

Sustainable Land Use Evaluation in Wanzhou District Chongqing City

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Abstract

The use of Wanzhou District Chongqing City Yearbook in 2001-2008 and other relevant information, based on the present strategic situation of Wanzhou District Chongqing city, the paper constructs the evaluation index system for land sustainable utilization and sets up the comprehensive evaluation model using linear weighting technology to evaluate the land sustainable utilization state during 2001--2008 of Wanzhou District Chongqing city. The result showed that the total level of land sustainable utilization was at basic sustainable stage from 2001 to 2008, the level of economic viability feasibility and social acceptability were the highest, the ecology and civilization were at second place, and then the productivity level of resource was the lowest and decreasing year by year. According to the results, many suggestions such as control population growth and environmental pollution should be put forward strictly in order to safeguard the land ecological environment.

Keywords: Land sustainable utilization, Evaluation, Wanzhou District Chongqing city

Sustainable land use is an important part to achieve the strategic goal of sustainable development. The basic condition of land development is to maintain the sustainability of land quantity and land quality, both to meet the social and economic development, without destroying the ecological environment of the land as the basic condition(Qian Yi, Tang Xiaoyan,2000,pp:146-149;Huang Yun, Liao Tiejun, Xiang Huahui,2003,pp:54-57). Pure economic interests and local issues are not the only consideration in decision-making. What makes the most important is seizing the key issues of influence and obstruction in sustainable land use. Only in this way can we formulate the right decisions and program. Three Gorges Project is an ambitious water project, also a huge

migration project. Because of the specific location, Three Gorges Project is facing extremely serious conflicts and challenges in land security and sustainable land use, Wanzhou is the largest migration in Three Gorges Reservoir area. Flooded area is large and the immigration task is heavy. The problem is increase of the land bearing pressure that seriously threat the reservoir area's fragile environment and ecosystems and be a reservoir of potential crisis and a huge burden of sustainable development. In order to achieve the goal of sustainable land use in Three Gorges Project reservoir, it is necessary to evaluate the sustainable use of land to improve the efficiency of land use. Sustainable land use is the basis for all the sustainable use, also is the key to sustainable development of economy and society.

1. Overview of study area and data source

Wanzhou District, Chongqing (Figure 1) is located in the upstream of Yangtze River, eastern Sichuan Basin, northeast edge of Chongqing City, hinterland of the Three Gorges reservoir area. It is 327km far from Chongqing, 321km from Yichang on the water road and located at longitude $107^{\circ} 55'22''$ - $108^{\circ} 53'25''$, latitude $30^{\circ} 24'25''$ - $31^{\circ} 14'58''$. Wanzhou is east to Yunyang, south to Shizhu and Lichuan, Hubei province, west to Zhongxian and Liangping, north to Kaixian and Kaijiang, Sichuan province. It covers an area of 3457km^2 , urban area of 32.5km^2 , total population of 171,509 people. The region is located in the Valley in East parallel to the ridge, lying high in north-south, low in the middle, generally increasing from North West to south east. The Yangtze River crosses the whole territory from southwest to northeast. It is a typical low mountain hill landscape, with shallow hill, hills, deep hills, low mountains and other landforms. The elevation is between 106.5-1726.0m. The climate is humid subtropical monsoon, four distinct seasons, mild climate, abundant rainfall, long frost-free period, annual average of 310d, the annual average temperature is 18.1°C , annual average sunshine 1484.4h, annual rainfall of 1205.5mm, relative humidity is 81%. The main production is rice, corn, potatoes, beans and tea, mulberry, Tung tree, herbs and other cash crops. Favorable climatic conditions and a variety of agricultural resources provide a good condition for sustainable use of land research data mainly comes from 2001-2008 Yearbook, 2000-2020 Land Use Planning, 2000-2010 urban system Planning of Wanzhou District

2. Evaluation System and Methods

2.1 Evaluation system construction and the index weight calculation

The paper established evaluation index system according to Fubojie and other scholars of indicators of sustainable land use system (FuBojie, ChenLixiang, Macheng, 1997, pp:112-118; ZhengXinqi, 2000, pp:97-100) join the specific regional situation and availability of data in Wanzhou District. from the land productive, land of ecological civilization, economic viability and social acceptability of the four areas, namely the production subsystem, ecological subsystem, social subsystem and the economic subsystem, to select the 25 individual indicators established Wanzhou District, Chongqing City, the sustainable use of land resources evaluation index system (Table 1).

