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Recent 10-year land use change and evaluation of their performance, in Chongqing, China

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Abstract

This article analyzes the past 10 years of land use change in Chongqing City, And build on this basis the region's land use evaluation system. Use the optimal combination weighting method for quantitative evaluation land use. The results show that: (1) Between 1999-2008 Chongqing sharp decline in arable land, , significant increase of construction land. (2) Index of flexibility of land resources configure decreasing. Land utilize degree had been decreasing during recent decades, due to the decline of land utilize degree and per arable area for abandon and fallow of land and population going-up. Efficiency and benefit of land use were obviously enhanced, But the overall level of land use efficiency and benefit is still in low degree and the output ratio of land even has a big gap to improve. (3) Land use performance value was still relatively low but its trend was maintain stably increasing, which is consistent with the change of social economical development and natural condition. Show that Chongqing city is moving in a reasonable land use, conservation and intensive use of direction development.

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1. Introduction

In recent several decades, especially since the International Geosphere and Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP) [1-3] initiated their core project on land use and cover change in the mid-1990s, researches on land-use/land-cover change have become a hotpot of global change studies. Therefore, studies on land use change and its performance can provide scientific basis for regional sustainable development.

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Characterized by mountainous and hilly terrains region, the development of Chongqing municipality have many problems, which are also common in the other cities in southwest of China, Such as relatively backward regional economical development and fragile ecological system [4]. Since Chongqing becoming as a test area of urban and rural harmonious in China, which is a new and greater opportunity for its development, the leap economic development is inevitable, but the challenges are still exist.

Based on analyses of land use change in the past 10 years in Chongqing, this paper discussed the land use status by introducing the land use performance concept to providing a scientific basis for decision-making on sustainable use of land of Chongqing municipality.

2. Materials and Methods

2.1 Study Area

Chongqing municipality is located in the southwest of China, with the area of which is 82300 km², and dominated by mountains and hills. It has great development potential due to rich in biological resources, mineral resources, water resources, and the unique Three Gorges tourist resources [4].

2.2 Data sources and processing

The land use information extracted from land use maps of Chongqing from 1999 to 2008 with scale of 1: 200 000 by Arcgis 9.2 software, and then integrated with detailed survey data of land use in corresponding period and region. The indicators of related socio-economy gained from 1999-2008 national economic and social development of Chongqing Statistical Bulletin and Chongqing Statistical Yearbook 1999-2008. As the basis for the evaluation, the properties table of evaluation index was constructed from relevant data after mathematical operation by SPSS 10.0, and Excel 2003 software. Based on statistical data, the selected evaluation indicators was to do no quantification treatment, use power function formula, to make results more effective [5].

2.3 Analysis of land use change

Land use dynamics degree, which can reflect the change rate of quantity of a certain land use type, not only can express the temporal and spatial variation of a single land types, but also can analysis the land use dynamics change in a certain region and differences among its subpart [6].

2.4 Evaluation of land use performance

In this study, evaluation index system of the land-use performance was considered in four fields: ① land use structure, ②land use degree, ③land use efficiency, and ④land use benefit [7]. The selected index showed in tab.1. The weighted value of these indicators was determined by a combination of subjective and objective methods according to the optimal combination weights method [8]. The weighted value of these indicators showed in tab. 1. The scores of land use performance calculated according to following equation.

$$P = A \times W_a + B \times W_b + C \times W_c + D \times W_d$$

Where P , A , B , C , and D represent the score of land use performance, structure, degree, efficiency, and benefit, respectively. W_a , W_b , W_c , W_d represent the weight values of land use structure, degree, efficiency and benefit, respectively.

Table.1 Evaluation index system of the land-use performance of Chongqing municipality

target layer	rule layer	factor layer	weight
land use performance (P)	land use structure (A)	land-use diversity index A1	0.1356
	0.1928	agricultural land and the construction land area ratio A2	0.2478
		cultivation index A3	0.1802
		percentage of forest cover A4	0.2277
		ratio of slope farmland A5	0.1224
		basic farmland protection index A6	0.0863
	land use degree (B)	land use rate B1	0.1955
	0.1621	construction area per capita B2	0.1734
		arable land per capita B3	0.2070
		multiple-crop index B4	0.1745
		woodland effective rate of utilization B5	0.1166
		volume fraction B6	0.1330
	land use efficiency(C)	fixed asset investment per unit area C1	0.1332
	0.3811	GDP of per hm ² land C2	0.1934
		environmental protection investment of per hm ² land C3	0.1687
		agricultural production and management investment of per hm ² land C4	0.1554
		infrastructure Investment of per hm ² land C5	0.1576
		construction land of elasticity C6	0.1917
	land use benefit (D)	GDP of per capita D1	0.1240
	0.264	waste emissions of per unit area D2	0.2478
		net income of per capita D3	0.1345
		unit of output value of construction land D4	0.2426
		unit of agricultural output value of agricultural land D5	0.1655
		green area of per capita D6	0.0856

3. Results and Analysis

3.1 Dynamic analysis of land use change

With the rapid economic development of Chongqing from 1999 to 2008, the structure of land use changed apparently (tab.2). Overall, the arable land kept declining in the past 10 years and totally reduced 293679.7 hm². During 1999 to 2004, the arable land reduced obviously, about 242193 hm², due to ecological restoration and the submerged inducing by Three Gorges reservoir projection. The declined rate of arable land acreage got to slow down after 2004 for enforcement of land consolidation project. Different from the change trend of arable land, the forest land and orchard obviously increased in the recent decade, with area of 320252.4 hm² and 75341.3 hm², respectively.

