# The Construction of Evaluation Indicator System for Low-carbon Village and Practice Research in Yuanjiang County

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**Abstract** Low-carbon village is a new eco-development model in the context of low-carbon economy, the inevitable trend for achieving coordinated development between man and nature, and the inevitable choice for achieving sustainable development. This paper has built a low-carbon village evaluation system with 3 levels and 20 indicators. On this basis, taking Yuanjiang County as empirical research object, we use distance function model method to analyze and evaluate the low carbonization of village in Yuanjiang County, in order to provide a reference for the low-carbon village evaluation.

**Key words** Low carbon, Low-carbon village, Indicator system, Yuanjiang County

## 1 Introduction

At present, the domestic evaluation studies on low-carbon village are mainly focused on the development of low-carbon agriculture, namely the status quo, existing problems, constraints and countermeasures concerning the development of low-carbon agriculture. However, there are few studies on the evaluation of integrated development of low-carbon village. We can mainly learn from the evaluation methods for low-carbon agriculture and low-carbon economy. Luo Xutian et al carried out comprehensive evaluation of low-carbon agriculture in northern Fujian from the perspective of economic, ecological and social benefits[1]. Luo Qingcheng et al used gray correlation method to build integrated model of agricultural productivity from technological level, ecological conditions and infrastructure[2].

In this paper, we firstly design the evaluation indicator system for low-carbon village, then take Yuanjiang County as the practice study object and use the built evaluation indicator system for low-carbon village for case study based on the minority rural development characteristics, and finally calculate the evaluation results, in order to provide a reference for evaluation theory and practice system of low-carbon village development.

## 2 Building of indicator system

Based on the comprehensive analysis of the current academic world's research on evaluation indicators for low carbon development[3-4], we divide the evaluation indicators into three levels, namely goal layer, criteria layer and indicator layer, from the internal logic of low-carbon village development.

The evaluation indicator system for low-carbon village can be seen in Table 1.

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## 3 Low-carbon village evaluation in Yuanjiang County

**3.1 Overview of Yuanjiang County** Yuanjiang Hani, and Yi and Dai Autonomous County is located in the south-central Yunnan Province, having jurisdiction over nine townships (towns, street offices). In 2011, the county's total population was 205500, and the population of ethnic minority accounted for 80.76% of the total population; the per capita net income of farmers in the county was 5990 yuan.

Yuanjiang is a typical mountain agricultural county, with a total land area of 2858 square kilometers (2 384.2 square kilometers of agricultural land and 383.99 square kilometers of arable land). Yuanjiang County is rich in water resources, but the distribution is uneven, less in winter and spring but more in summer and fall. Tobacco, sugar and livestock are the three traditional industries in Yuanjiang.

**3.2 Data sources** The data on various indicators are collected through the following channels: field surveys; Yuanjiang Statistical Yearbook; the "Twelfth Five - Year" Development Plan in Yuanjiang. The weight is calculated using analytic hierarchy process, based on expert scoring. Indicator data are shown in Table 2.

**3.3 Comprehensive evaluation of low carbonization development of low-carbon village**

**3.3.1** Calculation of comprehensive distance values. Using the comprehensive distance value, coupled with the assessment standards for low carbonization degree, we can get the level of low carbonization development.

The comprehensive distance value is calculated as follows:

The formula of low carbonization of agricultural production

$H_1(X_i; Y_i) = \sum_{i=1}^{n} |W_i E_i - W_i|$;

The formula of low carbonization energy structure

$H_2(X_i; Y_i) = \sum_{i=1}^{n} |W_i E_i - W_i|$;

The formula of low carbonization of lifestyle

$H_3(X_i; Y_i) = \sum_{i=1}^{n} |W_i E_i - W_i|$;

The formula of low carbonization of rural environment

$H_4(X_i; Y_i) = \sum_{i=1}^{n} |W_i E_i - W_i|$;

The formula of low carbonization of social environment

$H_5(X_i; Y_i) = \sum_{i=1}^{n} |W_i E_i - W_i|$

The comprehensive distance value of evaluation indicator system for low-carbon village

$H = \sum_{i=1}^{5} H_i$.

Based on the research of others[5] and expert advice, we design six levels to describe the low carbonization degree of low-carbon village, which can be seen in Table 3.

