

Research on Benefit Evaluation and Optimization Strategy of Rural Ecological Products Value Realization

-- Take the Villages in Pukou District of Nanjing as an Example

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Abstract: As the cornerstone of human existence and progress, ecological products indispensably support the sustainable development of society. In order to deeply discuss the benefits and achievements of eco-product value realization in various regions, this paper sorts out the research status of the evaluation system and method of rural eco-product value realization in Pukou District, and constructs an evaluation system of eco-product value realization benefit including 11 indicators of three subsystems: ecological benefit, economic benefit and social benefit. Using entropy weight method to measure the value realization benefit of rural ecological products. The results show that: (1) the overall development level of Pukou District is relatively high, and the work of promoting the realization of the value of rural ecological products is in good condition, and the overall development is in the growth stage; (2) From 2017 to 2022, the comprehensive benefits of ecological products in Pukou District have been steadily improved, and the comprehensive benefits have increased from 0.385 to 0.642; (3) Ecological benefits increased significantly, followed by economic benefits, and social benefits increased in a downward trend.

Keywords: Ecological Products; Evaluation Index; Benefit Evaluation.

1. Introduction

Report to the 20th CPC National Congress pointed out that respecting nature, conforming to nature and protecting nature are the inherent requirements of building a socialist modern country in an all-round way. When discussing China's unique concept of eco-products, the uniqueness of its concept is rooted in the local practice, showing the distinctive characteristics of China. In this process, the realization mechanism of ecological product value constitutes the key path to effectively transform the advantages of natural environment into the benefits of economic and social development, and is an important strategy to promote green development and achieve a win-win situation for ecological civilization and economic construction. General Secretary Xi Jinping pointed out that a good ecology itself contains infinite economic value, which can continuously create comprehensive benefits and realize sustainable economic and social development. Therefore, based on the prominent position of eco-product value realization in the ecological development of agriculture and rural areas, it is also the top priority to improve the evaluation system of eco-product value realization to realize the strategic goal of increasing farmers' income and sharing wealth in rural areas.

In this paper, the villages in Pukou District of Nanjing are selected as the research object, and the evaluation index construction of rural eco-product value realization is deeply studied, and the evaluation system of eco-product value realization benefit is constructed, and the evaluation of eco-product value realization effect is carried out based on the perspective of eco-product value realization benefit.

The purpose of this study is to explore the value realization benefit evaluation of rural ecological products in Pukou District, Nanjing, evaluate the development status of rural ecological products according to relevant calculation

indicators, and propose optimization strategies for the development of ecological products to help rural revitalization and development in Pukou District.

1.1. Overview of the Study Area

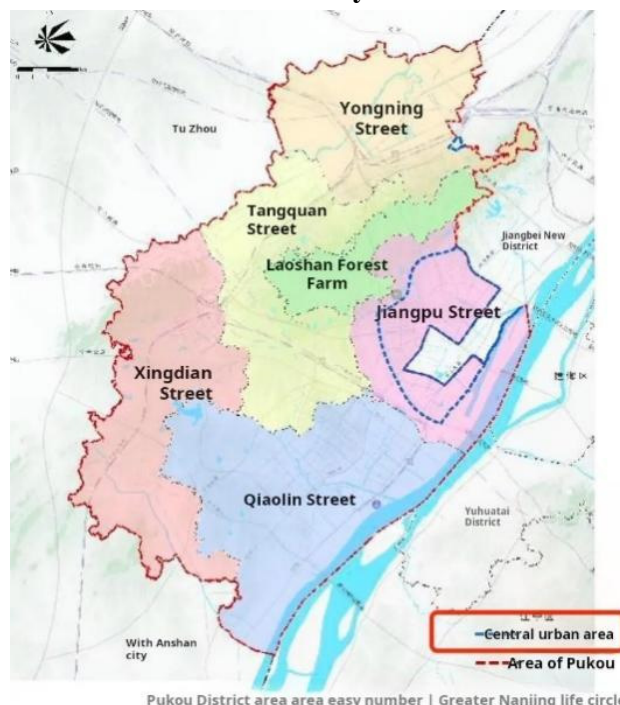


Figure 1. Overview of the study area

Report to the 20th CPC National Congress, the Communist Party of China, proposed to establish a mechanism to realize the value of ecological products. For a long time, Pukou District of Nanjing has always actively responded to the policy guidance, thoroughly implemented the core concept of "green ecology is economic wealth", devoted itself to

