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Sustainable Livelihood Evaluation and Influencing Factors of Rural Households: A Case Study of Beijing Ecological Conservation Areas

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Abstract: Rural households' livelihood sustainability is the core issue that affects their production and life standards, and it is a necessary evaluation index for rural sustainable development. As a sensitive area of urban–rural integration development in Beijing, the environmental protection measures and industrial structure adjustments in ecological conservation areas (ECAs) have influenced the sustainability and stability of local rural households' livelihood. First, based on livelihood capital quantification data, this study established an evaluation model of rural households' livelihood sustainability, which employed the combined weighting approach and the technique for order preference by similarity to ideal solution (TOPSIS). Second, this study investigated the influencing factors of rural households' livelihood using the methodologies of regression analysis and the mediating effect. The results showed the following: (1) the overall livelihood sustainability of rural households was at a medium level, scoring 0.4436; (2) the sanitation conditions of the community were rated as the critical factor with a positive impact on rural households' livelihood, which was followed by the frequency of online shopping, family expenditure, and management capability of village cadres; (3) improving one's rural household income can enhance rural livelihood sustainability indirectly. Finally, effective livelihood strategies were explored and put forward for ECA development.

Keywords: sustainable livelihood; rural households; livelihood capital; TOPSIS; Beijing

Citation: Guo, M.; Xie, M.; Xu, G. Sustainable Livelihood Evaluation and Influencing Factors of Rural Households: A Case Study of Beijing Ecological Conservation Areas. *Sustainability* **2023**, *15*, 10743. https://doi.org/10.3390/su151310743

Academic Editor: Hossein Azadi

Received: 19 April 2023
Revised: 1 July 2023
Accepted: 6 July 2023
Published: 7 July 2023

1. Introduction

The global ecological environment is undergoing severe challenges. Increasing evidence is showing that ignoring social and environmental damage erodes the capital base for future improvements. Therefore, sustainable development has turned out to be an important policy goal for most countries and international organizations [1]. For a long period of time, creating sustainable livelihoods has been increasingly regarded as an important part of sustainable development, and its concept was first proposed in a report by the World Commission on Environment and Development (WCED) in 1987. Since then, the role of sustainable livelihoods in terms of poverty eradication and social advancement has become an important topic in international development conferences, such as the 1992 United Nations Environment Conference and the 1995 Copenhagen World Summit for Social Development [2]. In China, farmers are the smallest livelihood unit in rural society [3]. As the world's largest developing country with numerous low-income households, China has always been committed to being an advocate and participant in global poverty alleviation. In 2020, none of the rural residents living below the current poverty line in China experience absolute poverty. Methods for retaining and enhancing the livelihood of rural households, as well as improving their stability and sustainability, were placed on the agenda to realize sustainable poverty alleviation.

The term livelihood refers to the collection of assets, abilities, and income-generating activities that are owned and acquired by individuals or families and that can be used to make a living and improve long-term living conditions. When an individual's livelihood can cope with and recover from shocks, as well as maintain or enhance its capabilities and assets to meet the needs at present and benefit future generations without undermining the natural and social resource base, it can be sustainable [4]. A sustainable livelihood (SL) is a way of thinking about the objectives, scope, and priorities for development to promote the progress of poverty elimination [5]. Based on this theory, the specific analysis approaches of sustainable livelihood were put forward to analyze livelihood issues, among which the framework proposed by the UK's Department for International Development, i.e., the sustainable livelihood approach (SLA), is the most widely used. This framework is composed of five components: vulnerability contexts, livelihood assets, transforming structures and processes, livelihood strategies, and livelihood outcomes [6]. It was frequently used to analyze the livelihood strategies generated by various livelihood capital endowments when people respond to external shocks and used to explore livelihood decisions and results.

Unlike sustainable development, SL views environmental issues from a human perspective with a focus on the lives and resources of largely poor rural areas and marginal urban community dwellers [7]. They tend towards obtaining data from the household, community, and local levels for qualitative analyses [8]. Over the last decade, the livelihood of fragile rural districts in developing countries has been of global concern. Scholars have evaluated the resilience of rural households in coping with external risks such as climate fluctuation [9] and migrant resettlement [10], and they have put forward livelihood adaptation strategies accordingly [11,12]. Moreover, some scholars have explored the impact of new land utilization patterns [13] and environmental governance policies being adopted [14], as well as the development of rural tourism [15] with respect to the sustainability of rural livelihoods and the environment. However, most studies selected underdeveloped village communities for qualitative case studies and quantitative household surveys [16,17]. Kumar et al. [18] took the most drought-prone state in India as the research object. In China, rural settlements in mountainous areas have been often used for livelihood strategies and poverty reduction research [19]. There have been few studies on important ecological function areas [20].

