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Retraction

Retracted: Environmental Quality Optimization of Sustainable Rural Revitalization Strategy Based on Improved Genetic Algorithm

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope

(2) Discrepancies in the description of the research reported

(3) Discrepancies between the availability of data and the research described

(4) Inappropriate citations

(5) Incoherent, meaningless and/or irrelevant content included in the article

(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] G. Zhang and Z. Zeng, "Environmental Quality Optimization of Sustainable Rural Revitalization Strategy Based on Improved Genetic Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 3775515, 15 pages, 2022.

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Research Article

Environmental Quality Optimization of Sustainable Rural Revitalization Strategy Based on Improved Genetic Algorithm

Guangqing Zhang[1] and Zixuan Zeng[2]

[1]*School of Political Science and Public Administration, Shandong University, Qingdao 266000, Shandong, China*
[2]*Guangxi (ASEAN) Research Center of Finance and Economics, Guangxi University of Finance and Economics, Nanning 530000, Guangxi, China*

Correspondence should be addressed to Zixuan Zeng; zengzixuan@gxufe.edu.cn

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To address the environmental quality of sustainable rural revitalization strategies, an improved genetic algorithm-based approach is proposed, environmental quality of rural revitalization strategies. Firstly, an index system to comprehensively assess the settlement environment of rural people based on the "production-production-production" space is built and then forms the trinity theoretical guidance framework; secondly, value of information entropy used to evaluate the dispersion of an index calculates the weight of each indicator and provides the basis for a comprehensive multi-index assessment; thirdly, by analyzing the spatial differences of rural human settlement environment quality, the quality of human settlement in rural areas has a positive correlation with the level of regional economic development. It shows that based on improved genetic algorithm, the environmental quality of sustainable rural revitalization strategy has been greatly improved, the growth rate of the comprehensive score of rural living environment in most regions reached more than 14%, and the comprehensive score growth rate of some rural living environment was 4.52%.

1. Introduction

Environmental quality is one of the most basic research contents on human settlement environment, emphasizing human settlement culture as a whole, from the aspects of human settlement material culture, human settlement spiritual culture, and human settlement system culture; comprehensively studying the cultural characteristics and development rules of human settlement, it involves people's settlement space, living space, cultural space, production space, literacy space, and other aspects, and is a comprehensive strong cross-subject [1]. Some international scholars mainly discuss the human settlement environment from the perspectives of landscape morphology, settlement morphology, historical geography, comfort development theory, and livable ability, mainly focusing on the spatial evolution of rural cultural landscape, localization, and diversification of traditional village cultural landscape.

Rural living environment is an important carrier of the progress and development of rural areas, and a good rural living environment has great significance for the healthy and sustainable development of rural areas. village. In the past few decades, due to the rapid progress of industrialization and urbanization, it has in fact created division and antagonism between urban and rural areas, a large and disordered development pattern. It has brought great damage to agricultural development and farmers' lives, exacerbated the conflict between people and land, and led to the long-term deterioration of rural habitats. The national development strategy: as the development of urban-rural relations has been adjusted, as shown in Figure 1, more and more attention has been paid to the study of rural human settlements [2].

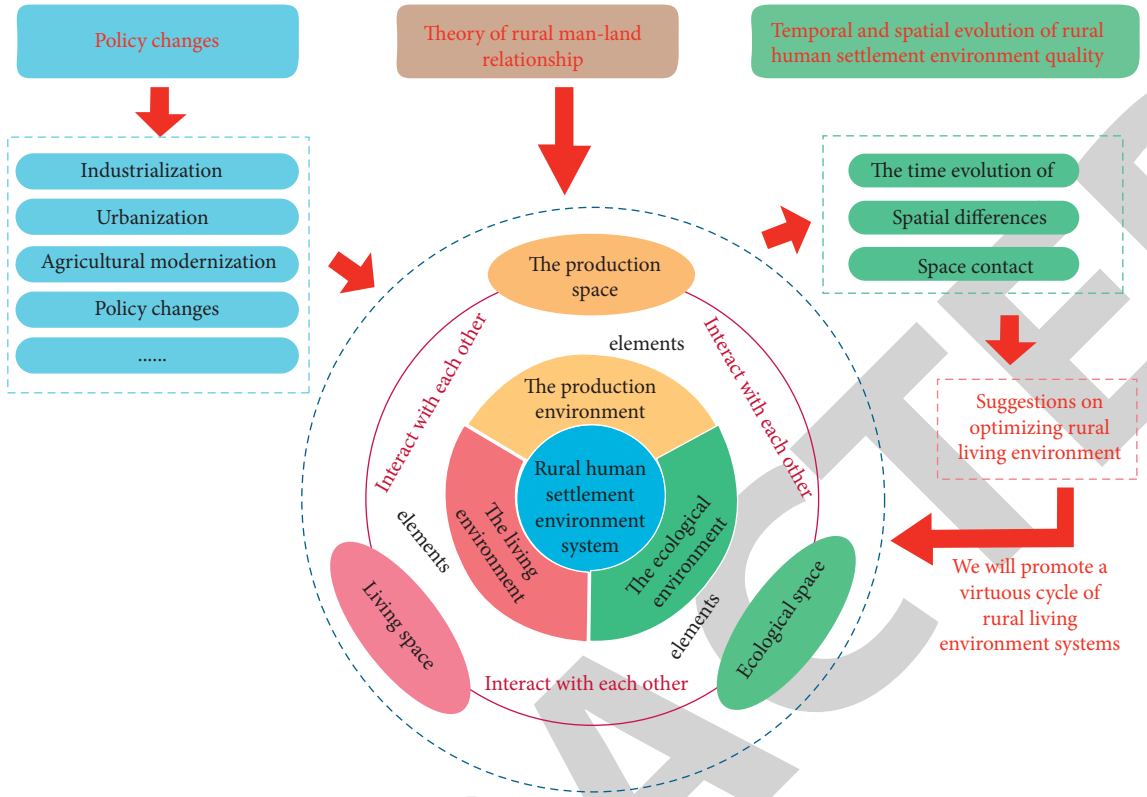

Figure 1: Theoretical framework of comprehensive evaluation of rural human settlement environment.

2. Literature Review

Rural habitat quality refers to, in rural areas, the organic combination of materials and nonmaterials that farmers need for production and life, it includes living conditions, public infrastructure and facilities, and other hard environments, it covers soft environments such as living comfort, information exchange convenience, economic development level, and social service level, and it is a dynamic complex giant system. At the same time, extensive and disorderly development model also makes agricultural and rural development still face many problems, the rural ecological environment has been destroyed, traditional rural culture is declining, public infrastructure is lacking, and the "negative effects" of rural habitats, such as the increasingly severe problem of settlement hollowness and the gradual disintegration of social structures, have become increasingly prominent and become the real epitome of the crisis in China's rural relationships. Therefore, in accordance with the National Action Plan to Improve the Quality of the Rural Environment, how to understand the evolution and patterns of rural settlements, and how to improve the landscaping and development of rural settlements are becoming more pressing issues.

