing the index system, it should not only reflect coordination of subsystems, but also make the entire index system form an organic system to comprehensively reflect coordination of land use. Therefore, no matter economic benefit, social benefit or environmental benefit, there should be connection between them [1].

1.1.2 Coordination principle. Coordinated development refers to the benign cycle of development with organic integration of speed, structure, quality and benefit in the process of development. In this situation, the index design should reflect the relationship between quantity and quality and between structure and strength, select those that can reflect current land use situations, and should include those that show the development trend of coordinated land use [2-3].

1.1.3 Scientific principle. Firstly, the model design should be reasonable and conform to laws of "social, environment and economic" systematic movement development. Secondly, the model element selection should be proper. These are the key to the design of coordination degree model.

1.1.4 Operational principle. It requires that indexes selected shall be clear, specific and easy to understand. It shall be easy to obtain those indexes through existing statistical data. In addition, the index system shall be simple, convenient and practical.

1.2 Evaluation index system for overall and coordinated urban and rural land use in Xiangtan City According to the above principles, with reference to quantitative evaluation index system of overall urban and rural development put forward by Chen Hongbin *et al*[4-6], and in combination with specific situations and availability of index data in Xiangtan City, we selected 25 indexes from economic coordination, environmental coordination and social harmony (as listed in Table 1).

1.3 Determining index weight Evaluation of overall and coordinated urban and rural land use involves many hierarchies and indexes. We adopted the analytic hierarchy process (AHP) to determine weight of each index. We divided overall and coordinated urban and rural land use system of Xiangtan City into 4 hierarchies, as shown in Table 1. Then, we built the judgment matrix and calculated the index weight by sum-product algorithm. Afterwards, we checked the consistency of judgment according to changes in the characteristic root of matrix. From top to bottom, we summed the weight of single criteria, until calculated weight of each element at the bottom and checked the consistency. Finally, through combined calculation, we got the weight of each index, as listed in Table 1.

1.4 Standardized processing of indexes There are three types of indexes. The first type is positive index (+). For this

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type, higher value is the better. The second type is negative index (−). For this type, lower value is better. The third type refers that when the index value reaches a value in certain reasonable range, the efficiency is the highest (± stands for interval index). The efficiency value of urban and rural land use system can be expressed by following formula:

$$W_A(w_i)\begin{cases}\dfrac{x_i-b_i}{a_i-b_i}, \text{ when } w_i \text{ has positive effect}\\ (x_0 \mid x_i - x_0)/x_0, \text{ when } x_i(x_0, w_i) \text{ has positiv effect; when } x_i x_0, w_i \text{ has negative effect}\\ \dfrac{a_i-x_i}{a_i-b_i}, \text{ when } w_i \text{ negative effect}\end{cases} \quad (1)$$

where $W_A(w_i)$ is efficiency of the variable w_i, $0 \leqslant W_A(w_i) \leqslant 1$; A is the stable range of system; x_i refers to actual value of order parameter, and x_0 signifies reasonable value of order parameter. From the efficiency function, it can be known that the higher value of $W_A(w_i)$ means the higher contribution of order parameter to system tending towards orderly.

Table 1 Evaluation index system for overall and coordinated urban and rural land use in Xiangtan City

Target hierarchy	Criteria hierarchy B	Criteria hierarchy C	Evaluation index hierarchy D	Efficiency	Weight
Coordination between urban and rural land use A(1.000)	Social coordination B_1(0.299)	Urban and rural social harmony C_1(0.165)	Population density//person/km^2 D_1	±	0.049
			Per capita building space in urban areas//person/m^2 D_2	+	0.023
			Per capita building space in rural areas//person/m^2 D_3	+	0.030
			Urban − rural resident income difference coefficient D_4	−	0.031
			Urban and rural resident household Engel coefficient difference D_5	−	0.032
		Public service level C_2(0.134)	Quantity of vehicles for every 10^4 people D_6	+	0.034
			Full time teachers for every 10^4 people D_7	+	0.033
			Quantity of hospitals for every 10^4 people D_8	+	0.033
			Quantity of hospital beds for every 103 people D_9	+	0.034
	Economic coordination B_2(0.431)	Land input and output C_3(0.241)	Workers in every square kilometer D_{10}	+	0.041
			Investment on fixed assets in every square kilometer//10^4 yuan D_{11}	+	0.052
			GDP in every square kilometer//10^4 yuan D_{12}	+	0.066
			Industrial added value in every square kilometer//10^4 yuan D_{13}	+	0.043
			Retail sales of social consumption goods in every square kilometer//10^4 yuan D_{14}	+	0.039
		Land use structure C_4(0.190)	Percentage of cultivated land D_{15}	±	0.051
			Percentage of residential areas and industrial and mining area D_{16}	±	0.041
			Percentage of traffic land D_{17}	±	0.044
			Percentage of land for water conservation projects D_{18}	±	0.033
			Percentage of unused land D_{19}	−	0.021
	Ecologic coordination B_3(0.270)	City greening C_5(0.145)	Percentage of city afforestation D_{20}	+	0.049
			Public greenery space per capita//m^2/person D_{21}	+	0.049
			Percentage of harmless treatment of domestic rubbish D_{22}	+	0.047
		Environmental protection and pollution control C_6(0.125)	Percentage of sewage treatment D_{23}	+	0.045
			Comprehensive utilization ratio of industrial solid wastes D_{24}	+	0.043
			Percentage of industrial soot removed D_{25}	+	0.037