Furthermore, the existing research also pays attention to the quantitative measurement and influencing factors of livelihood sustainability [21,22]. As for the selection of indicators, Li et al. [23] carried out a dynamic evaluation based on the livelihood capital, livelihood strategy, and the coupling degree between livelihood and ecological environments. Deng et al. [24] believed that livelihood bases, livelihood acceleration, and livelihood environments determine livelihood sustainability. It can be observed that livelihood capitals or livelihood assets are an important part of evaluating the sustainability of livelihoods. Livelihood capitals refer to the stocks of different types of capital that can be directly or indirectly used to make a living [25]. They are the basis and foundation for people to carry out various livelihood activities. All kinds of assets are dependent on the ability to pursue different livelihood strategies [26,27]. Thus, the attempt to make livelihoods more secure and sustainable has to build on the understanding of the assets people already have and how they are used [28].

This paper is structured as follows: After the Introduction, the research framework and related hypotheses of this paper are illustrated (Section 2). In Section 3, the physical, geographic, and socio-economic characteristics of ecological conservation areas (ECAs) in Beijing, as well as the empirical data sources, are presented. Following this is the establishment of the evaluation index system and the presentation of the influence mechanism model. Then, the results of the sample data processed using the combined weighting method, technique for order preference by similarity to ideal solution (TOPSIS), and the multiple linear regression model and the mediating effect model are given (Section 4). Finally, the conclusions and suggestions are discussed in Section 5.

2. Research Analysis Framework

2.1. Research Framework

Studies have found that the poor rely more heavily on products harvested from natural areas, such as wood fuel and wild food. Therefore, limiting the poor's access to natural resources using exclusive conservation policies could considerably endanger the livelihoods of local people [29]. For one thing, as a specially defined geographical space, the ecological protection areas shoulder the task of managing natural resources and promoting social wellbeing. Compared with rural settlements in mountainous areas, the resource endowment and regional development policies implemented in this area have a great influence on the income source diversification and employment behavior decisions of rural residents. In addition, the ECAs of Beijing are located on the periphery of the metropolis, which are the relatively undeveloped areas due to institutional restrictions. Therefore, based on the above analysis, this study focuses on the sustainable livelihood of rural households and examines the following issues: (1) how to measure the livelihood sustainability of rural households; (2) what are the constraints and opportunities related to sustainable livelihood development; (3) how to construct the response mechanism of rural households' livelihoods and boost their livelihood adaptability and resilience. This study took the ecological conversation areas in Beijing as the study area to evaluate the livelihood sustainability of rural households by quantifying livelihood capital, explore the influencing factors of livelihood sustainability, and provide a theoretical reference for promoting rural household livelihoods in important ecological function areas in combination with the actual situation in the research area. The research framework is shown as follows (Figure 1).

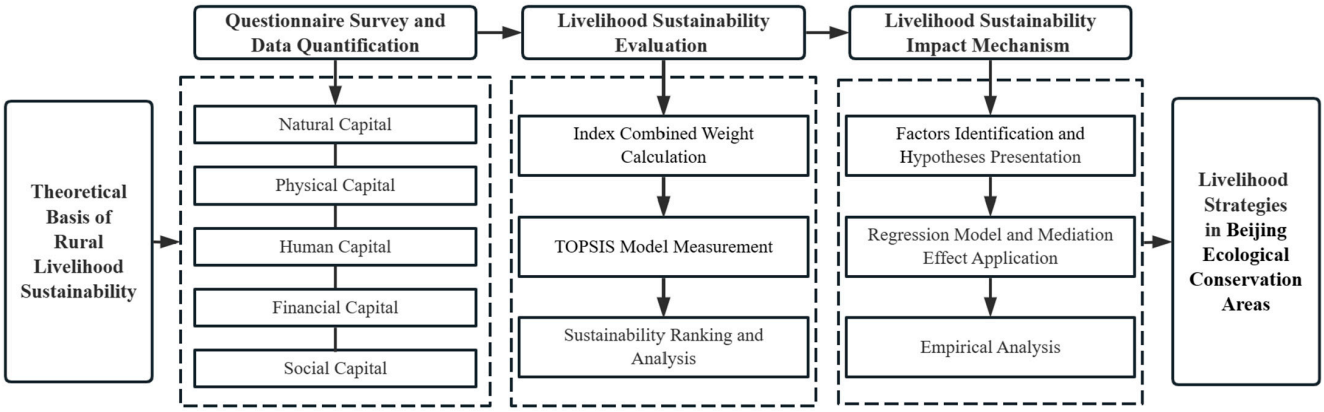

Figure 1. Research framework.

2.2. Research Hypotheses

The sustainability of rural livelihood is affected by multiple factors. This study carries out discussions from three dimensions: rural households, villages, and the environment [30–32].

From the perspective of rural household families, the diversification and improvement of consumption expenditure reflect the income and life quality of rural household families, while the frequency of online shopping indicates the efficiency of market information circulation and people's online shopping consumption ability. Therefore, the following research hypotheses were put forward.

Hypothesis 1a (H1a). *Rural household family expenditure directly affects livelihood sustainability.*

Hypothesis 1b (H1b). *Online shopping frequency has a direct impact on rural households' livelihood sustainability.*

According to the village aspect, the abilities of rural governance show the degree of rural economic development and social administration, among which the management ability of village cadres is indispensable. At the same time, community public security

and the distance between one's home and the nearest store are related to the safety of personal property and the satisfaction of daily consumption demands for rural households. Accordingly, the following research hypotheses were put forward.