Sustainable land use involves multi-level and multi-index. Here by using the combination of qualitative and quantitative system analysis method – AHP (Analytical Hierarchy Process) to determine the weight of each index (Zhong Yi, 2001, pp: 43-48). According to the principle of AHP, the evaluation indicators will be grouped by their properties, each group constitutes a hierarchical structure, forming a multi-level evaluation index system. We divide the sustainable land use system of Wanzhou District, Chongqing into three levels: Target layer (The level of sustainable land use), Rule layer (land productivity, ecological civilization, economic viability and social acceptability) and project layer (25 specific indicators). Reconstruct the Judgment Matrix, calculate weight of each index by "sum-product method", Then Matrix Eigen values and use the change of Judgment Matrix to check the consistency of judging the degree of synthesis weights from top to bottom, the weight of a single criteria were synthesized, and layer by layer, until the bottom of the calculated weight of each element and the general agreement test. Synthetic indicators calculated by the weight of each (Table 1).

2.2 Assignment and standardization of indicators

In the evaluation of sustainable land use, because of the dimensions of evaluation and different range, it does not directly comparable. When evaluating it necessary to eliminate the difference between dimensions, converse the index into a numerical comparison. Standardized indicators can be comparable to the original data. This article will converse coordinate function method to a method which cab standardize the data and the transform it to a better condition. Degree of coordination is a level between systems or elements of the development process between the degree of harmony with each other (Ma Jianhua, Guan Hua, 2003, pp:1-55), reflecting the system from disorder to order. Degree of the previous model with the coordination of research, most are sub-functions described by two, that all of the order parameter changes are one-way. In the land use system, the direction of order parameter will change will with each other, so it is necessary to set the third paragraph of the order

parameter function to describe these variables.(Ou Xiong, Feng Changchun, Shen Qingyun,2007,pp:42-45)

$$U_A(u_j) = \begin{cases} \frac{x_j - b_j}{a_j - b_j} & \text{when } U_A(u_j) \text{ in a positive effect} \\ \frac{x_0 - |x_j - x_0|}{x_0} & \begin{cases} \text{when } x_j < x_0, U_A(u_j) \text{ in a negative effect} \\ \text{when } x_j \geq x_0, U_A(u_j) \text{ in a positive effect} \end{cases} \\ \frac{b_j - x_j}{b_j - a_j} & \text{when } U_A(u_j) \text{ in a negative effect} \end{cases}$$

Note: $U_A(u_j)$ as an indicator of the system order effect, A is the system stability region; x_j for the order parameter the actual value; x_0 for the order parameter of reasonable value; a_j , b_j , respectively, for the order parameter of the upper and lower limit values number for the order parameter j ($j = 1, 2, 3, 4 \dots n$). This function is a piecewise function, the first line, second line, third line were the first, second, third paragraph of the function. When the order parameter values correspond to the bigger and better, the ordering of the land use system has a positive effect which applied to the first paragraph of the function. When the order parameter values corresponding to moderate size and has a threshold between the two, more than the threshold effect to changes in the opposite direction, that ordering of land use systems both positive and negative effects for the second paragraph of the function. When the order parameter corresponds to the lower the better, the ordering of land use system has a negative effect when applied to the third paragraph of the function.

2.3 Model of sustainable land use evaluation

The level of sustainable land use is all the result of combined effects of indicators; each indicator reflects the level of sustainable land use from a different point of view. To reflect the overall level of sustainable land use, land use also need comprehensive evaluation at the overall level. Therefore, this method of using a linear weighted affecting each indicator together with the weight coefficients, obtained Sustainable Land Use Evaluation Model. Evaluation model can be expressed as:

$$C = \sum_{j=1}^n U_A(u_j) W(u_j)$$

Note: C for the comprehensive level of sustainable land use score, $U_A(u_j)$ is the coordination of scores for each indicator, $W(u_j)$ for the index weights of the corresponding. Reference to different scholars on the division of sustainable land use evaluation criteria, this article will divide the sustainable land use into non-sustainable land use stage of the sustainable use, sustainable use of the initial stage, the basic stage of the sustainable use and sustainable use of four stages (Table 2)

3. Results and the analysis

3.1 Results

The research methods used in Wanzhou District in Chongqing (2001-2008) carried out a land use analysis; data sources are the "Yearbook of Wanzhou District, Chongqing City" (2001-2008), the results shown in Table 3. (The Analysis of the Table 3 is as 3.2 and 3.3)

3.2 General Analysis

Overall analysis: the overall level of sustainable land development increased gradually with time, from 2001's: 39.36 to 2008's:68.80, indicating that Wanzhou District in Chongqing made significant achievements in sustainable use of land since 2001. Economic subsystem and the social subsystem to achieve the highest level of sustainability, ecology and production of subsystems and subsystem followed by a different degree. In 2001 - 2003 it is in the initial stage of sustainable, when enter into 2004, the overall level of sustainable development of land has begun to enter the basic sustainable stage. Social subsystem, economic subsystem, production subsystem gradually enter into the Virtuous cycle stage of sustainable development. Ecological subsystem is in Basic sustainable stage and with fluxions.