Note: Urban and rural resident household Engel coefficient difference = Rural resident household Engel coefficient − Urban resident household Engel coefficient; Urban − rural resident income difference coefficient = 1 − Per capita net income of rural resident/Disposable income per capita of urban residents.

1.5 Comprehensive evaluation model We carried out comprehensive evaluation by weighted integration method. The calculation model for total points of sustainable use of land resources is as follows:

$$P = \sum_{i=1}^{n} W_i P_i,\ n = 1, 2, 3, \cdots$$

where P is the total points, n is number of indexes, W_i is the weight of the i-th index, and P_i is the evaluation score of the i-th index.

1.6 Judgment standard for evaluation of overall and coordinated urban and rural land use With reference to research achievements of Yang Shiqi *et al*[7], we divided the coordination degree into 10 stages, as listed in Table 2.

Table 2 Judgment standard for evaluation of overall and coordinated urban and rural land use

Types	Judgment result	Range of points
Not coordinated	Extreme	[0, 10)
	High	[10, 20)
	Medium	[20, 30)
	Normal	[31, 40)
	Low	[40, 50)
Coordinated	Low	[50, 60)
	Normal	[60, 70)
	Medium	[70, 80)
	High	[80, 90)
	Extreme	[90, 100]

2 Evaluation and analysis of overall and coordinated land use in Xiangtan City

Using relevant data from 2003 to 2010 of Xiangtan City, we evaluated and analyzed overall and coordinated urban and rural land use in Xiangtan City. Through evaluation and analysis of relevant data in these years, we got the evaluation results of coordinated use level of each year. For the purpose of calculation, the total points were multiplied by 100, and the evaluation results are listed in Table 3.

Table 3 Evaluation results of coordination degree of land use subsystem in Xiangtan City in 2003 – 2010

Year	Social coordination	Economic coordination	Ecological coordination	General coordination
2003	73.03	24.86	47.66	45.41
2004	75.92	27.17	48.82	47.59
2005	76.39	28.68	50.34	48.79
2006	76.54	31.60	51.42	50.38
2007	78.42	33.50	52.28	52.00
2008	78.98	35.56	54.46	53.64
2009	78.37	39.22	56.03	55.46
2010	79.93	45.04	61.21	59.83

Table 3 shows that coordination degree of land use system in Xiangtan City takes on a growth trend. From the low level of not coordinated (45.41) in 2003, it increased to low level of coordination (59.83) in 2010. On the whole, the coordination level of urban and rural land use in Xiangtan City gets improved gradually. However, there is a big difference in the coordination degree between three land use subsystems. The social benefit subsystem has the highest level of coordination. In 2003, it was up to medium level of coordination (73.03), and it reached 79.73 and nearly turned to the high level of coordination in 2010. The economic benefit subsystem has the lowest level of coordination. In 2003, it was medium not coordinated (27.17). In 2012, it reached the low level of not coordinated (45.06) with a growth rate of 65.8%. The low level of economic benefit subsystem is mainly resulted from poor coordination of land input and output. All five indexes of economic benefit subsystem are very low. Besides, the ecologic coordination level was low (43.84) in 2010, mainly because of low level of control of three kinds of wastes.

3 Countermeasures for overall and coordinated urban and rural land use in Xiangtan City

3.1 Coordinating the relationship between urban construction land and protection of cultivated land It should strictly protect cultivated land (especially farmland), further implement cultivated land protection system, strictly carry out land use purpose management and control system, control the amount of new construction land, and establish responsibility mechanism of cultivated land protection. Firstly, it should investigate thoroughly the area, composition and distribution of existing cultivated land and basic farmland, predict the amount of cultivated land that will be occupied, and put forward corresponding countermeasures. Besides, it should find out proper ways to improve balance between occupation and compensation. In addition, it is proposed to strengthen management of basic farmland protection area, establish responsibility of cultivated land protection, and contain the cultivated land from reducing. What's more, it should strictly control the occupation of cultivated land for non-agricultural construction, and implement construction of key projects and infrastructure, to realize dynamic balance of total amount of cultivated land.