Hypothesis 2a (H2a). *The management capability of village cadres positively affects rural households' livelihood sustainability.*

Hypothesis 2b (H2b). *Community public security promotes rural households' livelihood sustainability.*

Hypothesis 2c (H2c). *The distance from the nearest store has a direct impact on rural households' livelihood sustainability.*

From the environmental dimension, the improvement in infrastructure construction can promote the stability of rural livelihoods; in particular, efficient garbage disposal and the reasonable layout of courier stations mean a high performance of the rural public sanitary system and logistics facilities, which is conducive to improving the living standards and convenience of rural families. Thus, the following research hypotheses were proposed.

Hypothesis 3a (H3a). *The waste disposal condition positively affects rural households' livelihood sustainability.*

Hypothesis 3b (H3b). *The distance from the nearest courier stations has a direct impact on rural households' livelihood sustainability.*

Hypothesis 3c (H3c). *Community sanitation promotes rural households' livelihood sustainability.*

Moreover, rural households' income satisfaction embodies the subjective evaluation of their living environment and their quality of life under the existing livelihood capital conditions. Income-related indicators are often used to study livelihood capital composition and livelihood strategy choice [33,34]. Therefore, this study chose income satisfaction as an intermediary variable to further explore the indirect relationship between family, village, and environment and rural households' sustainable livelihoods. The following research hypotheses were proposed.

Hypothesis 4a (H4a). *The rural household family situation has an indirect impact on the rural households' livelihood sustainability.*

Hypothesis 4b (H4b). *The rural governance capabilities indirectly influence rural households' livelihood sustainability.*

Hypothesis 4c (H4c). *The infrastructure construction situation affects rural households' livelihood sustainability indirectly.*

3. Materials and Methods

3.1. Study Area

The Beijing ecological conservation areas (115°25′–117°30′ E, 39°30′–41°40′ N) are located in the north and west of Beijing, with a total area of 11,176.22 km^2. The area contains 7 administrative divisions, namely, the Mentougou District, Pinggu District, Huairou District, Miyun District, and Yanqing District, and the mountainous areas in the Changping District and Fangshan District (Figure 2). The area experiences a warm, temperate, semi-humid, continental monsoon climate with hot summers, cold winters, and the same periods of rain and heat. The terrain is higher in the north and lower in the south, and 80% of the forest resources, 60% of the water resources, and 65% of the wetlands in Beijing are located in the study region. The main mountain ranges are the Xishan, Yanshan, and Jundu Mountains. In addition, the Yongding River and Chaobai River flow through the

protected areas. The vegetation types in the territory are represented by warm temperate deciduous broad-leaved forests with temperate coniferous forests.

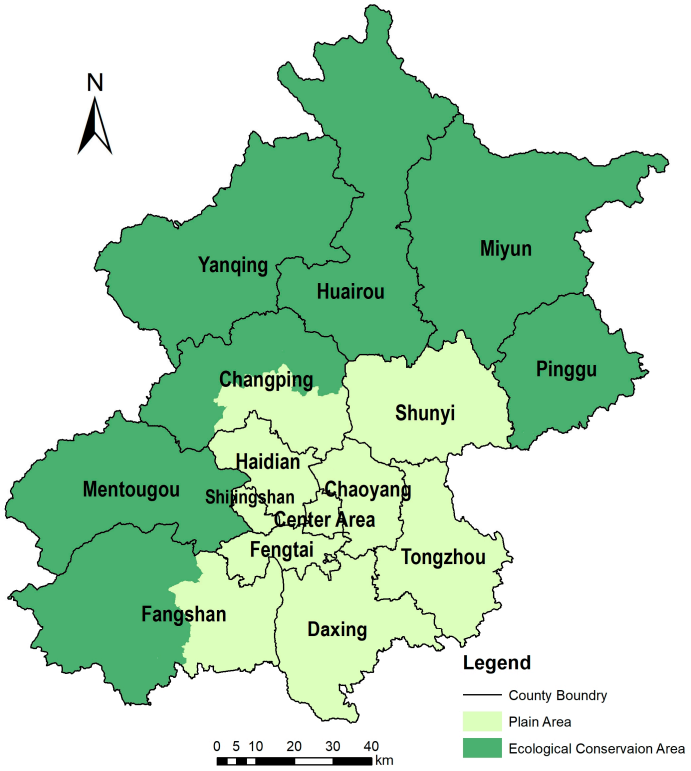

Figure 2. Locations of the ecological conservation areas in Beijing.

As an important ecological barrier and water source protection site in Beijing, the ecological conservation areas prioritize ecological protection and boost socio-economic equilibrium development. From 2018 to 2021, the municipal authorities allocated more than CNY 47 billion in fixed assets investment and CNY 13 billion in ecological protection compensation funds. The overall forest coverage rate of the area increased from 59.2% to 66%, which is 21.4 percentage points higher than that of the entire city; furthermore, the average concentration of PM2.5 diminished from 51.2 $\mu g/m^3$ to 31.3 $\mu g/m^3$. In 2021, the profits of leisure agricultural parks and rural tourism in this area were CNY 850 million and CNY 1.15 billion, respectively, accounting for 46% and 81.5% of those of the entire city.