improving the supply efficiency of ecological products, and carefully constructed a modern Pukou new look integrating rural natural scenery, pastoral and rural tourism highlights. The area has strengthened the governance of rural agricultural environment, accelerated the pace of beautiful countryside construction, achieved comprehensive coverage of rural planning, and successfully built a demonstration area of

beautiful countryside covering 479 square kilometers. The number of provincial traditional villages ranks among the best in the province and ranks first in the city.

At the same time, by interviewing villagers in several villages in Pukou District, we investigated the public's attention to the realization of the value of ecological products, as shown in the following figure:

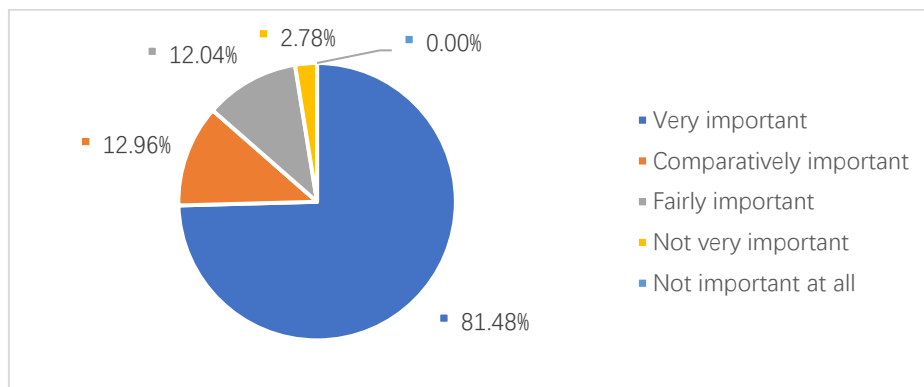


Figure 2. The villagers' attention to the realization of the value of ecological products

As can be seen from the above figure, the villagers attach great importance to the realization of the value of eco-products. Only a few villagers think that the realization of the value of eco-products is not very important, and almost no villagers completely deny the importance of the realization of the value of eco-products. On the whole, most villagers have high ecological awareness and are very supportive of the promotion of the realization of the value of eco-products by various government departments.

2. Literature Review

2.1. Eco-product Value Realization Benefit Evaluation System Construction Research Status

Realizing the value of ecological products is an important proposition of ecological civilization construction in the new period. Around this proposition, Chinese scholars have carried out many discussions and studies. In terms of the research on the transformation effect of "two mountains", Sun Chongyang and others (2020) selected ecological conditions and environmental conditions as "green mountains and green hills" indicators, and economic benefits and growth quality as "Jinshan Yinshan" indicators to evaluate the practical effect of "two mountains" in 11 cities in Zhejiang Province; Ni Lin et al. (2022) expounded the connotation of the transformation of "two mountains" based on the endogenous development theory, and used the evaluation index system to study the practical effect of "two mountains". In terms of quantitative research on the effectiveness of value realization, Wu Shangyun (2022) constructed an evaluation index system of eco-product value realization from three aspects: total value evaluation index, structural evaluation index and dynamic evaluation index, and conducted an empirical study on Chishui City. Wang Xiaoxin et al. (2023) constructed an evaluation index system of eco-product value realization from three aspects: eco-product supply, policy intervention (transaction) and improvement of people's livelihood and welfare, and evaluated the effectiveness of typical cases of eco-product value realization released by the Ministry of Natural Resources.