Yu et al. [3] mostly reflected the research on rural living environment in the research of theoretical system, the sociological significance of rural living environment, and the construction path of rural living environment [3]. Song C. et al. [4] expressed the rural human settlement environment as the logical connection between the rural human environment, the regional space environment, and the natural ecological environment [4]. Jingke [5] believed that the quality of rural living environment is the organic combination of material and nonmaterial elements to maintain rural life [5]. Lyu [6] researched comprehensive evaluation and optimization strategies for different types of rural human settlements, the existing evaluation methods of human settlements are mostly based on field research and qualitative evaluation, and it mainly focuses on the evaluation of residents' satisfaction with the quality of living environment [6]. Zheng et al. [7] from the aspects of infrastructure, energy consumption, etc., have expanded the evaluation index system of rural living environment quality [7]. Jun et al. [8] studied people and the environment from the perspective of human ecology, and it is believed that urban planning should coordinate the ecological living environment of urban and rural areas from a regional perspective [8]. Jia et al. [9] emphasized that the living environment should be people-centered and focus on regional and natural views, advocating urban planning and human settlement construction [9]. Lu et al. [10] first put forward the concept of "human settlement environment." They creatively combined systems theory, cybernetics, information theory, ecology, and other multidisciplinary theories and applied them to the study of the human settlement environment. It is emphasized that all human settlements, including villages, towns, and cities, can be studied as a whole, which marks the formation of human settlements science with urban planning as the core [10]. Zhou et al. [11] proposed the classical agricultural location theory, he

systematically analyzed the spatial distance relationship between the production location and the consumption location, and a concentric circle-layered rural structure is obtained [11]. Wang et al. [12] systematically expounded the formation and evolution of settlements for the first time, and a comparative study of different types of settlements such as cities, market towns, and villages was conducted, getting the geographical environment and traffic routes [12]. Ying [13] established the central place theory, he proposed the central place theory about the location of the city, greatly promoted the development of geography, and helped people to understand the location formation mechanism of cities and villages, and it has made a significant contribution to the research of rural geography [13]. Yang et al. [14] inspired by Dossadias' theory of human settlement founded "Human Settlement Science," and it integrates the three basic disciplines of architecture, geography, and planning, and builds a research framework for human settlement science [14]. Wang et al. [15] considered the evaluation and optimization of human settlements in metropolises, and the human settlement environment is evaluated from three aspects: living conditions, ecological environment quality, and infrastructure and public service facilities [15]. When Ji et al. [16] studied the evaluation of urban human settlements, and the living environment is divided into close living environment, community environment, and urban environment [16].

Based on current research, improved genetic algorithm, and environmental quality optimization of sustainable rural restoration strategy, environmental quality has been greatly improved and index system comprehensive assessment of rural habitats is based on the established "three generations" space, using the value of information entropy to assess the dispersion of an index, calculating the weight of each indicators, and creating a basis for comprehensive evaluation of many indicators.

3. Optimization of Environmental Quality for Sustainable Rural Revitalization Strategy Based on Improved Genetic Algorithm

3.1. Improved Genetic Algorithm

3.1.1. Overview of Genetic Algorithms. Genetic algorithm (GA) first proposed by Professor Holland in 1975 is a global stochastic optimization algorithm that simulates natural biological evolution and genetic mechanism. Genetic algorithm is an organic combination of the ideas of evolution and computer science, and it is based on the basic principles of the theory of biological evolution and genetics, and the basic principles of genetics. Darwin simulated the evolution process of biological groups in nature from simple to complex, from low-level to high-level, similar to the process from initial solution to optimal solution [17]. As a global optimization search algorithm, the genetic algorithm is easy to use. Many optimization problems can get satisfactory results through the genetic algorithm, which has been widely developed and applied in many fields. It has also been well received in the field of engineering optimization and gradually has been widely used in the hydraulic calculation of water supply. Genetic algorithms are based on the principles of biological genetic inheritance and eugenics, by mimicking natural selection and using genetic mechanisms, starting with a randomly generated initial population [18]. That is, a certain number of parents (initial solutions) are selected through constant population iteration, and they replicate, cross, and mutate, pass on good genes to their offspring, throw away the bad genes, and ultimately solve complex problems; in other words, the optimal individual (optimal solution) was obtained. Randomly generate the initial population, and based on the fitness of individuals in the population, for calculating selection, crossover, and variation among individuals in the population, the individuals in the population (the solution of the problem) continue to evolve and gradually approach the optimal solution of the problem. The calculation flowchart is shown in Figure 2, and the specific steps are shown in the following section.

3.1.2. Advantages and Disadvantages of Traditional Genetic Algorithm

(1) Advantages of Traditional Genetic Algorithm

① The feasible solution can be widely expressed, and the application field is wide.

Genetic algorithms can encode the parameters of the problem they are dealing with, and the gene string corresponding to the genetic space is obtained. The original solution space can be set, matrix, sequence, and other one-dimensional or multidimensional structures. So, genetic algorithms are widely used in many fields, such as computing science, artificial intelligence, manufacturing, automatic control, engineering, and social sciences.

② Global parallel search feature

This feature enables genetic algorithm to have better global search performance, for the multi-peak distribution, the solution space will not fall into a local single-peak extremum point, and it also makes the genetic algorithm itself easy to parallelize [19].

③ In the course of the search, genetic algorithms are not easy to fall into local optimization, even if the fitness function defined is discontinuous, it can also quickly and reliably solve the problems that cannot be solved by the transmission spinning method, and the global optimal or suboptimal solution can be found with a high probability [20].

④ Genetic algorithms can be improved in many ways; for example, there are improved methods such as parament genetic algorithm, simulated annealing genetic algorithm, hybrid genetic algorithm, and ant colony algorithm.

⑤ Genetic algorithms are scalable and easy to mix with other technologies; for example, genetic algorithm

and generalized reduced gradient method are used together.

(2) Disadvantages of Traditional Genetic Algorithm

① Genetic algorithms code in a variety of ways, different coding methods should be adopted for different application problems, so the specific coding problem needs to be improved.

3.1.3. The Implementation Method of Improved Genetic Algorithm

(1) Coding Method. Genetic algorithms must translate the parameters of the problem space into the genes of the genetic space and form chromosomes or individuals according to certain structures, which is called encoding [21]. At present, commonly used genetic algorithm forms of encryption include binary encoding, real number encoding, and character encoding. Among them, binary encoding is the most commonly used method in coding genetic algorithms, that is, the binary character set {0, 1} produces the usual 0.1 string to represent candidate solution of the problem space, and this coding method is simple and easy to analyze with pattern theorem.

(2) Fitness Function. In evolutionary nature, fitness, also known as adaptive value, refers to the fact that under certain environmental conditions, the ability of individuals to adapt to their surroundings, it can also represent an individual's ability to reproduce, the relative ability of a person with a known genotype to transfer a gene to the gene pool of his or her offspring is a measure of an individual's ability to survive and reproduce, and the greater the fitness, the higher the survival and reproductive chances. The fitness function in genetic algorithm is used to judge the merits and demerits of an individual, and the evaluation is carried out according to the generalized objective function of the problem. In the genetic algorithm, the fitness function is positive, so to convert the objective function to a maximum or minimum problem, and to translate the constraint problem into the objective function, thus, a generalized objective function is constituted to evaluate as fitness function.

3.2. Environmental Quality of Sustainable Rural Revitalization Strategies

3.2.1. Basic Manifestations of Rural Environmental Quality Problems in Sustainable Development. In recent years, the construction of urban infrastructure has been intensified, and the discharge of urban environmental pollution has been gradually brought under control, in contrast, environmental pollution and ecological damage are becoming increasingly serious in towns and villages, and there are both primary environmental problems and more secondary ecological damage problems.

(1) Pollution from Agricultural Production. With the acceleration of agricultural modernization, traditional agriculture was gradually replaced by modern agriculture with mechanical and chemical features, large quantities of chemicals, mulch, pesticide packaging, etc., passed through the natural food chain, in a network of three-dimensional circulation among environmental elements, reduced soil fertility, enhanced the resistance of pests and diseases, and caused the surrounding water eutrophication, and negative effect is obvious.