3.2. Data Sources

Based on the statistical data in the study area, villages in the Mentougou District, Huairou District, Yanqing District, and Miyun District were investigated using random sampling in 2021. The data were obtained by carrying out semi-structured interviews and questionnaires that were conducted among rural households. First, the questionnaire gathered information about the holding of livelihood capital. Additionally, related factors that may affect rural households' livelihood sustainability were investigated, including (1) rural household family situations, such as annual family spending on human relations, education, medical care, and insurance, as well as internet usage and the satisfaction with current income; (2) rural-affair-governing capabilities, including the management capability of village cadres, the situation of rural public security, and the distance from home to the store; and (3) the situation of infrastructure construction, which mainly involves the condition of rural garbage disposal, sources of pollution situation, the sanitation conditions of the community, and the distance from home to the courier station. Finally, 300 questionnaires were sent out, and 280 samples were recovered, of which 252 were valid, with an effective recovery rate of 90%.

3.3. Research Methods

3.3.1. Livelihood Sustainability Evaluation Indicator System

Livelihood capital is an important part of the sustainable livelihood framework and an indispensable condition for rural households to resist external risks and achieve long-term development. Compared with disposable income and employment status, it covers a wider range and can be used as a substitute variable to reflect livelihood sustainability. Therefore, based on the classification proposed by DFID, the paper constructed an assessment index system of rural household livelihood sustainability from five dimensions of livelihood capital, including human, natural, physical, financial, and social capital. Then, considering the existing references [35–40] on indicators related to livelihood capital and the availability of data in the study area, 17 representative indicators of the criteria layer were identified (Table 1). More details about the references and category assignment of each index are given in Appendix A (Table A1).

Table 1. The rural household livelihood sustainability indicator system.

Dimension Layer	Criteria Layer	Indicators	Indicator Definition	Mean	Standard Deviation
Livelihood capital	Natural capital	Land area C_1	Area of farmland (unit: hectare)	0.778	2.410
		Land quality C_2	1 = poor, 2 = fair, 3 = average, 4 = fertile, and 5 = very fertile	2.718	0.863
	Physical capital	Homestead area C_3	1 = 100 and below, 2 = 100–160, 3 = 160–200, and 4 = above 200 (unit: m^2)	2.508	0.951
		Family living fixed assets C_4	The number of fixed assets, such as refrigerators, televisions, washing machines, computers, private cars, e-bikes, motorcycles, and air conditioners.	8.056	1.714
		Livestock and poultry breeding C_5	Breeding livestock and poultry: 0 = no and 1 = yes	0.337	0.474
	Human capital	Family members C_6	Total number of family members	3.310	0.793
		Skill training C_7	Participation in professional skill training: 0 = no and 1 = yes	0.294	0.456
		Education level C_8	1 = primary school and below, 2 = junior high school, 3 = high school, 4 = college, and 5 = postgraduate	2.528	0.810
		Physical health condition C_9	0 = experienced major disease and 1 = healthy	0.075	0.265
		Annual frequency of seeking medical treatment C_{10}	Annual frequency of going to the hospital (unit: times)	1.306	0.548
	Financial capital	Off-farm management C_{11}	Running a business or a store: 0 = no and 1 = yes	0.095	0.294
		Annual family income C_{12}	1 = 30,000 and below, 2 = 30,000–90,000, 3 = 90,000–150,000, 4 = 150,000–300,000, and 5 = above 300,000 (unit: CNY)	2.790	1.025
	Social capital	Agricultural cooperative organization C_{13}	Joining the specialized farmers' cooperatives: 0 = no and 1 = yes	0.647	0.479
		Relatives' relations C_{14}	1 = average, 2 = good, and 3 = excellent	2.008	0.585
		Road condition C_{15}	0 = unpaved road and 1 = cement and asphalt road	0.968	0.176
		Transportation convenience C_{16}	1 = lower, 2 = average, 3 = higher, and 4 = high	2.631	0.664
		Neighborhood relations C_{17}	1 = average, 2 = good, and 3 = excellent	1.980	0.602

3.3.2. Index Weight Calculation

Before evaluating the livelihood sustainability index of rural households, the weights of indicators in the evaluation system were assigned according to their importance. The schemes for determining the index weight can be roughly divided into two categories. One is the subjective weighting method that usually involves the Delphi method [41] and the analytic hierarchy process (AHP) [42], which reflects the preference of decision makers or experts based on facts and experience; the other is the objective weighting method, such as the entropy weight method [43] and principal component analysis (PCA) [44]. They reveal the internal operating mechanism of indicators using scientific calculations. Thus, this study chose the combination weighting method, which could effectively overcome the limitations of a single method of empowerment and obtain more reliable results [45,46].