2.2. Research Status of Value Realization Benefit Evaluation Methods

In recent years, the research on the value realization evaluation of ecological products has been carried out at home and abroad. Zhou Lixuan et al. (2024) used the success evaluation method to judge the success of the way to realize the value of ecological products; Zhang Ying et al. (2021) summarized the evaluation method based on cost and benefit, and reflected the value of the services provided by the ecosystem through the cost and corresponding expected benefits; Lin Yiqing et al. (2023) used GEP accounting method to evaluate the value realization rate of ecological products; Zhang Enxiang et al. (2024) used the evaluation method of suitability for the development and utilization of ecological products, and thus put forward the value-added way of ecological products.

2.3. Research Review

To sum up, at present, the research on quantitative evaluation of eco-product value realization in China is still in its infancy, and scholars have made some achievements in the research on the path of eco-product value realization by constructing a multi-dimensional index system, but there are relatively few studies on the evaluation of rural eco-product value realization at present. In view of the complexity of ecosystem and the heterogeneity of resource endowment, there is no universal model to realize the value of ecological products, so we must scientifically choose the path to realize the value of ecological products based on our own endowment and development reality. Therefore, it is the key link to realize the transformation of "two mountains" to establish a scientific, standardized and widely recognized evaluation system for the value realization of ecological products.

3. Methods and Materials

3.1. Overview of the Entropy Law

Entropy weight method, according to the explanation of the basic principle of information theory, information is a measure of the degree of system order. According to the

definition of information entropy, the entropy value can be used to judge the dispersion degree of an index. The smaller the information entropy, the greater the dispersion degree of the index, and the greater the influence of the index on comprehensive evaluation. Therefore, information entropy can be used to calculate the weight of each index, which provides a basis for multi-index comprehensive evaluation.

3.2. Model Construction

In order to further understand the economic benefits of realizing the value of rural ecological products in Pukou District and avoid the influence of subjective factors, this paper chooses objective weighting method and uses entropy weight method to eliminate the influence of different index dimensions, get standardized data and the weight of each evaluation index, and then calculate its comprehensive score. The main steps are as follows:

Set the original matrix X:

$$X = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{bmatrix} \quad (1)$$

Where i stands for an index, j stands for a year, m stands for the number of evaluation indexes, and n stands for the number of evaluation years.

(1) data normalization processing

Because the data dimensions of each index are different, it is necessary to process the data first, and adopt the method of data normalization to set the standardized value of the j -th index of the i -th evaluated object as the original data of the j -th index of the i -th sample. $Y_{ij}X_{ij}$

Forward normalization formula:

$$Y_{ij} = \frac{X_{ij} - X_{min}}{X_{max} - X_{min}} \quad (2)$$

Negative normalization formula:

$$Y_{ij} = \frac{X_{max} - X_{ij}}{X_{max} - X_{min}} \quad (3)$$

(2) Determination of index weight

Based on the principle of information entropy, for an index, the entropy value can be used to judge the disorder degree of the index, that is, the dispersion degree of the index, and the information entropy value is negatively correlated with the dispersion degree of the index, so the information entropy can be used as a technical means to calculate the influence effect of each index and comprehensively evaluate multiple indexes.

1) Calculate the index coefficient of variation (p_{ij}), and the calculation formula is:

$$p_{ij} = \frac{Y_{ij}}{\sum_{i=1}^n Y_{ij}}, \quad i = 1, \dots, n, \quad j = 1, \dots, m \quad (4)$$

Wherein, p_{ij} represents the index variation coefficient; Y_{ij} represents the sample matrix value.

2) Calculate the index information entropy (E_j), and the calculation formula is:

$$E_j = -\ln(n)^{-1} \sum_{i=1}^n p_{ij} \ln p_{ij} \quad (5)$$

Represents the index information entropy in. > 0 , if $=0$, definition $=0$. $E_j E_j p_{ij} E_j$

3) According to the calculation formula of information entropy, the information entropy of each index is calculated as: E_1, E_2, \dots, E_m

4) Calculate the weight (w_j) of each index through information entropy, and the calculation formula is:

$$w_j = \frac{1 - E_j}{k - \sum E_j}, \quad j = 1, \dots, m \quad (6)$$

Where k represents the number of indicators, and $k = m$.