3.3 Single Analysis

From the analysis of individual indicators: social subsystem is in sustainable initial stage in 2001, in other years it is all in sustainable development stage and has been on the rise. Social acceptability were positive momentum,. the main reason is the support from the country after Chongqing became a municipality and the Three Gorges reservoir area .With the in development of economy , people's lives constantly improved, Engel coefficient

continue to go down, the social security system is being improved gradually smaller urban-rural gap. Ecological subsystem are in the stage of basic sustainability in 2001 - 2008, ecological sustainability is in fluctuated state, experienced up, down and smooth in the whole process. The main reason is to protect the ecological environment of the Three Gorges reservoir area, the capacity and level of pollution control and environmental regulation are increased. And implementation of the "landscape garden city project" and "mountains engineering" the two strategies added. The Three Gorges Reservoir water focus on environmental protection has greatly improved the air quality and water quality, industrial wastewater discharge compliance rate of industrial solid waste comprehensive utilization ratio increased gradually, gradually reduce the emissions of industrial dust. After 2003 due to construction, disaster, a large number of returning farmland to forests and other farmland, coupled with rapid population growth, all will inevitably result in excessive land reclamation and predatory business, resulting in declining per capita arable land, resulting in the land affected by the ecological environment, ecological subsystem, the downward trend in sustainability. After 2003, Wanzhou District, not only focus on the protection of farmland, but also strive to create ecological barrier, develop ecological economy Ecological protection has become a consensus and to keep the basic sustainable ecological in sustainability phase, and are on the rise. Production subsystem in 2001 - 2004 is in the initial stage of sustainable, in 2005-2007 is at basic sustainable stage, and in 2008 is in the sustainability of a decline. The basic trend is rising. When choosing the Production subsystem, pay more attention to food production capacity of the land that agriculture is in the fundamental position of the first industry. And land resources are related to the economic and social development factor which cannot be replaced; it is the foundation of agriculture. Food security is also related to the national security strategy. Therefore, more choices of indicators on food production capacity should be evaluated. In 2001---2007 production of land is rising because as technology advances, the results also benefit the agriculture, food production per unit area, multiple cropping index, land utilization, land productivity ,all have increased annually. Since 2007, with the decline of grain yield per unit area, grain yield, grain sown area, vegetable production, a direct result is the sustainability of land plummeted ecological subsystem. Economic subsystem has shown good momentum of growth from unsustainable to sustainable development. Phase Mainly because of economic development , transformation of economic growth ,and taking the path of a resource-saving economic development, guiding the industry towards intensive economic growth mode transformation, the industry in the high and new industries changes the primary task of economic development are the primary task. (The trends is shown in Figure 2)

4. Conclusions and Suggestions

4.1 Conclusions

The Wanzhou District in Chongqing comprehensive level of sustainable land use is still between the stage of basic sustainable and sustainable, economic viability and social acceptability achieved the highest level, ecological civilization of the second, and the production of the lowest and in a downward trend. The main reasons lead to different Status of sustainable land use in Wanzhou District; Chongqing is Reduction of arable land resources and changes of ecological environment. Following major problems: First, the limited arable land resources, big population density lead to increasingly tense of per capita arable land. Second, Wanzhou as the economic center of the Three Gorges Reservoir, soil erosion, air pollution and other environmental issues are seriously, even if the Wanzhou District of ecological improvement measures taken by many, but there are still parts of the environment problems.

4.2 Suggestions

For the status of sustainable land use in Wanzhou District Chongqing City, there are two proposals as follows:

4.2.1 Maintain a good ecological environment of land to promote sustainable use of land resources

Total amount of cultivated land is large in Wanzhou District, but the per capita arable land is less, sloping land and more low-yielding fields in the large area. Wanzhou in Three Gorges reservoir area, especially the hinterland, technology and financial investment is relatively low, with drought and other natural disasters, biological productivity of land is generally low, thus reducing the ecological carrying capacity .For the specific circumstances of Wanzhou District, Promotion of ecological agriculture is an important way to promote ecological land ecosystem. Reducing fertilizer and pesticide, reducing the pollution of soil, maintain a good ecological land environment and build a harmonious land use and production methods, promote sustainable use of land, is a strategic choice to achieve sustainable development of land resources in Wanzhou District, Chongqing.