First, we invited five experts who have a certain understanding of rural livelihood and ecological conservation areas by sending e-mails and asking them to rate the relative importance of each pair of indicators according to their knowledge and experience. Then, by using Yaahp software 10.5, we established the judgment matrix of each livelihood capital. After passing the consistency check, we obtained the weight results according to AHP so as to systematically determine the relative importance of each index according to the expert's experience. Second, based on the quantitative questionnaire survey data, this study endowed objective weight to indicators using the entropy weighting method to reduce the deviation caused by subjective factors. Then, the weights calculated using the two methods were combined to obtain the final weight assignment. The formula used is as follows:

$$w_j = \lambda s_j + (1 - \lambda) h_j \tag{1}$$

where w_j is the weight obtained for index j using the combination weighting method; λ is the equilibrium coefficient ($0 < \lambda < 1$), where the value used in this study was 0.5; s_j is the weight coefficient obtained for index j using the entropy method; and h_j is the weight coefficient obtained for index j using AHP.

3.3.3. TOPSIS Model Assessment

The technique for order preference by similarity to ideal solution (TOPSIS), proposed by Hwang and Yoon in 1981, is one of the multi-criteria decision-making (MCDM) methods that select the optimal option by computing a similarity index relative to the positive ideal solution and a distance index from the negative ideal solution [47–49]. This paper introduced the TOPSIS model to comprehensively evaluate the livelihood sustainability index and then ranked the indicators in a manner. After the dimensionless processing of data using the method of extreme value standardization, the normalized decision matrix was constructed as follows:

$$B = \left(b_{ij}\right)_{m \times n} \tag{2}$$

$$b_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}}, i = 1, 2, \ldots m; j = 1, 2, \ldots, n \tag{3}$$

where b_{ij} is the data of the ith sample of the jth index after normalization; n represents the nth index for criterion j; m represents the mth sample for criterion i; and a_{ij} represents the standard value of the ith sample of the jth index.

Next, the weighted normalized decision matrix was constructed:

$$C = \left(c_{ij}\right)_{m \times n} = b_{ij} \times w_j \tag{4}$$

Subsequently, the ideal solution and the negative ideal solution of the evaluation object were determined as follows:

$$c_j^+ = \left\{ \max_{m \geq i \geq 1} \left(c_{ij}\right) \middle| i = 1, 2, \ldots, m \right\} \tag{5}$$

$$c_j^- = \left\{ \min_{m \geq i \geq 1} (c_{ij}) \middle| i = 1, 2, \ldots, m \right\} \quad (6)$$

The calculation of the Euclidean distance between the evaluation object and the positive ideal alternative and negative ideal alternative value was achieved as follows:

$$D_j^+ = \sqrt{\sum_{i=1}^{m} \left(c_j^+ - c_{ij} \right)^2}, i = 1, 2, \ldots, m \quad (7)$$

$$D_j^- = \sqrt{\sum_{i=1}^{m} \left(c_j^- - c_{ij} \right)^2}, i = 1, 2, \ldots, m \quad (8)$$

Finally, the relative closeness to the ideal solution can be obtained using Equation (9):

$$f_j = \frac{D_j^-}{D_j^+ + D_j^-}, j = 1, 2, \ldots, n \quad (9)$$

where $0 \leq f_j \leq 1$, and the closer to 1 the value of f_j is, the higher the livelihood sustainability index.

3.3.4. Regression Model Setting

In order to explore the influencing factors of rural households' sustainable livelihood, this study established a model for regression analysis and the mediation effect test. Livelihood sustainability was selected as the dependent variable, which was calculated using the combination weighting method based on livelihood capital data. In the setting of independent variables, this study adopted eight variables from three dimensions: rural household family situations, rural governing capabilities, and the situation of infrastructure construction. Furthermore, factors that affect the livelihood sustainability of rural households were screened and controlled in the following data analysis, including education level, health status, homestead area, and whether there are pollution sources around the community. More details of the description of variables are shown in Table 2.

Table 2. Variable descriptions of the regression model.

Type	Variable	Variable Meaning and Assignment
Dependent variable	Livelihood capital	Calculated with the combination weighting method
Mediator variable	Income satisfaction C_{18}	1 = low, 2 = lower, 3 = average, 4 = higher, and 5 = high
Independent variable	Family expenditure C_{19}	1 = 30,000 and below, 2 = 30,000–60,000, 3 = 60,000–90,000, and 4 = above 90,000 (unit: CNY)
	Frequency of online shopping C_{20}	1 = none, 2 = rare, 3 = occasional, and 4 = frequent
	Management capability of village cadres C_{21}	1 = poor, 2 = fair, 3 = average, 4 = good, and 5 = excellent
	Community public security C_{222}	1 = poor, 2 = fair, 3 = average, 4 = good, and 5 = excellent
	Distance from the store C_{23}	Distance between home and the nearest store (unit: km)
	Waste disposal condition C_{24}	1 = average, 2 = good, and 3 = excellent
	Distance from the courier station C_{25}	Distance between home and the nearest courier station (unit: km)
	Community sanitation condition C_{26}	1 = poor, 2 = fair, 3 = average, 4 = good, and 5 = excellent

Table 2. *Cont.*

Type	Variable	Variable Meaning and Assignment
Control variable	Education level C_8	1 = primary school and below, 2 = junior high school, 3 = high school, 4 = college, and 5 = postgraduate
	Physical health condition C_9	0 = experienced major disease and 1 = healthy
	Homestead area C_3	1 = 100 and below, 2 = 100–160, 3 = 160–200, and 4 = above 200 (unit: m^2)
	Pollution sources situation C_{27}	There are pollution sources within 5 km of the community: 0 = no and 1 = yes

This paper investigated the influencing mechanism of rural households' sustainable livelihood in two steps. First, we used a multiple linear regression model to examine the impact of variables in each dimension on livelihood sustainability. Multiple linear regression models can estimate the influence of each variable on the response in the presence of multiple predictors [50]. The benchmark regression model is as follows:

$$Y = \alpha_0 + \alpha_1 X_i + \alpha_2 Z_i + \mu \tag{10}$$

where Y is the livelihood sustainability index, X_i is the independent variable, Z_i is the control variable, α_0 is a constant term, α_1 and α_2 are regression coefficients, and μ represents the random disturbance term.

