Construction of Ecological Performance Evaluation Index for Rural Construction

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Abstract. The construction of ecological performance evaluation index system of beautiful rural construction aims to promote the benign and high-quality development of rural ecological construction with the evaluation of rural ecological performance, and ultimately help to achieve the goal of regional "rural revitalization". Focusing on the ecological performance evaluation of rural construction in eastern Zhejiang Province, this paper screened and tested the evaluation indexes, and each index was given different weights based on the existing ecological performance evaluation index system combined with pre-selected evaluation indexes such as literature search and field research by means of expert consultation, questionnaire survey and analytic hierarchy process (AHP). The evaluation index system of ecological performance of beautiful rural construction was initially constructed with 2 first-class indexes, 11 second-class indexes and 29 third-class indexes in order to improve the rural ecological space environment, enhance the rural ecological civilization, develop the quality of life of villagers, and promote rural revitalization.

1. Ecological performance of rural construction

Over the past decade or so, along with the progress of urbanization and urban-rural integration, rural construction has gradually become the focus of national development. The "rural revitalization" development strategy put forward in the report of the 19th National Congress of the Communist Party of China on October 18th, 2017 has clearly defined the construction objectives and policies of "prosperous industry, ecological livable, rural civilization, effective governance and affluent life"[1], which has raised the rural construction work to a new height. Theoretically, rural construction is a complicated system engineering, which includes agricultural production, farmers' life and rural ecology[2]. Rural ecology is an important part of building a beautiful countryside, especially under the general requirements of realizing national ecological civilization and building a "beautiful China" in the new era, the revitalization of rural ecology is extremely important. On the other hand, in a broad sense, ecology includes politics, economy, culture, environment, resources, system and other aspects. It refers to the coupling relationship between the various environmental conditions and the interaction between the main body of life on which the existence, development, reproduction and evolution of life depend[3], but for the construction of rural ecology, this paper mainly focuses on the two main aspects of natural ecological environment and human ecological value.

In addition, "performance evaluation" originated from the content of management science in order to understand, manage and improve the performance of a system, that is, its input, processing and output process[4]. It can be understood as the evaluation of the results of the project operation according to the target within a specific time frame and under a specific standard through comparison and analysis. With the development of urban and rural planning and landscape architecture, the study of "performance" has gradually become the focus of the study, combined with the relevant research, the concept of "ecological performance evaluation" has not been clearly defined[5].

There are not many studies on the ecological performance of rural construction in China, mainly as a sub-item of the performance of beautiful rural construction. Yang Huan has studied the performance evaluation and sustainable development model of new rural construction in Guanzhong area[6]. Xu Kaiheng has studied the performance evaluation of rural construction in Jilin province based on social integration[7], most of which are comprehensive analysis and evaluation of rural economy, society, ecology, industry and so on; An Chao, Shen Qingji, et al. studied the construction method of green infrastructure network based on the ecological performance of spatial utilization[8]. Song Xiaoya, Guo Rong et al. studied the construction of Harbin urban ecological performance evaluation index system[9], which focused on the urban spatial form, and less on the ecological performance of rural construction. Foreign studies are also focused on landscape performance, sustainable development performance and other aspects. The focus is on ecosystem service value, ecological capacity and so on.

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At the implementation level of rural construction operation, based on the practice of constructing beautiful countryside in the east of Zhejiang Province in recent years, in order to deal with a series of problems in the development of rural construction in China, such as ecological environment destruction, population outflow and aging, the decline of traditional industries and so on, China's central government and local governments have led efforts to build new and beautiful rural areas and improve the environment of small towns, and constantly improve the policy and strategic guidance of the next stage through the summary of construction, formed the national "Guide to Assessment of Beautiful Countryside Construction"[10], "Assessment and Scoring Methods of Environmental Comprehensive Renovation of Small Towns in Zhejiang Province" [11]and other evaluation index system including ecological, economic, social and other aspects of the content, played a good role in promoting the development of rural construction. Focusing on the performance of ecological construction, as an important part of rural sustainable development, rural ecological construction is the inevitable requirement of rural revitalization. According to relevant studies, there are still many unsatisfactory aspects in the research contents and methods of ecological performance evaluation of rural construction, such as the disconnection between ecological construction and performance evaluation, the diversity of ecological performance evaluation indexes and many other issues. Therefore, this paper constructed a set of scientific, reasonable, fair and orderly ecological performance evaluation index system of beautiful rural construction, which is the most effective way to lead the rural ecological revitalization. What's more, it not only can improve and perfect the scientific and standard evaluation index system of rural ecological construction in China, but also can help to revitalize rural ecology, promote construction by evaluation, assist construction by evaluation, and combine evaluation with construction[12], as well as promote the high-quality sustainable development of rural ecological construction, and constantly revitalize and activate the countryside.