4.2.2 Strict control of population growth, improve the population quality, promote sustainable consumption concept

Since the new century, Wanzhou District, Chongqing has entered the period of low fertility level. But in recent years, due to a variety of social causes, the population management chain of grassroots family planning system is

interrupted so the fertility rate rebound of non-policy. Excessive population growth, on the one hand would carry enormous pressure on land; on the other hand have a negative impact on the environment. Meanwhile, the rural population is also the core issues to constraint and affects urban and rural areas of Wanzhou District, Chongqing. According to the specific conditions, it is necessary to strict control of population growth within land resources carrying. On this basis, to actively improve the quality of population, promote consumption view of sustainable and resource-saving, is the best way to improve land use sustainability.

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Table 1. The index system of sustainable land use

Evaluation objects	Sub-categories	Weight	Indicators	Weight	Coordination
Index System for Sustainable Land Use	Production subsystem (B1)	0.375	Sown area of grain (hm ²)	0.038	+
			Vegetable production per capita (Kg / person)	0.046	+
			Cropping	0.059	+
			Per capita share of grain (Kg / person)	0.019	+
			Land utilization (%)	0.018	+
			Food production (Million t)	0.029	+
			Vegetable production (Million t)	0.042	+
			Grain yield per unit area (kg/hm ²)	0.076	+
			Land productivity (%)	0.048	+
	Economic Subsystem (B2)	0.228	Urbanization (%)	0.013	+
			GDP per capita (Million)	0.063	+
			Average wage of workers in urban units (Yuan)	0.034	+
			Proportion of agriculture (%)	0.046	+
			Per capita net income of farmers (Yuan)	0.039	+
			Elasticity of energy consumption	0.033	-
	Social subsystem (B3)	0.130	Engel Coefficient (Rural) (%)	0.039	-
			GDP, fiscal revenue (%)	0.033	±
			Urban per capita consumption expenditure (Yuan)	0.022	+
			Engel Coefficient (City) (%)	0.017	-
			Urban housing construction area (m ²)	0.010	+
			The natural population growth rate (‰)	0.009	±
	Ecological Subsystem (B4)	0.267	Industrial Wastewater Discharge Standards (%)	0.067	+
			Per capita cultivated land (hm ²)	0.108	+
			Comprehensive utilization of industrial solid waste (%)	0.031	+
			Industrial dust emissions (t)	0.061	-

Table 2. Criteria for Sustainable Land Use

Value of comprehensive evaluation	<25	25-50	50-75	>75
Criteria	Not sustainable	The initial stage of sustainable	Basic sustainable	Sustainable use

Table 3. Evaluation results of sustainable land use 2001-2008, Wanzhou District, Chongqing City

Year	Social subsystem	Ecological subsystem	Production subsystem	Economic subsystem	The overall level of sustainable development
2001	37.99	61.40	36.87	18.33	39.36
2002	56.98	71.30	41.41	28.65	48.52
2003	58.48	81.14	31.25	34.06	48.77
2004	69.62	75.62	44.68	45.66	56.42
2005	83.67	59.89	52.97	54.09	59.06
2006	81.79	59.98	75.91	67.15	70.41
2007	89.38	58.22	87.26	77.76	77.60
2008	88.76	59.49	58.31	85.69	68.80

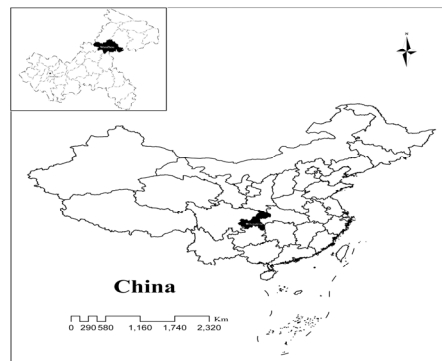


Figure 1. The location of Wanzhou District Chongqing City

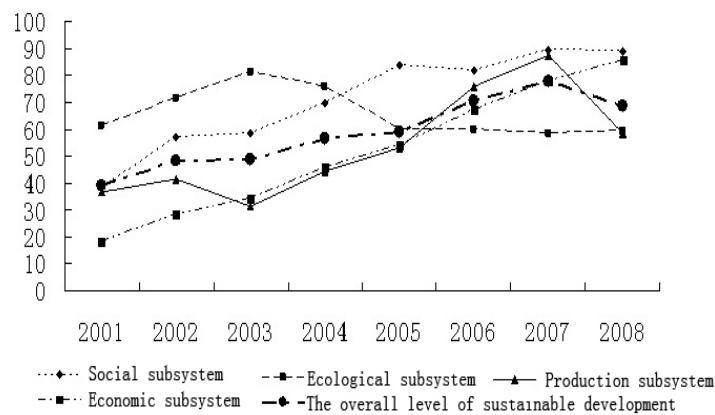


Figure 2. Trend of sustainable land use system of Wanzhou District, Chongqing