Then, we constructed the mediation effect by constructing the method of stepwise regression analysis:

$$Y_i = \beta_0 + \beta_1 X_i + \gamma control_i + \mu_1 \tag{11}$$

$$Inter_i = \beta_0 + \beta_1' X_i + \gamma control_i + \mu_2 \tag{12}$$

$$Y_i = \beta_0 + \beta_1'' X_i + \varphi Inter + \gamma control_i + \mu_3 \tag{13}$$

where Y_i is the livelihood sustainability index; X_i is the independent variable; $Inter_i$ is the mediator variable; and $control_i$ is the control variable. β_0 is a constant term, whereas β_1, β_1', β_1'', γ, and φ are coefficients, and μ_1, μ_2, and μ_3 represent the random disturbance terms.

4. Results

4.1. Index Weight Results

It can be observed from Table 3 that there are certain differences in the results obtained using the AHP and entropy methods. The rankings of the final weights were as follows: human capital (0.3069) > financial capital (0.2529) > natural capital (0.1637) > physical capital (0.1566) > social capital (0.1199). This showed that rural households' human capital and financial capital had a great influence on their overall livelihood capital, followed by natural capital and physical capital and that social capital had the least influence. Hence, the development and investment of human resources and financial services require more attention.

Table 3. Index weights of the evaluation indicator system.

Dimension	Criteria Layer	Weight	Indicators	Entropy	AHP	Final Weight
Livelihood capital	Natural capital	0.1637	Farmland area C_1	0.1246	0.0950	0.1098
			Land quality C_2	0.0128	0.0950	0.0539
	Physical capital	0.1566	Homestead area C_3	0.0238	0.0535	0.0386
			Family living fixed assets C_4	0.0084	0.0970	0.0527
			Livestock and poultry breeding C_5	0.1010	0.0295	0.0653
	Human capital	0.3069	Family members C_6	0.0191	0.0508	0.0349
			Skills training C_7	0.1139	0.0426	0.0782
			Education level C_8	0.0141	0.0685	0.0413

Table 3. *Cont.*

Dimension	Criteria Layer	Weight	Indicators	Entropy	AHP	Final Weight
			Physical health condition C_9	0.2396	0.0291	0.1343
			Annual frequency of seeking medical treatment C_{10}	0.0071	0.0291	0.0181
	Financial capital	0.2529	Off-farm management C_{11}	0.2181	0.0900	0.1540
			Annual family income C_{12}	0.0178	0.1800	0.0989
	Social capital	0.1199	Agricultural cooperative organization C_{13}	0.0405	0.0140	0.0273
			Relatives' relations C_{14}	0.0216	0.0420	0.0318
			Road condition C_{15}	0.0030	0.0210	0.0120
			Transportation convenience C_{16}	0.0104	0.0210	0.0157
			Neighborhood relations C_{17}	0.0243	0.0420	0.0332

4.2. Evaluation Results

Based on the TOPSIS evaluation, the closeness degree was ranked and graded using the following classifications: grade 1 (0, 0.2), grade 2 [0.2, 0.4), grade 3 [0.4, 0.6), grade 4 [0.6, 0.8), and grade 5 [0.8, 1.0); these represented the livelihood sustainability index from low to high. As shown in Table 4, the lowest score of the farmland area in natural capital was 0.1154; the highest score of the road condition in social capital was 0.8467, with an average of 0.4436, indicating that the overall livelihood sustainability of rural households in the ecological conservation area was at a medium level. In addition, as shown in Figure 3, the weighted average of the five types of livelihood capital was calculated according to the weights and scores of indicators. Social capital (0.5691) was relatively high, followed by human capital and physical capital (0.4342); financial capital (0.3136) and natural capital (0.2225) were relatively low.

Table 4. The ranking and grading of evaluation results.