Therefore, based on the national "Guide to Assessment of Beautiful Countryside Construction", "Assessment and Scoring Methods of Environmental Comprehensive Renovation of Small Towns in Zhejiang Province" and the evaluation index system of "Landscape Performance" in the United States[13], the practice and characteristics of rural ecological construction, from two aspects of natural ecological environment and human ecological value, the evaluation index system of ecological performance of beautiful rural construction was preliminarily constructed, and the evaluation indexes were screened and tested by means of expert consultation, questionnaire survey, fuzzy comprehensive evaluation, analytic hierarchy process and other methods, and each index was given different weights. This study attempts to build a scientific and reasonable evaluation index system of ecological performance of rural construction and to provide a basis for the construction, evaluation and development of beautiful rural ecology.

2. Index system construction

The selection of ecological performance evaluation indexes for rural construction should be representative and applicable. At present, the selection of ecological performance evaluation index and the construction of index system focused on rural construction are still in the research and exploration stage. The main methods include expert consultation scoring method, factor analysis method, fuzzy comprehensive evaluation method, questionnaire survey method and so on. This study aimed at the ecological performance evaluation of beautiful rural construction, the selection of the index system and the establishments of the logical structure diagram are as follows Figure 1.

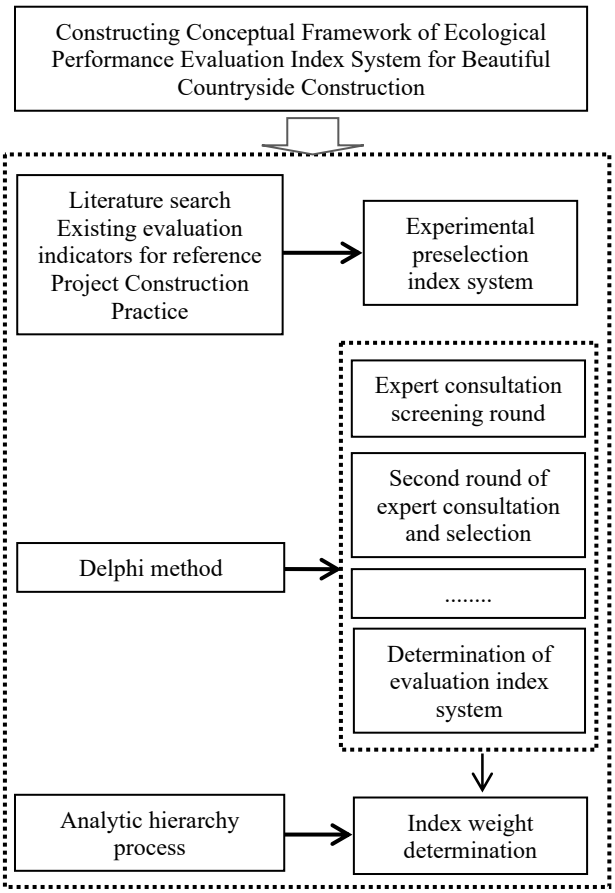

Fig. 1. Logical Structure Diagram of Screening and Establishment of Index System

2.1 Construction of experimental preselected indexes

The experimental pre-selected indexes of ecological performance evaluation of beautiful rural construction are mainly obtained from four aspects: the existing evaluation index system, the related literature search, the exchange of expert interviews, and the field research and practice summary of the project. This is the first step of constructing the evaluation index system. The choice is subjective, focusing on the comprehensive selection of indexes.

On October 2018-December 2018, based on the study of the theory of beautiful rural construction and

ecological performance evaluation, it mainly draws lessons from the national "Guide to Assessment of Beautiful Countryside Construction", "Assessment and Scoring Methods of Environmental Comprehensive Renovation of Small Towns in Zhejiang Province", and the evaluation index system of "Landscape Performance" in the United States on the performance of ecological construction. Based on the summary of the practice of rural ecological construction and its own characteristics, this paper preliminarily draws up two levels of natural ecological environment and human ecological value as the experimental pre-selected indexes of the ecological performance evaluation of rural construction.