(2) Life Pollution. Due to the backward construction of rural environmental protection infrastructure, the coverage of rural household garbage collection and transfer system is low, and a large amount of solid waste is randomly stacked and occupies large tracts of arable land, breeding and spreading of harmful bacteria, lack of supporting sewage treatment facilities, eventually contaminating soil and water, and becoming the source of nonpoint source pollution. In addition to industrial pollution, the countryside itself is also a major source of pollution. As a large grain-producing area, rural areas in northern Jiangsu use a large number of pesticides and chemical fertilizers every year. The average use intensity of chemical fertilizer in northern Jiangsu was 882.71 kg/hm^2, 26.7% higher than the average level of Jiangsu Province, pesticide use intensity is greater than 500 kg/hm^2, and some villages are even more than 2000 kg/h prong, belonging to a higher intensity. In 2015, chemical oxygen demand from agricultural sources in northern Jiangsu reached 197,200 tons, accounting for 56.2% of the province; ammonia emissions were 17,100 tons, accounting for 47.0% of the province. In addition, the discharge of sewage from the villagers is also a source of pollution in the countryside itself. In the process of rural renovation, the garbage disposal and transportation facilities have been improved in northern Jiangsu, but the sewage treatment is far from enough. In 2015, the harmless treatment rate of rural sewage in northern Jiangsu was only 25.9%, less than half of the 65.3% in the Yangtze River Delta. See Figures 3 and 4.

(3) Ecological Damage. Farmers have weak ecological consciousness, in order to satisfy their own interests, large-scale reclamation, and overuse of land, resulting in a large amount of surface organic soil loss, desertification. Lack of garbage classification system, pesticide packaging and other hazardous waste carelessly discarded, and straw burning caused a sharp deterioration of the surrounding atmosphere. On the other hand, domestic pollution and industrial wastes from surrounding cities have been transferred to rural areas, and the countryside has become the "sewage field" of the city, which aggravates the deterioration of the rural ecological environment.

3.2.2. Connotation of Rural Living Environment. Rural habitat in the narrow sense refers to rural living environment; rural habitat in a broad sense refers to rural areas, promoting production development and rural life in a complex system of physical and nonphysical human-land relations, and it is the comprehensive embodiment of

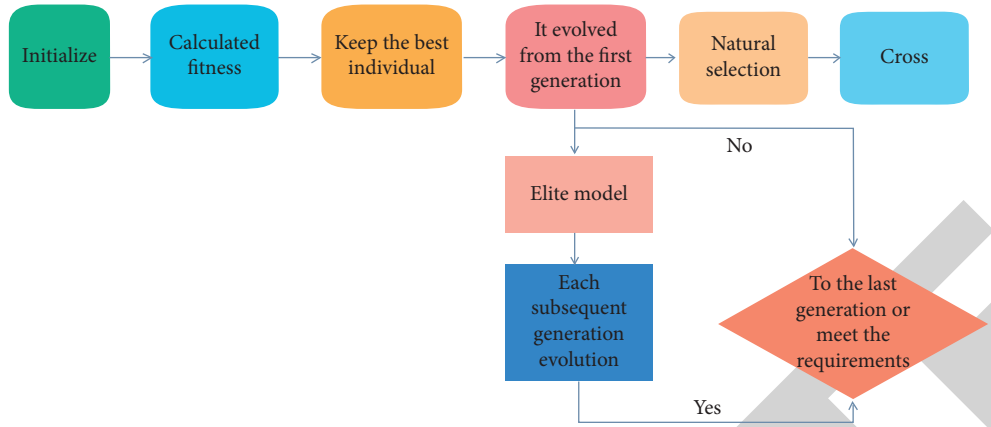

Figure 2: Flowchart of genetic algorithm.

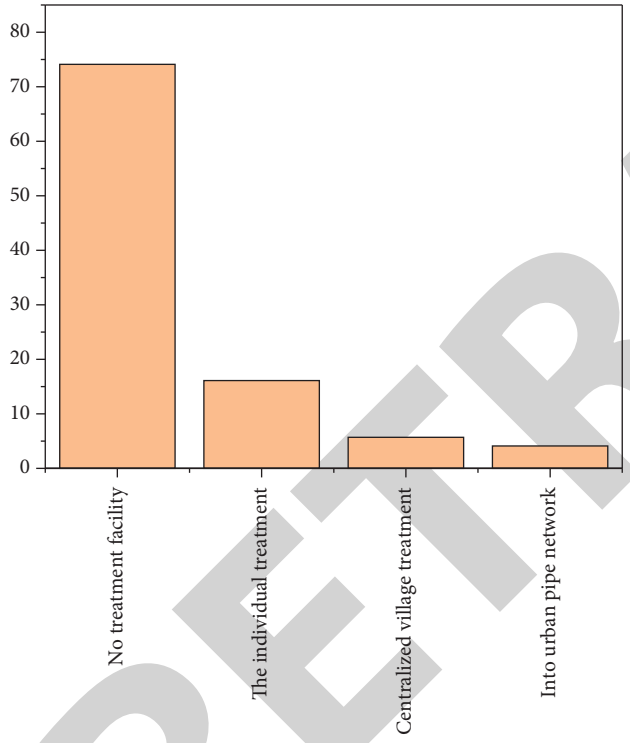

Figure 3: Structure of rural sewage treatment methods in northern Jiangsu.

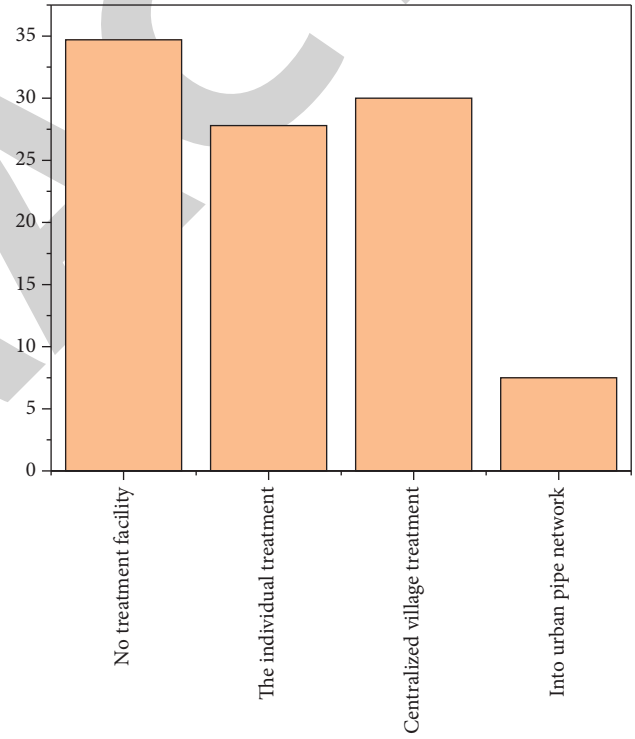

Figure 4: Composition of rural sewage treatment methods in the Yangtze river delta region.

humanistic social activities and natural ecological environment in rural area space. Its content covers the physical geography, ecological environment, industrial development, lifestyle, infrastructure, environmental health, educational and cultural atmosphere, social organization, etc. In short, rural living environment is the general term of natural, economic, social, and cultural environment in which farmers live, produce, and live. Specifically, it includes rural production environment, rural living environment, rural ecological environment, rural social environment, and rural cultural environment (Figure 5). The natural ecological environment lays the material foundation for the life of rural residents, rural production activities, and rural social culture as an important driving force and creates a social foundation for rural life, and rural living environment represents the quality of life of rural residents.