Since 1999, the area of construction land got being gradually increased, 74334.1 hm² in total and in which residential and industrial land accounting for 46133.7 hm², traffic land accounting for 14585.2 hm²,

and water conservancy facilities land accounting for 13615.3 hm². It can be seen the most growth in residential and industrial land, accounting for 60% of new construction land. Reclaimed area of unused land had increased year by year, 61855.9 hm² in total from 1999 to 2008.

Table.2 The land use changing of Chongqing reclaimed area from 1999 to 2008

Land use type	1999		2004		2008		change rate between 99-04 years (%)	change rate between 04-08 years (%)
	Area (hm ²)	Proportion (%)	area (hm ²)	proportion (%)	area (hm ²)	Proportion (%)		
arable land	2529611.7	30.75	2287418.7	27.8	2235932	27.18	-1.60	-0.56
garden land	164903.4	2.00	220943.5	2.69	240244.7	2.92	5.66	2.18
wood land	2970846.5	36.11	3251275.3	39.52	3291098.9	40.00	1.57	0.31
grass land	237071.4	2.88	238054.6	2.89	237210.1	2.88	0.07	-0.09
Other agricultural land	1030450.3	12.53	946332.6	11.5	915919.3	11.13	-1.36	-0.80
construction land	518836.5	6.31	558948.5	6.8	593170.6	7.22	1.29	1.53
unused land	775145.3	9.42	723891.8	8.8	713289.4	8.67	-1.10	-0.37

Due to the perspective of land use dynamic degree, change of land use types had different speeds in 1999-2004 and 2004-2008 two phases. In conclusion, the decreasing trend of arable land, other agricultural land, and unused land weakened, the increasing trend of garden land and woodland weakened, the change rate of grassland increases firstly and then decreased, and the increasing trend of construction land increased. It is consistent with the social and economic development.

3.2 land use Performance Evaluation Results

Land use performance of Chongqing from 1999 to 2008, which calculated according to performance model, showed in tab.3. Land use structure score was 0.7132 in 1999 and dropped into 0.2942 in 2008. Show that the contradiction between construction land and the arable land became conspicuously. The results showed that the trend of land use degree was decline, with its score dropped from 0.1143 in 1999 to 0.0387 in 2008. In Chongqing, efficiency and utilization benefit of land use significantly grew, the scores of which were 0.0655 and 0.0467 in 1999 increased to 0.4472 and 0.3011 in 2008, respectively. Thus, the current land productivity rate of Chongqing is low, but also showed that the output rate of land in Chongqing still had much space for improvement. Land use performance value is not high in the overall level, but kept steady growing, with 0.1767 in 1999 to 0.2598 in 2008. that indicated the land use was moving on a reasonable, conservation, and intensive way under the Chinese national macro-control.

Table.3 Land use performance in Chongqing City from 1999 to 2008

year	A	B	C	D	P
1999	0.7132	0.1144	0.0655	0.0467	0.1767
2000	0.6778	0.121	0.0612	0.0654	0.1543
2001	0.5534	0.1232	0.0733	0.0662	0.1532
2002	0.5321	0.1201	0.0765	0.0611	0.1477
2003	0.5109	0.0987	0.1123	0.1298	0.1723
2004	0.4877	0.0876	0.1566	0.1533	0.2166
2005	0.4655	0.0833	0.1084	0.1576	0.2268
2006	0.3765	0.0544	0.2866	0.1839	0.2325
2007	0.3244	0.0432	0.3476	0.2564	0.2436
2008	0.2942	0.0387	0.4472	0.3011	0.2598

4. Conclusion

Since 1999 to 2008, The area of arable land was decreased rapidly with 293679.7 hm² and the area of construction land was increased with about 74334.1 hm² during these ten years, which was the inevitable result of going-up of population and quickly urbanization.

The conflict between increase of construction land area and decrease of arable land area became more severity in Chongqing municipality, which would induced the index of flexibility of land resources configure decreasing. The trend of land utilize degree had been decreasing during recent decades. Efficiency and benefit of land use were obviously enhanced. But the overall level of land use efficiency and benefit is still in low degree and the output ratio of land even has a big gap to improve. Land use performance value was still relativity low but its trend was maintain stably increasing, which is consistent with the change of social economical development and natural condition.

Rapid economical devolvement, reform of city construction and improvement in standard of living in recent decade, Therefore, it should well conformed economical development and utilization of land resources, to provide reliable security for regional sustainable development.

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