For more scientific and reasonable pre-selection index, we also conducted a field study on the ecological construction of beautiful rural areas in eastern Zhejiang from January to March 2019. The ecological performance of rural construction and development in recent years was preliminarily classified and evaluated. At the same time, it also interviewed and exchanged with experts in the field of rural construction evaluation, leaders of competent departments of villages and towns, leaders of local planning bureaus, local villagers and grass-roots government functionaries, further refined and improved the second-and third-first-classndex system, and formulated the main contents of each index evaluation.

Through the comprehensive analysis of the above aspects, we have preliminarily drawn up an experimental pre-selected index system, including 2 first-class indexes, 14 second-class indexes and 40 third-class indexes, which can reflect the ecological performance evaluation of the beautiful rural construction in the new era.

2.2 Expert group decision-making on preselected indexes

We use Delphi method to select the pre-selected indexes for expert consultation. Through the questionnaire survey, each preselected index is set to be suitable for selection, unsuitable for selection, and optimized and adjusted. Then, 22 senior experts in the field of beautiful rural construction, government leaders, practitioners and township grass-roots workers were selected to complete the questionnaire, and the results of the questionnaire were statistically evaluated and analyzed. Although this work has certain subjectivity, but because the experts who participate in decision-making consultation all have rich practical experience and theoretical knowledge in the construction of beautiful countryside, the comprehensive and integrated analysis of the questionnaire opinions of many experts can change the subjectivity into objectivity to a certain extent, and preliminarily screen out the unsuitable evaluation indexes, The distribution of the number of participating decision-making experts is shown in Table 1.

Table 1. Statistics on the Distribution of Consulting and Decision-making Experts

Category of experts	Population distribution
A senior expert in the field of beautiful rural construction	4
Leader of the competent government department	4
Grass-roots staff	8
Practitioner	6
Total	22

According to the requirements of Delphi method, the selected experts must be "experts inside and outside the organization", "each member of the group understands the basic problems",[14] so in the selection of experts, we have selected experts and scholars who have in-depth research or rich management and practical experience in rural construction, and the government personnel with strong pertinence. On the other hand, the general Delphi method "sample size of 10-15 opinion participants is enough".[15] In order to make the results of screening indexes more reasonable and perfect, we finally selected 22 experts to participate in consulting decision-making, and conducted expert consultation by combining e-mail and written questionnaires.

After the integrated analysis of the experts' opinions, we retain most of the indexes (more than 80%) from which the experts think are suitable for selection, modify the indexes which are optimized and adjusted, and exclude the indexes which are not suitable for selection, thus forming a round of screening results. We will modify and optimize the questionnaire after the second round of expert review and improvement, so that after many rounds of expert consultation and screening, the final evaluation index system of experts basically agreed.

2.3 Determination of ecological performance assessment index system

In consultation with experts, we continue to optimize and adjust the ecological performance evaluation indexes. After three rounds of expert consultation and screening, the expert group's recognition of the evaluation index system is basically the same, from which the ecological performance evaluation index system of the beautiful rural construction in the new era is basically determined, and finally the ecological performance evaluation index system of the beautiful rural construction is formed with 2 first-class indexes, 11 second-class indexes and 29 third-class indexes, as shown in Table 2 below.

Table 2. Ecological Performance Evaluation Index System of Beautiful Countryside Construction

First-class index	Second-class index	Third-class index	Remark description
Humanistic ecolog	Degree of protection of cultural	Recreational and sports activities	Mass participation in various forms