Indicator	Score	Grade
Farmland area C_1	0.1154	1
Physical health condition C_9	0.2221	2
Off-farm management C_{11}	0.2450	2
Family members C_6	0.3530	2
Skill training C_7	0.3920	2
Education level C_8	0.3992	2
Family living fixed assets C_4	0.4157	3
Livestock and poultry breeding C_5	0.4164	3
Land quality C_2	0.4407	3
Annual family income C_{12}	0.4584	3
Neighborhood relations C_{17}	0.4927	3
Homestead area C_3	0.5019	3
Relatives' relations C_{14}	0.5030	3
Transportation convenience C_{16}	0.5365	3
Agricultural cooperative organization C_{13}	0.5751	3
Annual frequency of seeking medical treatment C_{10}	0.6267	4
Road condition C_{15}	0.8467	5
Average	0.4436	

From the perspective of social capital, the social relationship network formed by blood ties and regions of rural households was relatively stable, and the construction of village traffic facilities and the development of agricultural specialized cooperative organizations were relatively sound. Regarding human capital, the field investigation uncovered that most rural households had not received systematic labor skill training. The sustainability of their livelihood was restricted by the shortage of professional knowledge and the prevalence rate of family members. Furthermore, the high score of the annual average frequency of seeking medical treatment may reflect one's attention to their health and initiative for seeking timely medical treatment, which improved human capital. In terms of physical capital, most rural households had the basic material guarantee to maintain family production and life, including housing and family-owned fixed assets.

Second, due to a strict environmental protection policy, few families in the study area were engaged in livestock and poultry raising. The survey found that families who raised large-scale livestock and poultry usually had a large amount of contracted land, and the diversity of income sources made their livelihood more sustainable. From the point of view of financial capital, the property of rural households was at a medium level, which needed further improvements in terms of rural household income and a broadening of financing channels. Concerning natural capital, the quality of land was moderately sustainable. However, with the economic development and urbanization process taking place in Beijing, many young and middle-aged laborers poured into urban areas to make a living; thus, agricultural land faced a crisis of abandonment or returned to being forests. The scale of arable land is decreasing year after year, and the per capita land possession of farmers is becoming smaller and more scattered. The basis for maintaining a traditional livelihood using cultivated land was weakened, and most of those with a traditional livelihood turned to non-agricultural labor or part-time management.

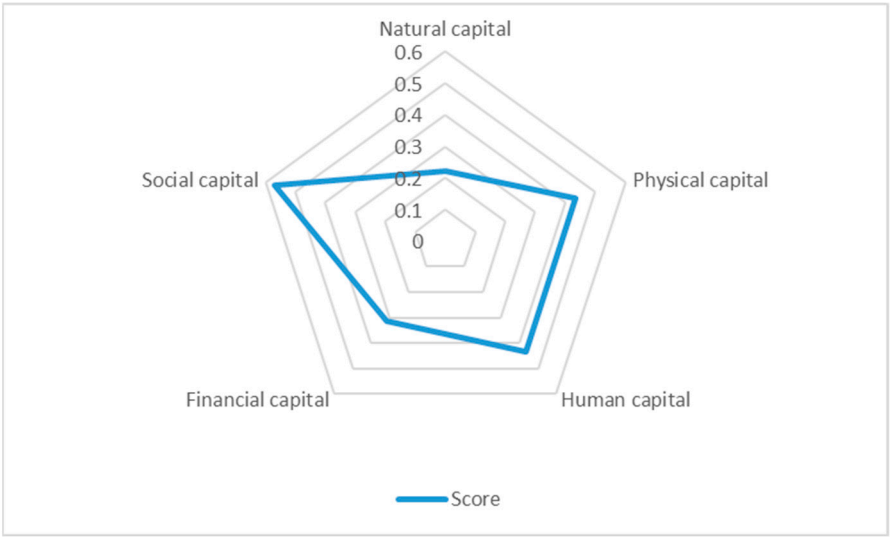

Figure 3. Scores of various types of livelihood sustainability indexes.

4.3. Empirical Analysis of the Regression Model

According to the multiple linear regression model, three related factors—namely, rural household family status (model 1), rural governing capabilities (model 2), and infrastructure construction situation (model 3)—were selected as the independent variables to examine the influencing mechanism of rural households' livelihood sustainability sequentially. Then, control variables were added to carry out the regression analysis (Table 5).

Table 5. Benchmark regression analysis of the influencing factors of sustainable livelihood.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
C_{19}	0.299 **			0.182 **		
	(0.128)			(0.124)		
C_{20}	0.076 **			0.059 **		
	(0.047)			(0.038)		
C_{21}		0.176 **			0.150 *	
		(0.094)			(0.090)	
C_{22}		0.015			0.011	
		(0.132)			(0.127)	
C_{23}		0.058 **			0.055 **	
		(0.032)			(0.031)	

Table 5. *Cont.*

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
C_{24}			0.118			0.211 *
			(0.120)			(0.116)
C_{25}			0.045			0.044
			(0.046)			(0.045)
C_{26}			0.466 ***			0.408 ***
			(0.102)			(0.099)
C_8				0.342 ***	0.030	0.064
				(0.074)	(0.085)	(0.083)
C_9				−0.089	−0.151	−0.110
				(0.212)	(0.215)	(0.210)
C_3				0.002 **	0.002 **	0.002
				(0.001)	(0.001)	(0.001)
C_{27}				0.591 ***	0.934 ***	0.845 ***
				(0.152)	(0.181)	(0.178)
Constant	1.283	1.905 ***	4.140 **	0.906	2.031 ***	3.862 ***
	(1.518)	(0.357)	(0.408)	(1.267)	(0.485)	(0.508)
R^2	0.097	0.126	0.091	0.176	0.136	0.177

Note: ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively. The values in brackets are standard errors.