Rural production environment is the general term of rural industrial development, industrial structure, and investment in industrial development. Rural living environment refers to rural residents' income, living conditions, infrastructure construction, and public service level. Rural ecological environment refers to the quantity and quality of ecological resources that affect farmers' survival and development, the general term for pollution of ecological resources by production and living, and villagers'

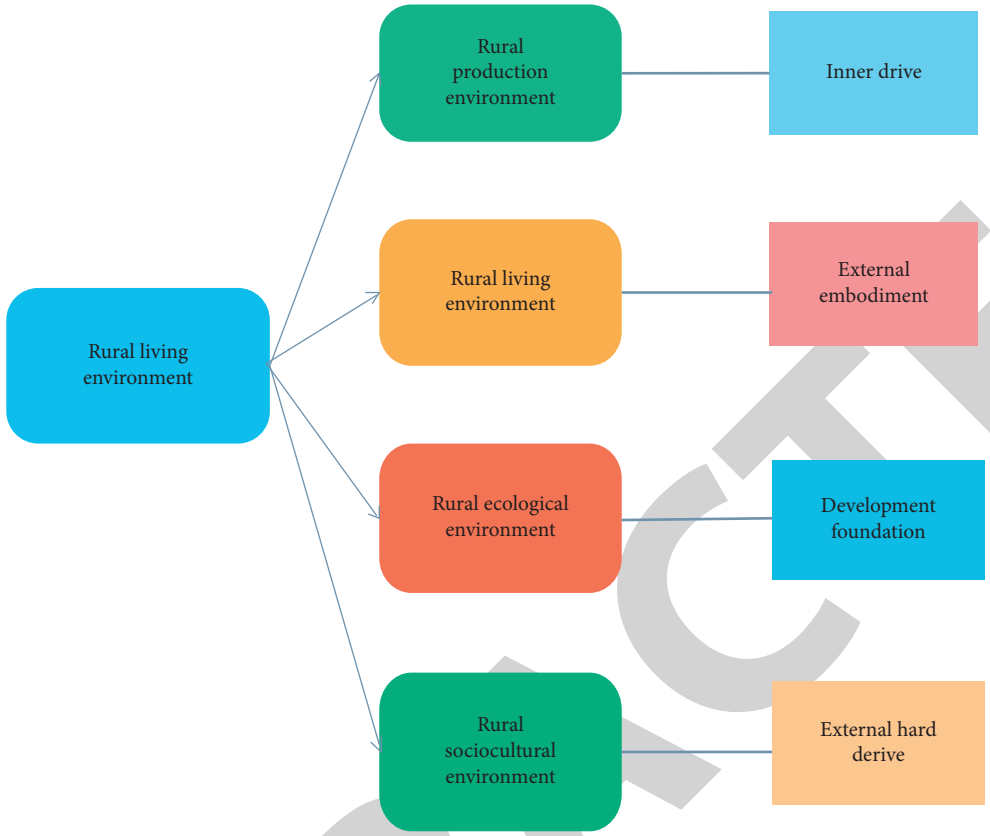

Figure 5: Construction system of rural human settlement environment quality.

environmental treatment and protection [22]. Rural social and cultural environment is the general term of rural poverty alleviation, policy support, organizational form, population structure, and farmers' education level. These four environments can reinforce and echo each other, but they can also contradict each other and even destroy each other. Among them, production is the key, ecology is the foundation, life is the core, and social culture is the carrier.

3.2.3. Evolution Analysis of Rural Human Settlement Environment Quality. With the promotion of urbanization, cultural factors have entered the countryside with colorful characteristics and gradually shaken the characteristics of traditional rural culture. While rural residents are exposed to new cultural elements, they are also constantly choosing, and the rural living environment changes accordingly. However, the evolution of rural human settlement environment quality and sub-system quality is not completely synchronous (Figure 6).

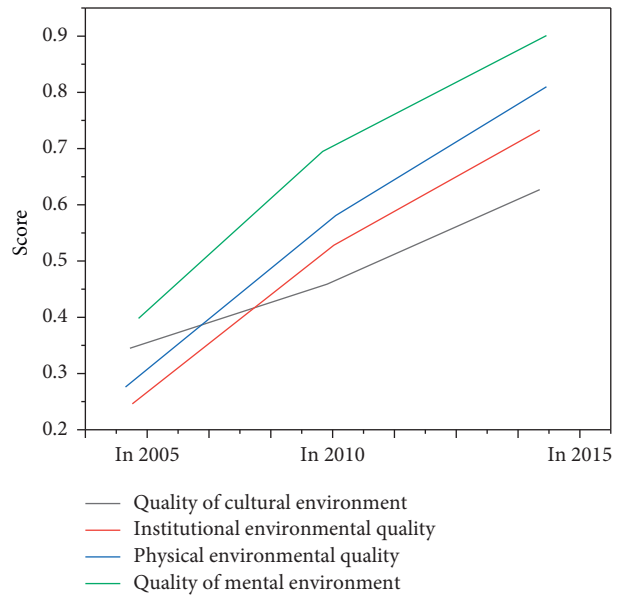

Figure 6: Evolution trajectory of cultural environment quality and sub-system quality of rural human settlements.

3.2.4. Driving Mechanism of Rural Human Settlement Quality Evolution. The dynamic mechanism of environmental quality development in rural areas refers to the rules of operation of dynamic, dynamic systems, interactions of the environmental system of rural settlements, and interaction of various factors and systematic evolution. As part of the rural rehabilitation strategy, the reasons for the current poor quality of rural settlements and the rapid development of rural areas are being analyzed in general. The material culture of the population, or the optimization and

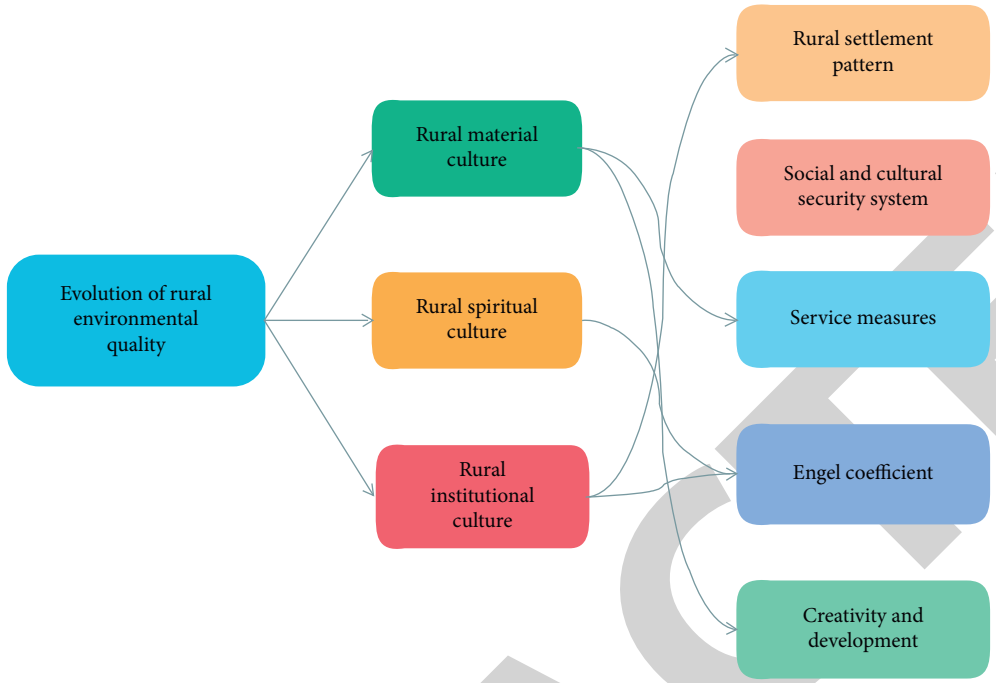

Figure 7: Driving mechanism of rural human settlement quality evolution.

improvement of the quality of the rural environment in the future, is inseparable from government support, support for the production system, diversified needs, and basic public service delivery (Figure 7).