ical value	heritage resources	Rural characteristic culture	Rural brand building, protection and inheritance of intangible cultural heritage
		Degree of maintenance and utilization of cultural facilities	Protection, exploitation and utilization of material culture
		Publicity system of cultural heritage resources	Compile a list and a management and protection system
	Propaganda degree of rural culture	Propaganda degree of rural culture	Spiritual civilization, socialist core values, village rules, etc
		Achievements in the construction of township ethos civilization	Civilized rural style, good family style, simple folk style, civilized way of life and behavior
		Recognition by government departments	A district, city, province, or national government department.
	Degree of consciousness of ecological protection	Degree of maintenance and utilization of eco-environmental protection facilities	Facilities such as garbage sorting and recycling, sewage treatment, etc
		Management and maintenance system of eco-environmental protection facilities	Compile a list and a management and protection system
		Increase in villagers' awareness of environmental protection	Questionnaire
	Villagers' Satisfaction with Rural Ecological Construction	Ecological construction satisfaction	Questionnaires, interviews
		Villagers' public participation	Questionnaires, interviews
Natural ecolog	Degree of improvement of	Village vegetation coverage	Changes of landscape ecological pattern in villages
ical environment	ecological vegetation base	Village greening coverage	Rural public green space
		Protection of agro-forestry land	Ecological woodland and basic farmland protection
	Degree of improvement in rural environmental sanitation	Rural sanitation	Clean floor and water
		Node environment style	Entrance logo, landmark node landscape
	Waste and material utilization	Waste reduction	Agricultural production, sick and dead animals, etc
		Amount of environmental protection materials used	Native material
		Material reuse	Clean energy use Material recycling
	Degree of biodiversity conservation	Habitat conservation and restoration	Natural habitat ecosystem
		Population and species diversity	Plant species, animal populations
	Degree of improvement of atmospheric environment	Air quality improvement	Meet the national standards and local environmental function zoning requirements
		PM2.5 particle reduction	Degree of air pollution
	Degree of soil environmental improvement	Loss and erosion of soil	Bare land improvement, soil conservation
		Land rehabilitation improvement	Remediation of contaminated soil
	Degree of improvement of water resources and environment	Water quality	Meet the national standards and local environmental function zoning requirements
		Construction of rain and sewage	Rainwater recycling, sewage treatment
		Rain and flood management	Flood control and drainage

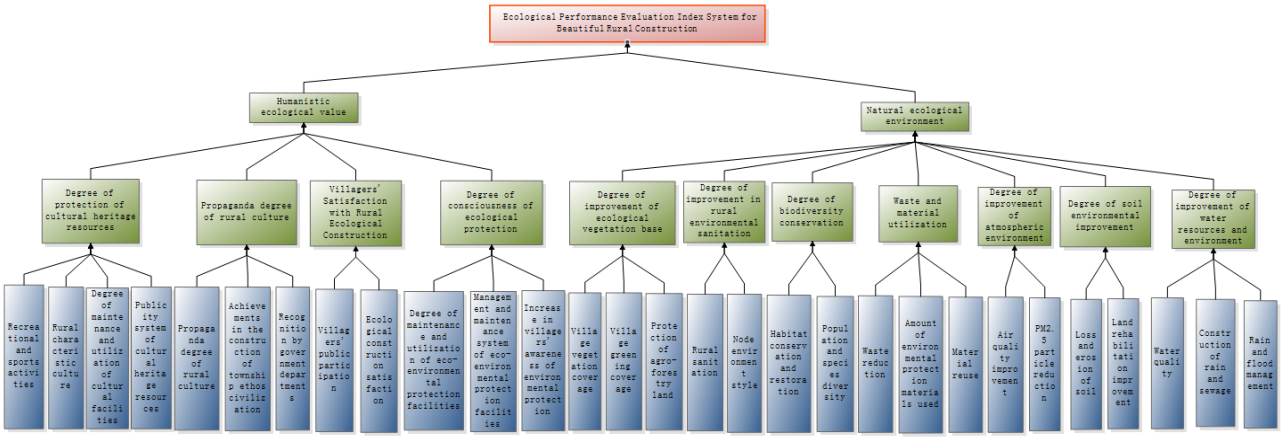

Fig. 3. Hierarchical Structure Model of Ecological Performance Evaluation Index System for Beautiful Rural Construction (self-drawn by the author)

3. Weight determination of evaluation indexes

The determination of index weight has a direct impact on the final evaluation results. At present, Analytic Hierarchy Process (AHP) is the most commonly used and effective quantitative method. It is an important qualitative and quantitative, systematic and hierarchical analytical method proposed by American operations researcher and University of Pittsburgh professor T.L.Saaty et al. in the early 1970s. The calculation of the index weight in the common language evaluation system can greatly reduce the drawbacks caused by personal subjective judgment.

Analytic Hierarchy Process (AHP) divides "complex problems into various elements, groups these elements according to the dominance relationship to form an orderly progressive hierarchy, determines the relative importance of many factors in the hierarchy by comparison, and then synthesizes human judgment to determine the overall order of the relative importance of many factors in decision-making".[16] Analytic Hierarchy Process (AHP) is used to determine the weights of ecological performance evaluation indexes of beautiful rural construction, which is more objective, scientific and effective. This study will use AHP software platform to assist calculation to determine the weights of each index. the analysis steps are shown in Figure 2.