**Table 1 The evaluation indicator system for low-carbon village**

| Goal layer A | Criteria layer B | Indicator layer C | Survey or calculation methods |
|---|---|---|---|
| Sustainable development of low-carbon village | Low carbonization of agricultural production($B_1$) | Level of farmland irrigation $C_1$ | Effective irrigated agricultural area/Total area of commonly used farmland |
| | | Film recovery rate $C_2$ | Film recovery amount/Regional film utilization amount |
| | | Application rate of fertilizer per unit area of farmland $C_3$ | Application rate of fertilizer per hectare of this region |
| | | Popularization rate of fine varieties $C_4$ | Planting area of fine varieties/total area of farmland |
| | | Straw recycling and treatment rate $C_5$ | Recovery of straw/total straw produced |
| | Low carbonization energy structure($B_2$) | Energy consumption per 104 yuan of GDP $C_6$ | The energy consumed by the products worth 104 yuan, produced in a given period |
| | | The proportion of non-fossil energy consumption to total energy consumption $C_7$ | The amount of non-fossil energy consumption/total amount of energy consumption |
| | | The percentage of homes owning methane tank $C_8$ | Accumulated number of methane tanks/number of rural households |
| | Low carbonization of lifestyle($B_3$) | The degree of rural residents' awareness of the low carbon knowledge $C_9$ | Number of rural households with knowledge about low carbon/total number of rural households surveyed |
| | | Penetration rate of energy-efficient appliances $C_{10}$ | Number of energy-saving household appliances/total number of household appliances |
| | | Treatment rate of life garbage $C_{11}$ | Garbage treatment amount/total garbage emissions |
| | | Treatment rate of sewage $C_{12}$ | Sewage treatment capacity/total sewage discharge |
| | Low carbonization of rural environment ($B_4$) | Forest vegetation coverage $C_{13}$ | Forest cover area/total regional area |
| | | Village's air and water quality $C_{14}$ | Number of rural households satisfied with village's air and water environment/total number of households surveyed |
| | | Road access rate $C_{15}$ | The ratio of total length of all roads to the total regional area in a calculation area |
| | Low carbonization of social environment($B_5$) | The natural population growth rate $C_{16}$ | Birth rate in the reporting period-mortality rate in the reporting period |
| | | Education level of population $C_{17}$ | Average years of education |
| | | Regional level of national income $C_{18}$ | National income in the region |
| | | The proportion of added value of primary industry to regional GDP $C_{19}$ | Added value of primary industry/regional GDP |
| | | The proportion of farmers receiving technological training $C_{20}$ | Number of rural households receiving technological training/total number of rural households surveyed |

**Table 2 Various evaluation indicators for low-carbon village in Yuanjiang**

| Criterion layer | Indicator layer | Weight ($W_i$) | Actual value ($X_i$) | Target value ($Y_i$) | Level value ($E_i$) |
|---|---|---|---|---|---|
| Low carbonization of agricultural production $B_1$(0.344) | Level of farmland irrigation $C_1$ | 0.055 | 63.2% | 100% | 0.632 |
| | Film recovery rate $C_2$ | 0.026 | 40% | 90% | 0.44 |
| | Application rate of fertilizer per unit area of farmland $C_3$ | 0.125 | 1/362 | 1/225 | 0.62 |
| | Popularization rate of fine varieties $C_4$ | 0.013 | 93% | 100% | 0.93 |
| | Straw recycling and treatment rate $C_5$ | 0.125 | 15% | 80% | 0.187 |
| Low carbonization of energy structure $B_2$ (0.129) | Energy consumption per 104 yuan of GDP $C_6$ | 0.033 | 1/1.129 | 1/1.016 | 0.899 |
| | The proportion of non-fossil energy consumption to total energy consumption $C_7$ | 0.082 | 8% | 11.4% | 0.701 |

(Table 2)

| Criterion layer | Indicator layer | Weight ($W_i$) | Actual value ($X_i$) | Target value ($Y_i$) | Level value ($E_i$) |
|---|---|---|---|---|---|
| | The percentage of homes owning methane tank $C_8$ | 0.014 | 40.3% | 79.46% | 0.507 |
| Low carbonization of lifestyle $B_3$ (0.054) | The degree of rural residents' awareness of the low carbon knowledge $C_9$ | 0.031 | 20% | 100% | 0.2 |
| | Penetration rate of energy-efficient appliances $C_{10}$ | 0.006 | 15% | 80% | 0.187 |
| | Treatment rate of life garbage $C_{11}$ | 0.014 | 0 | 74% | 0 |
| | Sewage treatment rate $C_{12}$ | 0.003 | 40% | 63.5% | 0.625 |
| Low carbonization of rural environment $B_4$ (0.344) | Forest vegetation coverage $C_{13}$ | 0.219 | 50.96% | 55% | 0.926 |
| | Village's air and water quality $C_{14}$ | 0.036 | 89.5% | 100% | 0.895 |
| | Road access rate $C_{15}$ | 0.089 | 90% | 99.2% | 0.907 |
| Low carbonization of social environment $B_5$ (0.129) | The natural population growth rate $C_{16}$ | 0.061 | 1/2.3‰ | 1/4‰ | 1 |
| | Education level of population $C_{17}$ | 0.011 | 4.07 | 9.05 | 0.449 |
| | Regional level of national income $C_{18}$ | 0.024 | 5900 | 7917 | 0.745 |
| | The proportion of added value of primary industry to regional GDP $C_{19}$ | 0.027 | 1/45.0% | 1/20% | 0.44 |
| | The proportion of farmers receiving technological training $C_{20}$ | 0.006 | 38.1% | 100% | 0.381 |