3.3. Relationship between Rural Revitalization and Optimization of Rural Living Environment. The rural revitalization work plan proposed in the plan mainly includes coordinating urban and rural development space, optimizing the layout of rural development, targeted poverty alleviation in rural areas, modern agricultural production and operation, agricultural science and technology, industrial integration, and innovation and entrepreneurship'; we will build an ecologically livable and beautiful countryside, improve the appearance of villages, and develop a prosperous rural culture, building a modern rural governance system, building rural infrastructure, rural public service supply and social security system, rural talent training, and so on. And the rural living environment is studied by the author, and the physical elements include rural natural ecology, rural spatial organization, housing and public service facilities, road transportation, and municipal infrastructure; nonmaterial elements include economy and population, social life, rural cultural environment, and policy system [23]. It follows that the work content of rural revitalization and the research content of rural living environment are interrelated in many aspects, and optimizing the rural living environment is an important aspect of rural revitalization. Rural revitalization involves a broader range of issues; in addition to the living environment, it also pays attention to rural industrial development, rural governance system, and urban-rural and regional relations, does these things well, and plays an important positive role in improving rural habitats. Therefore, in terms of their relationship, the optimization of the rural settlement environment is part of the rural renaissance and is a necessary condition for rural recovery. In short, the concept of rural revitalization is extremely comprehensive; ultimately, we will achieve comprehensive and all-round revitalization of rural areas, and the optimization of rural living environment is also an important aspect of rural revitalization. Only the living conditions of the villagers have been improved, the overall appearance of the village has been improved, the construction of various facilities in the village has been improved, the quality of rural life felt by villagers has improved, and rural revitalization will be truly realized. Improving the rural living environment is an integral part of rural revitalization and is a core component of rural revitalization; and committed to rural revitalization, it will provide more solid guarantee for the construction of rural living environment. See Figure 8.

4. Optimization Strategy

4.1. Theoretical Framework of Comprehensive Evaluation of Rural Human Settlement Environment Based on "Production-Production-Production" Space. Rural living environment is essentially one of the manifestations of man-land relationship regional system, and it is a dynamic complex system. Production space, living space, and ecological space are the three basic elements of national space, and it is also the three subsystems of rural human settlement environment system. There has been an exchange of material, energy, information, and other elements in the rural human settlement system, and it fits in with the full utilization and orderly integration of production function, living function,

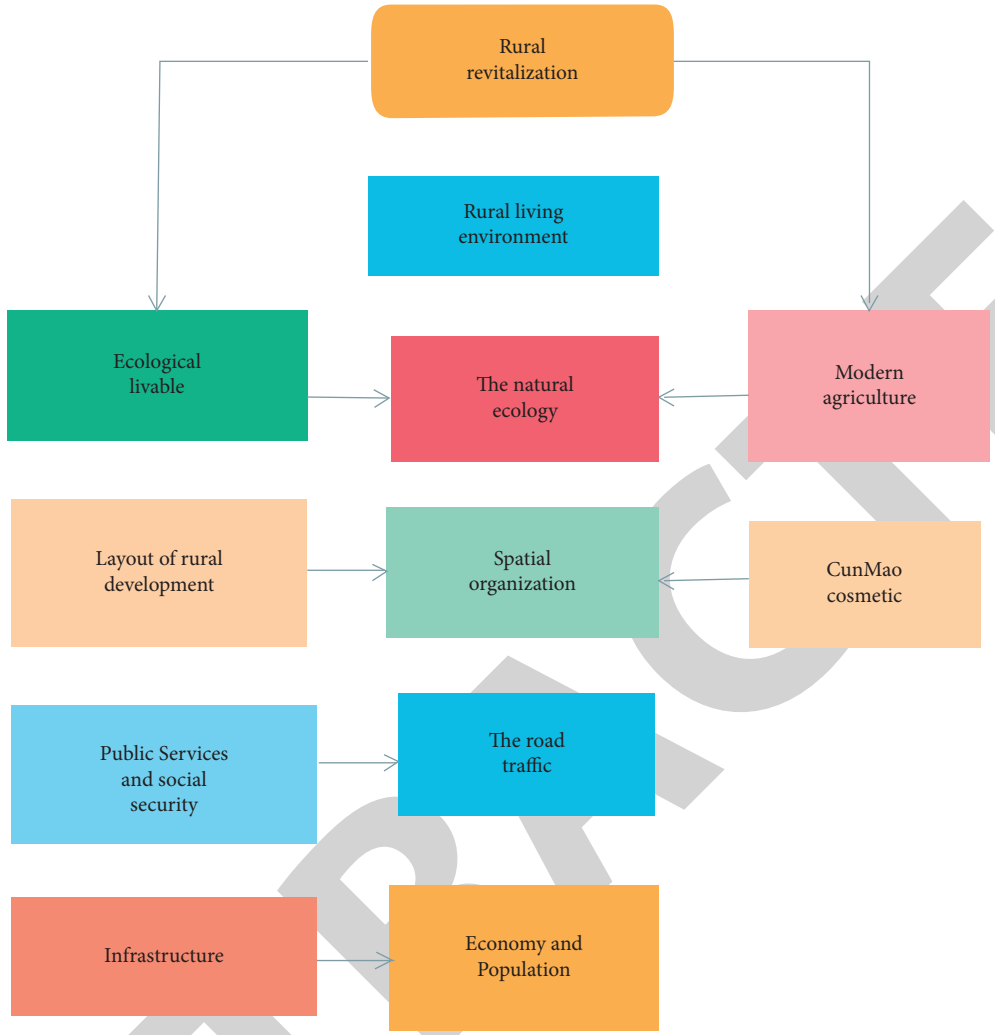

Figure 8: Relationship between rural revitalization and optimization of rural living environment.

and ecological function in the "production-production-production" space. Evaluate the quality of rural living environment by integrating production space, living space, and ecological space, and then form the theoretical guidance framework of the trinity. Production space is a space where people produce in order to obtain products and increase social wealth, and it is also the basic space field of rural human settlement environment construction and improvement. Living space is a spatial aggregation that provides people with daily activities such as living, employment, consumption, and leisure, and it is an important field of rural human settlement environment construction. Ecological space is not only the natural base of rural living environment construction, but also an important space to provide ecological products and services for rural residents.

4.2. Construction of Comprehensive Evaluation Index System of Rural Human Settlement Environment Based on "Production-Production-Production" Space. Combined with the complexity of rural living environment system, with the development level of rural living environment, the particularity of the problems they face, the differences of actual relevant statistical indicators among provinces and cities, following the principles of scientific, dynamic, hierarchical, comparable, and operable, construct a system consisting of target layer, system index layer, and the evaluation index system composed of three parts of specific index layer (Table 1).