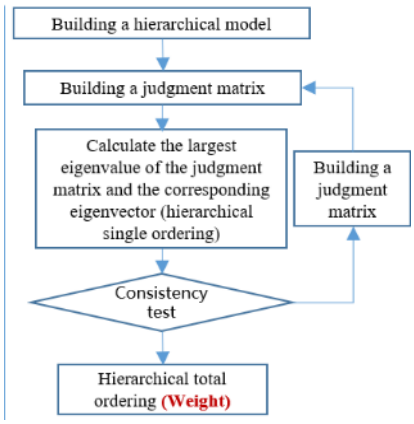

Fig. 2. Analytic Hierarchy Process Step Diagram (self-drawn by the author)

We divided the selected evaluation index system into four levels, the top first-classs the target level, that is, the ecological performance evaluation of beautiful rural construction, followed by the middle criterion level and the lower scheme level, corresponding to the first, second and third-class indexes, respectively. It also builds a hierarchy model in the yaahp software, as shown in the following figure 3.

Next we need to build the judgment matrix. It is difficult and unscientific to assign weight to each factor directly. According to the usual practice of Analytic Hierarchy Process (AHP), we compare the importance of different index elements and assign them. The meaning of the assignment scale is shown in Table 3 below.

Table 3. Meaning of Comparison Assignment Scale of Index Elements

Assignment scale	Meaning
1	Indicating that the two factors are of equal importance compared to each other
3	Indicating that the former is slightly more important than the latter
5	Indicating that the former is significantly more important than the latter
7	Indicating that the former is more important than the latter in comparison with the latter
9	Indicating that the former is more important than the latter when compared with the latter
2,4,6,8	Indicating an intermediate value of the adjacent judgment
Reciprocal	If the ratio of importance of factor i to factor j is a_{ij}, then the ratio of importance of factor j to factor i is $a_{ij}=1/a_{ij}$

According to this method, in fact, the subjective factors are still relatively large, in order to make the evaluation relatively scientific and reasonable, we use the method of expert group decision-making. Using the hierarchical structure model, the AHP questionnaire was generated, and 22 experts and scholars, government personnel were invited to complete the questionnaire by visiting, exchanging, e-mail and so on. By importing the recovered Excel expert questionnaire into the yaahp software, and then view the imported questionnaire data in the group decision panel of the software judgment matrix interface, the data before group decision-making

calculation are processed. In order to determine the revised consistency, the software automatically completes the judgment matrix calculation and consistency test of the questionnaire data, and the final consistency ratio is 0.0746 < 0.1. We think the consistency of the judgment matrix is acceptable, so we get the weights of various indexes of ecological performance evaluation as shown in Table 4.

Table 4. Weight Table of Various Indexes for Ecological Performance Evaluation of Beautiful Rural Construction

First-class index	Second-class index	Third-class index
Humanistic ecological value（0.25）	Degree of protection of cultural heritage resources（0.1042）	Recreational and sports events (0.0287)
		Rural culture (0.0096)
		Degree of maintenance and utilization of cultural facilities (0.0551)
		Propaganda system for cultural heritage resources (0.0108)
	Propaganda degree of rural culture（0.0329）	Propaganda level of rural ethos civilization (0.0034)
		Achievements in the construction of township ethos civilization (0.0219)
		Recognition by Government departments (0.0076)
	Degree of consciousness of ecological protection（0.0904）	Degree of maintenance and utilization of eco-environmental protection facilities (0.0572)
		Management and maintenance system of eco-environmental protection facilities (0.0096)
		Increase in villagers' awareness of environmental protection (0.0235)
	Villagers' Satisfaction with Rural Ecological Construction（0.0226）	Satisfaction degree of ecological construction (0.0169)
		Public participation of villagers (0.0056)
Natural ecological environment（0.75）	Degree of improvement of ecological vegetation base（0.0779）	Village vegetation coverage (0.0182)
		Green coverage rate in villages (0.0145)
		Protection of agroforestry land (0.0451)
	Degree of improvement in rural environmental sanitation（0.3174）	Rural health status (0.2539)
		Node environment style (0.0635)
	Waste and material utilization（0.1224）	Waste reduction (0.0409)
		Amount of environmentally friendly materials used (0.0173)
		Material reuse (0.0642)
	Degree of biodiversity conservation（0.0388）	Habitat conservation and restoration (0.0323)
		Population and species diversity (0.0065)
	Degree of improvement of atmospheric environment（0.0990）	Air quality improvement (0.0742)
		PM2.5 particle reduction (0.0247)
	Degree of soil environmental improvement（0.0221）	Soil loss and erosion (0.0177)
		Land rehabilitation improvements (0.0044)
	Degree of improvement of water resources and environment（0.0725）	Water quality (0.0242)
		Construction of rain and sewage (0.0412)
		Rain and flood management (0.0071)