**Table 3 Distance function method – low carbonization grading**

| Grade | Comprehensive distance value | Low-carbon rural development level |
|---|---|---|
| 1 | 0.15 | Very high |
| 2 | 0.30 | High |
| 3 | 0.45 | So-so |
| 4 | 0.50 | Poor |
| 5 | 0.65 | Very poor |
| 6 | 0.95 | Extremely poor |

**3.3.2** Calculation results. According to the formula of low carbon distance value, we get the evaluation results of low-carbon village in Yuanjiang County as follows:

(i) The distance value of low carbonization of agricultural production $H_1 = 0.184$;

(ii) The distance value of low carbonization of energy structure $H_2 = 0.0347$;

(iii) The distance value of low carbonization of lifestyle $H_3 = 0.044$;

(iv) The distance value of low carbonization of rural environment $H_4 = 0.028$;

(v) The distance value of low carbonization of social environment $H_5 = 0.031$.

(vi) The comprehensive distance value of evaluation indicator system for low-carbon village in Yuanjiang $H = 0.323$.

The distance value of low carbonization of agricultural production accounts for 56.9% of the comprehensive distance value of evaluation indicator system for low-carbon village in Yuanjiang; the distance value of low carbonization of energy structure accounts for 10.8% of the comprehensive distance value of evaluation indicator system for low-carbon village in Yuanjiang; the distance value of low carbonization of lifestyle accounts for 13.8% of the comprehensive distance value of evaluation indicator system for low-carbon village in Yuanjiang; the distance value of low carbonization of rural environment accounts for 8.7% of the comprehensive distance value of evaluation indicator system for low-carbon village in Yuanjiang; the distance value of low carbonization of social environment accounts for 9.6% of the comprehensive distance value of evaluation indicator system for low-carbon village in Yuanjiang (Table 4).

**Table 4 The proportion of various indicators to comprehensive distance value**

| | Low carbonization degree of agricultural production | Low carbonization degree of energy structure | Low carbonization degree of lifestyle | Low carbonization degree of rural environment | Low carbonization degree of social environment | Comprehensive distance value of low-carbon village evaluation |
|---|---|---|---|---|---|---|
| The distance value | 0.184 | 0.0347 | 0.044 | 0.028 | 0.031 | 0.323 |
| Proportion | 56.9% | 10.8% | 13.8% | 8.7% | 9.6% | 100 |

From the grade standards of rural low carbonization degree, it shows that the rural low carbonization level in Yuanjiang County is at the general level (0.323). The distance value of low carbonization of agricultural production accounts for 56.9% of the comprehensive distance value of evaluation indicator system for low-carbon village in Yuanjiang, which indicates that the low carbonization of agricultural production makes the smallest contribution to the low-carbon village development degree in Yuanjiang. The low carbonization rural environment makes the greatest contribution to the overall low-carbon village development, only accounting for 8.7% of the total distance value.

## 4 Conclusions

Low-carbon village is a new eco-development model in the context of low-carbon economy, the inevitable trend for achieving coordinated development between man and nature, and the inevitable choice for achieving sustainable development. This paper has built

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dition of reasonably and standardized use of fishery drugs, feeds, and fertilizers.

(8) High safety. In the process of ecological aquaculture, it is required to take whole process quality control. Both ground environment and inputs of means of products should be strictly certified. Quality standard should be clearly defined for internal quality, production technology, and operating procedures of aquatic products. From pre-production, production and post-production, breeding, processing, management, storage, packaging and sales, as well as waste use, the whole process should be monitored, and traceable management is implemented, to practically ensure food safety and harmless environment of circulation and processing process.

(9) Standardization. Namely, it is recommended to pay special attention to standardization of ecological fishery technology and production of harmless, green and organic aquatic products. Through implementing certification of outstanding ecological environment of aquatic products and standardized ecological breeding technology, it is expected to set up market image of "ecological Poyang Lake and green aquatic products", raise competitive power of aquatic products of Jiangxi Province at both domestic and foreign markets, and increase aquaculture benefits.

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a low-carbon village evaluation system with 3 levels and 20 indicators. On this basis, taking Yuanjiang County as empirical research object, we use distance function model method to analyze and evaluate the low carbonization of village in Yuanjiang County, in order to provide a reference for the low-carbon village evaluation. In order to promote low-carbon village construction, it is necessary to form a set of scientific and authoritative indicator system and evaluation methods, namely to establish a universal theory and method for guiding the theory and practice of low-carbon village development evaluation. For the differences in the rural development, the establishment and application of evaluation indicator system for low-carbon village should be combined with specific objects.

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