5) Calculate the j -th comprehensive evaluation score of the i -th evaluated index

$$S_j = \sum_{j=1}^n w_j p_{ij} \quad (7)$$

3.3. Source of Data

The per capita disposable income of rural residents, the total output value of agriculture, forestry, animal husbandry and fishery, rural tourism income and the income ratio of urban and rural residents are measured. In order to ensure the reliability and authenticity of the data, the data of this study comes from the statistical yearbook of Pukou District from 2017 to 2022, the statistical bulletin of national economic and social development of Pukou District and the data of Pukou District Bureau of Statistics.

4. Results and Discussion

4.1. Evaluation Index Weight Results under Entropy Weight Method

This paper takes Pukou District as an example, based on the analysis of the connotation, mechanism and benefit of value realization of ecological products. Following the principles of scientificity, hierarchy and comprehensiveness, and in accordance with the requirements of realizing efficient and sustainable development of eco-product value, an evaluation system for realizing benefits of eco-product value is constructed from three aspects: ecological benefits, economic benefits and social benefits. Among them, the ecological benefits include three indicators: the proportion of days with good air, the average annual concentration of PM2.5, and the forest coverage rate; Economic benefits include four indicators: per capita disposable income of rural residents, gross output value of agriculture, forestry, animal husbandry and fishery, tourism income and public finance budget income; Social benefits include four indicators: Engel coefficient of rural households, per capita housing construction area of rural residents, income ratio of urban and rural residents, and per capita consumption expenditure of rural residents. Using the entropy weight method, through the calculation of the above formulas (1)-(6), the index weights of the evaluation system of ecological product value realization benefit in Pukou District of Nanjing from 2017 to 2022 are determined, as shown in Table 1.

After sorting the weights of each index, it can be found that the average annual concentration value of PM2.5 is the largest, and the weight of the per capita housing construction area of rural residents is the smallest.

Through formula (7), the comprehensive benefits of ecological product value realization and the evaluation results of each subsystem are obtained, and the results are shown in Table 2.

Table 1. Weight results of evaluation index of ecological product value realization benefit

Target layer	Criterion layer	Index layer	Indicator unit	Indicator attribute	weight	sort	
Value realization benefit of ecological products	ecology benefit	Proportion of days with good air	%	forward direction	0.3228	three	
		Average annual concentration value of PM2.5	Microgram/m3	negative direction	0.4845	one	
		Forest coverage rate	%	forward direction	0.1927	nine	
	economy benefit	Per capita disposable income of rural permanent residents	Yuan Dynasty (1206-1368)		forward direction	0.2641	six
		Gross output value of agriculture, forestry, animal husbandry and fishery	hundred million yuan		forward direction	0.2378	seven
		tourist income	hundred million yuan		forward direction	0.2919	four
		public budget income	hundred million yuan		forward direction	0.2062	eight
	society benefit	Engel coefficient of rural households	%		negative direction	0.4179	2
		Per capita housing construction area of rural residents	square meter		forward direction	0.1535	11
		Income ratio of urban and rural residents	%		negative direction	0.1547	10
		Per capita consumption expenditure of rural residents	ten thousand yuan		forward direction	0.2739	five

Table 2. Evaluation Results of Rural Eco-products Value Realization Benefit in Pukou District from 2017 to 2022

age	Ecological benefits	Economic benefits	Social benefits	Comprehensive benefits
2017	0.1679	0.3501	0.2571	0.2635
2018	0.1918	0.6081	0.5487	0.4666
2019	0.3914	0.2316	0.7998	0.4867
2020	0.9168	0.4332	0.3695	0.5488
2021	0.9552	0.6909	0.5525	0.716
2022	0.8803	0.8380	0.6108	0.7665

4.2. Discussion

This paper summarises the current status of research on the construction of the evaluation system and evaluation methods of the benefits of ecological product value realisation, and takes the countryside of Pukou District, Nanjing City as the specific research object, and constructs the evaluation system of the benefits of ecological product value realisation which includes three subsystems of ecological, economic and social benefits with the help of entropy weighting method, and researches the benefits of the value realisation of the countryside's ecological products.