4. Discussion and analysis

According to the calculation result of the index weight of ecological performance evaluation, in the aspect of natural ecological environment, the index weight is 0.75, which is about three-fourths. This indicates that the performance of natural ecological environment is the main basis for judging the ecological performance of rural construction, which coincides with the ecological development concept of "Green Water and Mountain is the Gold" strongly advocated by the government. Among the eco-environmental assessment indexes, the index weight of the improvement degree of rural environmental sanitation is close to half——0.3174, which indicates that it is extremely important to improve the rural natural ecological environment, to do a good job of environmental sanitation, to keep the village clean and tidy, and to keep the water body clean, which is an important measure to improve the rural ecological image. Secondly, the index weight of garbage and material utilization is 0.1224, and the reduction of domestic and production wastes, the use of environmental protection materials and the reuse of materials are the important contents of the index. For the vegetation base, biodiversity, atmospheric environment, water resources environment, soil conditions and other aspects of the content of indexes is an important part of the evaluation of rural natural ecological environment construction performance, accounting for the weight of indexes are basically below 0.01.

The index weight of human ecological value is 0.25, which indicates that human ecological value is also an important aspect that cannot be ignored in the ecological performance evaluation. Promoting the revitalization of rural culture is an indispensable part to enhance the soft power of rural development and meet the spiritual and cultural needs of the people. In the index of human value, the index of the degree of protection of cultural heritage resources is the first with a weight of 0.1042, which reflects that the material and cultural resources are the material basis for the revitalization of rural culture. In the process of rural construction, it is necessary to maintain and make good use of cultural facilities,

publicize the characteristic cultural heritage, cultivate local self-confidence, rally people's support and build the spiritual home of the people. In addition, it is also of special significance to enhance villagers' awareness of ecological environment protection with a weight of 0.0904, including the maintenance and utilization of ecological facilities such as garbage sorting and recycling, sewage treatment, and the construction of management system, so as to gradually improve the overall quality of villagers and jointly build a beautiful, clean and livable rural landscape.

In conclusion, we should let our countryside "see the landscape, remember to live in homesickness, and stay in homesickness". This requires us in the process of rural ecological construction, both natural ecological environment and human ecological value, indispensable, only in this way can we achieve the overall revitalization of rural ecological construction and high-quality development, improve the rural ecological space environment, enhance the rural ecological civilization, improve the quality of life of the villagers.

Notably, although this study used questionnaire survey, analytic hierarchy process, fuzzy comprehensive evaluation and other methods to comprehensively screen the ecological performance evaluation indexes, the weights of the evaluation indexes were assigned, and from the weight of the small can be seen the relative importance of ecological performance evaluation indexes between the high and low, the follow-up of the beautiful rural ecological construction practice to do further practical guidance. However, in the process of analysis, it is not difficult to find that the whole process of analysis is mostly dependent on the subjective judgment of thinking to complete. It will not be objective, but also need to follow-up practical research on the ecological performance evaluation index system and the weight value to do further validation and in-depth analysis.

5. Conclusion

The performance evaluation of beautiful rural construction is a complicated and systematic process. This study focuses on the ecological construction, and initially constructs the three-class evaluation index based on the natural ecological environment and the human ecological value and the corresponding main evaluation contents. Combining with the analytic hierarchy process (AHP), each evaluation index has been given a certain weight, which needs to be deepened and perfected in the future practice research. It is hoped that this paper can help protect the natural ecological environment and utilize the humanistic ecological value of rural construction in China, and play a certain role in promoting the development of rural revitalization in China. Generally speaking, this study focuses on the ecological performance evaluation of China's beautiful rural construction, grasps the current stage to realize the ecological civilization construction in the new era, vigorously implements the "rural revitalization", and strives to build a "beautiful China" in the period of major national development strategic opportunities to provide some intellectual support for rural ecological construction and development. In this respect, this study still has certain significance of the times, practical value and reference.

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