(1) Production space, select the rural employment rate, per capita local fiscal revenue, per capita fixed asset investment, rural per capita disposable income, and per capita balance of household savings deposit, 5 indicators to represent the overall situation of rural economic production; select the per capita total power of agricultural machinery and the proportion of effective irrigated area in cultivated land area, and two indicators were used to represent the modernization level of agricultural production in rural areas, both of which were positive indicators.

(2) Living space, rural per capita housing area, road mileage per 10,000 people, and rural per capita electricity consumption; three indicators were used

Table 1: Evaluation system and weight of rural human settlement environment quality measurement index.

System layer and weight	Index layer and weight	Index properties
Production space sub-system	Rural employment rate: 0.09542	+
	Per capita local fiscal revenue: 0.05184	+
Living space sub-system	Per capita housing area: 0.08546	+
	Per capita electricity consumption: 0.04895	+
Ecospatial sub-system	Pesticide application amount: 0.05462	+
	Mulching film coverage: 0.23545	−
	Village forest coverage rate: 0.6515	−

to represent the living security level of rural residents, ten thousand people with hospitals, beds in health centers, ten thousand doctors (licensed physician + licensed assistant physician), the teacher-student ratio of regular middle schools, the teacher-student ratio of regular primary schools, the number of regular middle schools per 10,000 people, and five indicators are used to represent the welfare security level of rural medical care and education, all of which are positive indicators, as shown in Figure 9.

(3) Ecological space involves not only the direct ecological supply of nature, but also the self-purification of ecology under human activities, but given the availability of data, the author selected the fertilizer application amount, pesticide application amount, mulching film coverage rate, village forest coverage, and 4 indicators to represent the strength of rural ecological function. The village forest coverage rate is a positive index, and the larger the value is, the stronger the rural ecological function will be; the other indexes are all negative indexes.

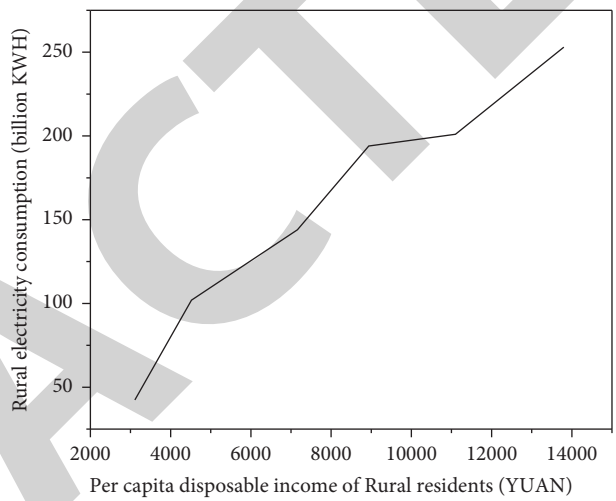

Figure 9: Per capita disposable income and electricity consumption of rural residents.

4.3. Improved Entropy Method. To minimize and avoid subjective factors and some objective limitations in the weighting process, the entropy method was used to assign weights to each indicator of the quality of the human settlement environment countryside. In information theory, the calculation formula (1) of information entropy is as follows:

$$H_{(x)} = -\sum_{j=1}^{m} p(x_i) Inp(x_i). \quad (1)$$

Information entropy mainly reflects the chaos degree of the system, information mainly reflects the degree of order, entropy is equal to the absolute value of information, but the sign is the opposite. The more information an indicator provides, the corresponding weight should also be larger and vice versa. On the one hand, when the entropy method is used for evaluation, extreme values often occur; however, to ensure data integrity, extreme values cannot be deleted directly; therefore, it is necessary to change the index data; in order to improve the entropy method, the author chooses the method of standardizing the transformation of each index first. On the other hand, when calculating the final result of rural human settlements quality, the original value is magnified by 1000 times, and the results are horizontally aligned and accurately clustered. The main calculation steps of the improved entropy method are as follows:

① Standardization of raw data: positive indicators are treated as formula (2), and negative indicators are treated as formula (3).

$$x_y = \frac{\left(x_{ij} - \overline{x}\right)}{s_j}, \quad (2)$$

$$x_y = \frac{\left(\overline{x} - x_{ij}\right)}{s_j}. \quad (3)$$

Type: x_{ij} is the standardized index value; $\overline{x}$ is the mean value of the JTH index; x_{ij} is the original value of the index of the ith region and item j; s_j is the standard deviation of the JTH index value.

In order to reasonably solve the impact caused by negative numbers, the normalized values are shifted as shown in

$$Z_{ij} = x_y + A. \quad (4)$$

Where z_{ij} is the translated value and A is the translation.

② Quantize the uniformity of each indicator and calculate the specific gravity p_{ij} of the region I index value of item J, as shown in

$$P_{ij} = \frac{Z_{ij}}{\sum_{i=1}^{n} Z_y}, \quad (i = 1, 2, 3, \ldots) \tag{5}$$

where n is the number of regions and M is the number of indicators.

③ Calculate the entropy E_j of item j index, as shown in

$$E_j = -k \sum_{i=1}^{n} P_{ij} In\left(P_{ij}\right). \tag{6}$$

Type: $k = 1/\text{Inn}$, $E \geq 0$.

④ Calculate the difference coefficient (D) of item J, as shown in

$$D_j = 1 - E_j. \tag{7}$$

⑤ To normalize the difference coefficient, calculate the weight (W) of item j, as shown in

$$W_j = \frac{D_j}{\sum_{j=1}^{m} D_j}, \quad (j = 1, 2, 3, \ldots, m). \tag{8}$$

⑥ Calculate the quality of rural human settlements in region I (F), as shown in

$$F_i = \sum_{j=1}^{m} W_j P_{ij} \cdot 1000, \quad (i = 1, 2, 3, \ldots). \tag{9}$$

Type: w_j is the weight value of item j; P_{ij} is the index value after the double conversion of standardization and homogeneity quantization of each index.

4.4. Research Methods and Data Sources. A comprehensive assessment of the quality of a rural settlement environment involves many factors, and the lack of a linear relationship between them makes it difficult to determine to avoid artificial interference caused by subjective distribution methods to ensure the accuracy and reliability of test results. The author selects a key component analysis to assign weight to each evaluation index.

4.4.1. Dimensionless Treatment. Range standardization is used to deal with positive and negative orientations and dimensional differences of data.

$$\text{Positive indicators}: X_y = \frac{X_y - X_{\min(y)}}{X_{\max(ij)} - X_{\min(ij)}}, \tag{10}$$

$$\text{Negative indicators}: X_y = \frac{X_{\max(ij)} - X_{ij}}{X_{\max(ij)} - X_{\min(ij)}}. \tag{11}$$

In equations (10) and (11), X_{ij} represents the value of the ith sample and the jth index; $X_{\max(ij)}$ represents the maximum value of the sample matrix; $X_{\min(ij)}$ represents the minimum value of the sample matrix; and $X_{(ij)}$ represents the standardized value.

4.4.2. Comprehensive Evaluation Score. The standardized data are weighted and summed with the index weights, and the comprehensive evaluation score of rural human settlement environment quality was obtained.

$$T_i = \sum_{j=1}^{n} E_{ij} U_{ij}. \tag{12}$$

In formula (12), Ti represents the evaluation value of rural human settlement environment quality, E_{ij} represents the weight of evaluation index, and U_{ij} represents the score of A single index.