4.2.1. Comprehensive Benefits

From 2017 to 2022, the comprehensive benefits of ecological products in Pukou District showed an overall growth trend, with the benefit value increasing from 0.26 to 0.77, with an average annual growth rate of 26.33%. Among the benefits of each subsystem, the order of annual average growth rate is ecological benefit (49.78%), economic benefit (35.93%) and social benefit (33.09%). This shows that ecological benefits and economic benefits are the main driving forces to realize the benefit growth of ecological products in Pukou District. Compared with the first two, social benefits have a slightly slower growth rate, but they are still an important part of realizing the benefit of ecological products.

4.2.2. Ecological Benefits

From 2017 to 2022, the ecological benefits realized by the value of rural ecological products in Pukou District showed an overall upward trend, from 0.1679 to 0.8803. The ecological benefits realized by the value of ecological products were related to forest coverage, air quality and surface water environmental quality. Among them, from 2018 to 2019, the growth rate reached 104.09%, and from 2019 to 2020, the growth rate reached 134.27%. In these two years, Pukou District launched environmental remediation actions in an all-round way, and completed 99 remediation tasks such as black and smelly ponds in rural areas, keeping the environmental quality of surface water ranked first in the city and adhering to the two bottom lines of "development" and "ecology".

4.2.3. Economic Benefits

From 2017 to 2022, the economic benefits of ecological products in this region showed an overall growth trend, with a total increase of 0.49, with an average annual growth rate of 35.93%. In 2018-2019, the economic benefit value was greatly reduced, with the rate of reduction reaching 61.92%, which was due to the cumulative reduction of the total output value of agriculture, forestry, animal husbandry and fishery and tourism income of 4.004 billion yuan. However, from 2019 to 2022, the economic benefits continued to grow substantially, which benefited from the strengthening of financial guarantee in Pukou District, promoting the establishment and improvement of the policy system and institutional mechanism of financial support for rural revitalization, and providing a strong guarantee for the implementation of the rural revitalization strategy.

4.2.4. Social Benefits

From 2017 to 2022, the value of ecological products in Pukou District showed an overall upward trend, with a total increase of 0.35. This is because from 2017 to 2022, the per

capita consumption expenditure of rural residents and the per capita housing construction area of rural residents are all increasing, the income gap between urban and rural areas is gradually decreasing, the rural infrastructure is becoming more and more perfect, and the living conditions of residents are obviously improved. Due to the impact of the epidemic in COVID-19 at the end of 2019, the social benefits have also been greatly hit, and the social benefits have been greatly

reduced in 2019-2020. From 2017 to 2022, the Engel's coefficient of rural households did not increase or decrease significantly, and almost remained at 29.4%, with an average growth rate of 0.5%, which indicated that more attention should be paid to the quality of life of villagers in the process of realizing the value of ecological products in Pukou District.