3.2 Transforming economic growth ways and taking the resource-saving economic development road The primary task of Xiangtan City is to develop economy. However, for a long time, the land resource development in Xiangtan City remains at the extensive mode. Such method will bring about many harmful consequences, including resource shortage, low benefit of input and output, ecological disruption and environmental pollution. The transformation of economic growth ways is to get rid of those ways depending on high input, high consumption, low output and low benefit, and to form proper economic growth ways favorable for saving resources, reducing consumption, and increasing benefit, as well as helpful for optimum allocation of resources. This is also the kernel part of improving the level of overall and coordinated land use.

3.3 Preparing and strictly implementing overall and coordinated urban and rural land use planning Preparing and strictly implementing overall and coordinated urban and rural land use planning is the precondition and guarantee of overall and coordinated urban and rural land use. It is recommended to strictly implement the overall and coordinated urban and rural land planning, to realize dynamic balance of cultivated land. Besides, it should control the supply for non-agricultural construction land, and carry out coordinated development of population, resource, economy and society, to reverse the reducing trend of cultivated land. Furthermore, it should strengthen macro control of land to achieve optimum allocation of land resource and coordinated land use, improve land utilization ratio and land productivity, and promote steady rise of overall and coordinated land use in Xiangtan City.

3.4 Protecting ecological environment to promote overall and coordinated urban and rural land development We recommend laying special stress on protecting ecological sensitive areas, such as mountains, natural wetland, natural forest, natural protection area, scenic spot and forest park, to strictly control development of unused land that has ecological function. On the condition of practically protecting cultivated land and farmland, it should lay equal stress on protection, living and ecology, to gradually raise the proportion of ecological land and improve ecological function of green land system. Besides, we propose building harmonious, safe and high efficient green space system in Xiangtan City, adopting new process, new energy and new material to reduce emission of three kinds of industrial wastes, and strengthening control of three kinds of industrial wastes. In addition, it should establish agricultural ecological compensation mechanism,

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trailers with higher tonnage. Since processing and utilization enterprises have to keep certain level of stock, the supply and quality of pretreated straws are strict. It needs specialized transport and delivery management of the third-party logistics enterprises. Therefore, it is recommended that straw processing and utilization enterprises sign agreements with third-party logistics enterprises, to establish long-term cooperative partnership.

4.2.5 Improving logistics infrastructure and information platform, to realize information sharing. Government should speed up rural road construction, improve the every village coverage project, and promote the improvement of rural straw recycle channels. Besides, it should encourage straw recycle and processing and utilization enterprises to share information, so as to ensure balanced supply and demand of straws, and increase the operation efficiency of straw recycle logistics system.

4.2.6 Increasing research and development input, and improving policies for supporting straw recycle. Government sectors and scientific research institutions should accelerate special investment and technical research and development of integrated machinery, bundling machine, vehicle and pretreatment facilities for crops. Furthermore, government should issue and improve relevant management methods and financial preferential and subsidy policies, particularly for construction and operation of stock yard and purchase of straws.

5 Conclusions

The construction of straw recycle logistics system is not only the precondition and basis for industrialization and comprehensive use of straw resources, but also the requirement for implementing the Scientific Outlook on Development, developing the biomass energy resource, and realizing sustainable development of rural economy. However, the existing straw recycle logistics operation has problems of high logistics cost, low logistics efficiency and imperfect management system. Thus, it is required to consolidate social logistics resources, increase financial support, improve straw recycle logistics network and promote circulation and utilization of straw resources. In this study, on the basis of straw recycle process, we explored the definition of straw recycle logistics network, analyzed open-loop feature of the network, and introduced the idea of construction of straw recycle network. From the perspective of rough and fine processing enterprises of straws, we designed two straw recycle logistics modes. Finally, from the levels of logistics infrastructure network, organization network and information network, we put forward strategies for construction, operation and management of straw recycle logistics network, in the hope of providing basis and reference for construction of straw recycle logistics system and policy-making of straw resource industry.

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change the dirty, disorderly and poor production and living environment in rural areas, and build new socialist countryside with "developed production, well-off living, civilized village culture, clean village environment, and democratic management". It is essential to improve urban image and promote integration of historical culture and modern civilization. Finally, it should rationally develop and utilize resources from environmental ecology, living comfort and living convenience, improve rural and urban living environment and ecological system, and build integrated urban and rural ecological protection system.

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