4.5. Index System Construction. Centering on the overall requirements of the rural vitalization strategy, starting from the actual situation of rural construction, based on the four levels of rural production environment, rural living environment, rural ecological environment, and rural social support environment, the index system is established (Table 2) and complied with the principles of comparability, objectivity, and availability of indicator data, 39 second-level indicators were selected and basically include the five areas of rural industry revitalization, talent revival, cultural revival, ecological restoration, and organization restoration, and it can reflect the human settlement environment construction situation rural people holistically.

4.6. Evaluation and Analysis of Rural Human Settlement Environment Quality

4.6.1. Measurement and Evaluation of Rural Human Settlement Environment Quality. According to the above calculation steps, the quality of rural human settlement in 17 provincial cities in a province has been processed, and the comprehensive score of the quality of rural human settlement environment in each city and the score of each subsystem was obtained (Table 3).

X province is an important economic and populous province in the north, it is also a region with prominent urban and rural problems, showing obvious coastal and inland dual characteristics in economic and social aspects, and this feature is also reflected in the quality of rural living environment. Among them, CITY *A* is the highest quality rural town in the aimag, with a rating score twice that of the last city, *D*. The quality of rural settlements in most cities in the province is above average (0.4635). The aimag has a good socioeconomic background, a good ecological environment, and the quality of the rural population. The quality of the rural population of the peninsula is highly concentrated, top 4 cities in *A*, *B*, *C*, and *E*; the spatial distribution of rural human settlement quality in inland areas is relatively random, but there are still some regional differences. The fact that the quality of the rural environment is highly positively correlated with the level of economic development in the region shows that economic development is an important

Table 2: Evaluation index system of rural human settlement environment quality.

Rule layer	Index layer	Unit	Attribute	The weight
Rural production environment	Per capita agricultural output value	Yuan	Positive	0.0256
	Value-added of service industry	%	Positive	0.2415
Rural living environment	Per capita electricity consumption	Kw/人	Positive	0.5484
	Disposable income	Yuan	Positive	0.0452
Rural ecological environment	The proportion of energy	%	Negative	0.0125
	Centralized processing rate	%	Positive	0.0136
	Forest coverage	%	Positive	0.0321

Table 3: Score and ranking of rural human settlement environment quality.

	Rural production environment	Rural living environment	Rural ecological environment
A	0.0412	0.0235	0.0452
B	0.0234	0.0156	0.0631
C	0.0148	0.0544	0.0196
D	0.0248	0.0577	0.0128
E	0.0123	0.0724	0.0345

guarantee to reduce the disparity in the rural environment. Using the Jenks natural fault method, the quality assessment scores of the rural population of 17 cities in the aimag and the scores of each sub-system were evaluated as material elements. The villagers are concerned about rural social life and policies that benefit farmers. Based on the villagers' own understanding, at the same time, combined with relevant literature research, the components and research objects of rural living environment are determined, as shown in Figure 10.

4.6.2. Analysis of Spatial Differences in Rural Human Settlement Environment Quality

(1) Areas With High-Quality Rural Living Environment. Including *A*, *B*, *C*, and *D*4 city, the quality evaluation score is above 0.55, and its common characteristics are developed social economy, good ecological environment, and relatively rich rural life. 4 cities are located in the economically and socially developed peninsula region, excellent location, relatively perfect infrastructure, urban and rural integration level, and high level of public services. In the future, we should give full play to the shining role and promote urbanization and new industrialization in rural revitalization; cultivating rural-specific industries, we will build a system modern agricultural industry, production system, and management system. Outstanding natural conditions and developed urban economy have promoted the integration of urban and rural areas; scores of rural life, ecology, and sociocultural factors are all at the top; however, the development of rural industries needs to be further strengthened [23]. City *B* has the longest coastline in a province; with the highest score of rural production environment quality, the ecological and social and cultural environment is also in the forefront, forming a good rural environment suitable for living; however, the next step is to strengthen the construction of new rural communities, as shown in Table 4. City *C* has the highest score in rural social and cultural environment, but the level of industrial integration development is low. In the future, we should vigorously develop new forms of agriculture, especially circular agriculture, and further improve the efficiency of agricultural production. *C* city is the region with the lowest and highest level of agricultural industrialization development in China; with a high degree of intensification of agricultural production and a good degree of grassroots organization construction, the next step is to increase the development of circular agriculture, reduce the use of chemical fertilizers and pesticides, and constantly improve the ecological environment.

(2) Areas With High Quality of Rural Living Environment. The average level of rural living environment quality is 0.5541. The five cities all have a good foundation for agricultural development, the quality of rural living environment is good on the whole, but there are weaknesses to varying degrees, and the coordinated development of all subsystems is low, which restricts the overall improvement of rural human settlement environment quality. On the basis of sound agricultural development, exploring a new model of rural collective economy, improve the land transfer mechanism, and raise the level of intensive production. We should actively change the development model, and we will focus on increasing investment in ecological and environmental governance. We will vigorously develop rural tourism and agriculture with local characteristics, extend the industrial chain, build industrial clusters, continuously improve the production environment, increase the efficiency of industrial production, and contribute to the continuous improvement of rural habitats. There is still a need to improve rural living conditions, so attention should be paid to the development of rural infrastructure and public services, vigorously develop new forms of agricultural business, and intensify efforts to improve the agricultural ecological environment.

(3) Areas with Low Quality of Rural Living Environment. The overall characteristics of rural industrial structure are single,

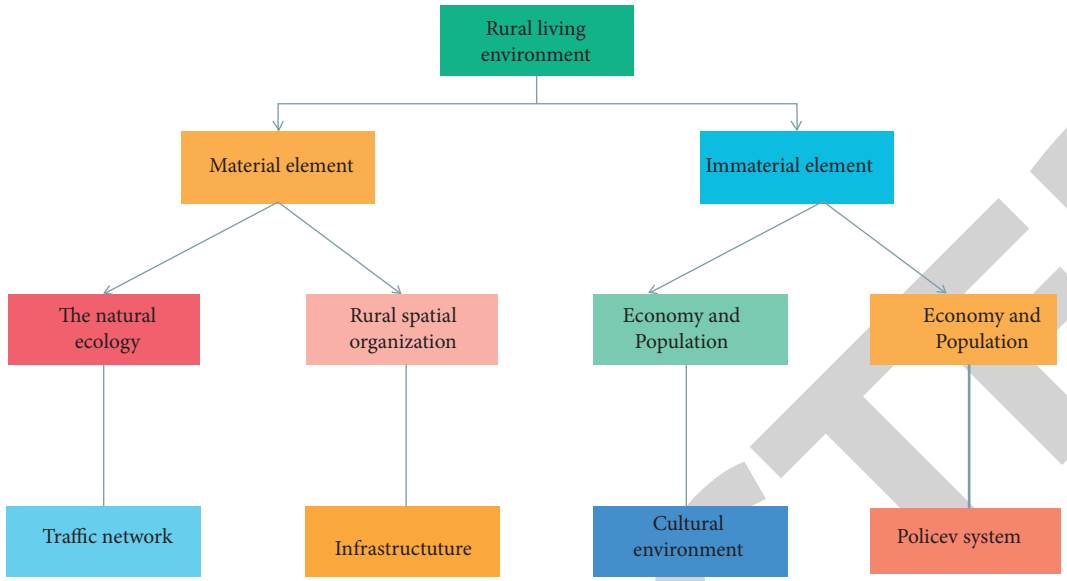

Figure 10: Constituent elements of rural human settlement environment.

Table 4: Regression analysis results of economic indicators and human settlement environment level.