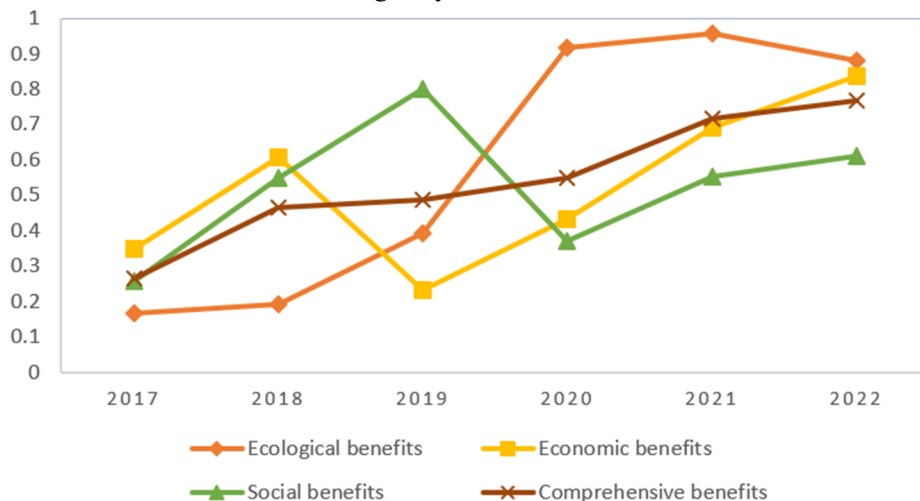


Figure 3. Dynamic changes of value realization benefits of rural ecological products in Pukou District from 2017 to 2022

5. Conclusion

At present, China is entering an important historical stage of overall green economic and social transformation and realizing the harmonious coexistence and modernization between man and nature, which is of great significance to the sustainable development of the country. The realization of the value of ecological products is helpful to improve the ecological benefits and continuously meet the people's growing needs for a beautiful ecological environment. At the same time, it will help to transform ecological benefits into economic benefits and help China's high-quality economic development. This paper summarizes the research status of the evaluation system and evaluation method of eco-product value realization benefit, and takes the village of Pukou District in Nanjing as the specific research object, and constructs the evaluation system of eco-product value realization benefit including three subsystems of ecological benefit, economic benefit and social benefit with the help of entropy weight method to study the eco-product value realization benefit of this village.

Through the research and analysis of the value realization benefit of rural ecological products in Pukou District of Nanjing, this paper draws the following conclusions. (1) The work of realizing the value of ecological products in Pukou District of Nanjing has been steadily advanced, and the work has made good progress. Most villagers attach great importance to the promotion of realizing the value of rural ecological products, and the per capita disposable income of farmers has been continuously improved. (2) The overall level of comprehensive benefits of ecological product value realization in Pukou District of Nanjing showed an upward trend from 2017 to 2022, which benefited from the correct principles, policies and promotion means of government departments, and achieved good results in the realization of ecological product value. (3) Pukou District strives to actively transform the value of ecological products into economic benefits and social benefits, and the income of local residents

has increased significantly, and the quality of life has improved significantly.

In addition, in view of the obvious optimization potential in the process of promoting the value realization of rural ecological products in Pukou District, this paper hereby puts forward the following strategic suggestions in order to provide guidance for the further development of the region. (1) adhere to the ecological priority. In the practice of realizing the value of ecological products, we should pay special attention to ecological protection and restoration, provide sustainable supply of ecological products, enhance the ecological benefits of ecological products, and lay a solid foundation for the transformation of economic and social benefits on the premise of maintaining the stability of the natural environment. It is necessary to fully implement the systematic idea that "mountains, rivers, forests, fields, lakes, grass and sand are a community of life", pay more attention to overall consideration in regional development and ecological environment protection, fully adapt to local actual conditions, adjust measures to local conditions, and vigorously develop characteristic industries. (2) we should actively expand the value realization mode of ecological products. In the process of transforming ecological benefits of ecological products into economic benefits, we should not rely on a certain industry. We should actively expand the path of realizing the value of ecological products, explore various modes of realizing the value of ecological products, and diversify and promote the transformation of ecological benefits into economic benefits. (3) we should actively explore diversified market-oriented ecological compensation, build a resource rights trading platform, and carry out in-depth ecological resources indicators such as forest coverage, water rights, forest rights and other ecological rights trading.

To sum up, the process of realizing the value of ecological products is long and continuous, which calls for close cooperation and co-creation from all walks of life, aiming at exploring and constructing a new development model of harmony between man and nature. In the future, we hope to

open up a two-way gain path that not only promotes ecological environment protection but also helps economic and social prosperity, which will be a sustainable development path with China characteristics.

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