The index type	Coefficient k	Significant	Adjust the R square
C	0.314	≤0.001	0.545
GDP per capita	0.324	0.011	0.322
Per capita disposable income	0.158	0.074	0.645
Collective gross income	−0.042	0.752	0.478

agricultural production is based on traditional agriculture, and rural infrastructure construction is relatively poor. Planning for the improvement of rural living environment should be made scientifically and rationally; with infrastructure construction as the guide, adopting a growth-driven cluster development model, we will constantly improve the living environment in rural areas.

(4) Areas with Low Quality of Rural Living Environment. The average score of rural living environment quality was 0.2456, the common characteristics are relatively backward agricultural development model, high incidence of rural poverty, and the basic living facilities are not perfect. Agricultural output value, villagers' living standard, living conditions, and public service level are all at the bottom of the province.

4.7. Results and Analysis. In order to directly reflect the evolution law of rural human settlement quality, relying on ArcGIS10.2 software platform, based on the established index system and weight calculation, the evaluation index and ranking of rural human settlement environment in central China are obtained, natural breakpoint method was used to classify the rural human settlement environment and sub-system quality in 2000, 2010, 2015, and 2017, and the quality grade from low to high is divided into five grades: poor, poor, general, good, and excellent.

4.7.1. Spatial and Temporal Characteristics of Comprehensive Quality of Rural Human Settlements. Select the comprehensive score of rural living environment quality, using ArcGIS global spatial autocorrelation analysis tool, the global Moran's SI estimate can be calculated. If the value is less than 0, the spatial correlation is negative, and a value equal to 0 indicates that the spatial distribution is random. The global Moran's SI estimated value of human settlements in 2000 is 0.277, and the Z score and P value of the normal statistics in that year passed the significance test (Table 5); that is, the distribution of the comprehensive quality of rural human settlements in 2000 presents an agglomeration trend. The global Moran's SI estimates of human settlements in 2010, 2015, and 2017 are all close to 0, and normal statistics Z score and P value did not pass the significance test; it shows that the overall distribution of comprehensive quality of rural human settlement environment does not exist spatial dependence, and it is scattered. The comprehensive quality of rural human settlements in the west of the study area is gradually higher than that in the east. The internal interaction intensity of rural human settlement environment system gradually increases in the west, even higher than that in the east. The upward trend line from south to north in the study area evolved from "L" shape with large curvature to "inverted U" shape with small curvature, this shows that the comprehensive quality of human settlements in the north is improving rapidly, and the gap between the interaction

Table 5: Moran's SI estimates of the comprehensive quality of rural human settlements.

year	Moran' SI	The variance	Score	*P* values
2000	0.258	0.015	2.475	0.003
2010	−0.054	0.017	−0.034	0.845
2015	−0.087	0.013	−0.019	0.914
2017	−0.014	0.014	0.214	0.847

intensities of rural human settlements in the north and south is gradually narrowing.

4.7.2. There Is an Obvious Upward Trend of Differentiation

① In terms of time, since 2000, on the whole, remarkable progress has been made in improving the rural living environment. On the one hand, the rural living environment in prefecture-level cities has been greatly improved, the growth rate of the comprehensive score of rural living environment in most regions reached more than 14%, and the growth rate of the comprehensive score of some rural living environment was 4.52%. On the other hand, for the most part, in 18 years of development, the rural living environment fluctuates. This can be attributed to, first, local economies which have witnessed rapid growth. Second, the growth of rural human settlement environment in some areas from 2000 to 2017 was special; with a small population and high forest coverage rate, although the ecological foundation is good, due to the continuous improvement of urbanization and industrialization, the rural human settlement environment system has undergone drastic changes.

② From the spatial dimension, the development of rural human settlement quality areas is uneven; in the study area, there is a relative decline in the southeast and a gradual rise in the northwest. First, central cities in each region, especially provincial capital cities, have obvious advantages in rural living environment; among them, the quality of rural human settlements in Wuhan and Changsha is always at a high level. Second, there are differences in the construction of rural human settlements in the three urban circles; among them, the rural habitat score in urban agglomerations ranged from the highest average to the lowest average since 2010, and the overall urban aggregation score is slightly higher than the other two since 2010. Third, there are differences in rural habitats. Within the three urban districts, habitats have improved to varying degrees in all parts of the urban agglomeration, but with little internal change, this is reflected in the coherent development of the different regions in the urban agglomeration, the rural living environment within urban agglomerations has steadily improved, the gap between different regions within urban agglomerations has widened, the rural human settlement environment in all areas of the urban circle has maintained a high improvement rate, and internal differences are relatively narrow.

On the one hand, provincial capitals have excellent economic conditions, there are various types of public services in the villages under its jurisdiction, and the basic supporting facilities for rural living environment are complete; meanwhile, the positive interaction between rural and urban areas in these areas, and the income of rural residents in this area are relatively high and the rural industry is vigorous. On the other hand, there are big differences in infrastructure, public service facilities, information accessibility, economic base, and other original living environments within provinces and regions, and policies to improve the living environment vary from region to region.

4.7.3. Temporal and Spatial Evolution Process of Rural Human Settlement Sub-System Quality

① The overall level of development of the production space sub-system is increasing, and major changes have taken place in the spatial model. First of all, the average production space of the rural human settlement environment in the Middle Triangle increased significantly, from 2,603 in 2000 to 3,238 in 2017, and the growth rate reached 24.39%. With the rapid development of urbanization and industrialization in this period, comprehensive rural reform was deepened, various policies have been implemented to support and benefit agriculture, in a market economy, factors of production are fully mobile, rural areas are moving from closed to open, the number of migrant workers in cities has increased, and rural economic development has become increasingly diversified; in turn, more jobs were created in rural areas, the income of rural residents increases, and the living environment from the perspective of production space is optimized. Second, with the improvement of agricultural modernization, mechanization of farming, irrigation, transportation, and processing of agricultural products was gradually realized, agricultural land became more productive, rural labor was liberated by the mechanization of agriculture, at the same time, the brand construction of agricultural products has been promoted, and the integration of agricultural resources has also been increased; local academy of agricultural sciences has established a strategic alliance of agricultural science and technology innovation in urban agglomerations, it provides a better platform for the output and transformation of agricultural scientific and technological achievements in the region, and this has also boosted the income of rural residents and local government revenue, and then improved the rural living environment. The spatial pattern of production space sub-system of rural human settlement environment has changed greatly. During this period, with the major strategic decision of building "city

circle" put forward in 2003, superior location and resource conditions are used more effectively, other areas within the city circle have achieved rapid economic development, and agricultural modernization has also improved rapidly; therefore, the production space sub-system of rural human settlement environment in urban circle is improved relatively quickly. In addition, the spatial distribution of excellent grade regions still shows a triangular distribution pattern; that is, the regional centers with better continuous comprehensive strength still maintain relative advantages in quality.

5. Conclusion

(1) Rational habitat optimization is an important part of the implementation of the rural rehabilitation strategy, and the rural habitat covers all aspects of the natural and social environment of the residents countryside. It is consistent with the meaning of rural habitat, rural industrial environment, rural habitat, rural ecological environment, rural socio-cultural environment, construction of numbers from four angles, environmental quality test analysis, and measurement results.

(2) The driving mechanism of temporal and spatial evolution of rural human settlement environment is preliminarily analyzed. The results show that the government support and security system have been optimized, and the rural cultural industry has been gradually modernized. The needs of rural residents, social organizations, and other diversified subjects have changed, and public cultural service facilities have also been improved.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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