The results demonstrated positive correlations between the sanitation conditions of the community and the sustainable livelihood of rural households at a significance level of 1%. The family expenditure, frequency of online shopping, management capability of village leaders, and distance from stores all had positive effects on the rural households' livelihood sustainability at a significance level of 5%. First, concerning the rural household family status, the growth in family non-rigid expenditure on education, culture, and entertainment reflected the increase in income and the upgrade in consumption structure, thus ensuring the material foundation of sustainable livelihood. The promotion effect was as high as 29.9%. Then, the high frequency of online shopping hinted that rural households had certain online channel trading abilities, further resulting in the improvement of livelihood sustainability. Second, as shown in model 2, the service capacity and the executive power of village leaders and village committees directly affected the harmony of rural society and rural residents' satisfaction with the village affairs administration. This is why the governance capability of village cadres positively promoted the rural households' livelihood sustainability, the estimated coefficient of which was 0.176. On the one hand, the increase in the distance from home to the nearest stores may increase the number of saving deposits of rural households and can reduce consumption expenditure to some degree. On the other hand, with the growth in the internet penetration rate in rural areas, the importance of brick-and-mortar stores to farmers' lives gradually decreased. Therefore, this indicator promotes the sustainability of livelihood from the perspective of enhancing financial capital. Third, the estimated coefficient (0.466) in model 3 confirmed the direct impact of community sanitation conditions on livelihood sustainability. The completion of a community public sanitary service system was related to the physical and mental health of rural families. Hence, the clean and orderly rural living environment had positive impacts on the development of livelihood in ecological conservation areas.

After adding the control variables, the model showed significant positive correlations between the livelihood sustainability of rural households and the sanitation conditions of the community, followed by family expenditure, the frequency of online shopping, and the distance from stores. Among the control variables, the pollution sources situation was positively related to a sustainable livelihood at a significance level of 1%. One possible reason for this was that the related enterprises that created pollution around the community compensated rural households with certain funds, which could be used to change their production and operation methods, and helped ameliorate their livelihood conditions. In models 4 and 5, the homestead area had a positive effect on the livelihood sustainability

of rural households at a significance level of 5%. In other words, rural households with more years of education possessed stronger adaptability and the mastery of more sufficient knowledge and skills, which is helpful for seizing the opportunity to increase livelihood capital. Beyond these factors, the education level was positively related to a sustainable livelihood at a significance level of 1% in model 4, which indicated that the homesteads owned by rural households provided an important foundation for their stable living.

According to the previous method, the standard values of three types of indicators—namely, the rural household family situation (B_1), the capabilities of rural governance (B_2), and the infrastructure construction condition (B_3)—were calculated. Then, the mediating effect model was tested using the stepwise regression method (Table 6). Model 1 showed that the influence of the rural household family situation and income satisfaction on livelihood sustainability passed the significance levels of 5% and 1%, respectively. The estimated coefficient of the family situation was reduced from 0.280 to 0.184 such that the proportion of the mediating effect in the total effect was 34.29%, which illustrated that income satisfaction played a partial mediating role. Likewise, in model 2, the mediation effect accounted for 21.67% of the total effect, indicating that income satisfaction also partially mediated the link between rural governance ability and sustainable livelihoods. However, the regression results of the infrastructure construction in model 3 showed that it had an insignificant impact on rural households' sustainable livelihood, while income satisfaction had a significant positive effect. Thus, income satisfaction did not play an intermediary role between infrastructure construction and livelihood sustainability. After the control variables were added, it was found that the partial mediations in models 4 and 5 remained significant and that the proportions of their mediations in the total effect were 19.87% and 25.77%, respectively; furthermore, model 6 had no mediations. This confirmed that income satisfaction had a partial mediating role in the process of the family situation and the capabilities of rural governance affecting livelihood sustainability. Improving farmers' income was beneficial in terms of enhancing their livelihood sustainability and stability.

Table 6. Results of the mediating effect model.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
B_1	0.184 **			0.241 **		
	(0.164)			(0.158)		
B_2		0.158 *			0.157 *	
		(0.084)			(0.081)	
B_3			0.002			0.042
			(0.116)			(0.112)
C_{18}	0. 346 ***	0.342 ***	0.355 ***	0.357 ***	0.345 ***	0.366 ***
	(0.069)	(0.068)	(0.069)	(0.072)	(0.072)	(0.072)
C_8				0.127	0.105	0.111
				(0.086)	(0.085)	(0.085)
C_9				−0.304	−0.288	−0.315
				(0.208)	(0.209)	(0.209)
C_3				−0.002 **	−0.003 **	−0.003 **
				(0.001)	(0.001)	(0.001)
C_{27}				0.698 ***	0.723 ***	0.701 ***
				(0.177)	(0.177)	(0.179)
Constant	1.514 ***	1.325 ***	1.639 ***	2.378 ***	2.143 ***	2.415 ***
	(0.233)	(0.263)	(0.348)	(0.351)	(0.390)	(0.444)
R^2	0.101	0.108	0.096	0.200	0.205	0.193

Note: ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively. The values in brackets are standard errors.

To ensure the reliability of the estimation results, this study adopted the methodologies of the ordinary least square (OLS) and the robust standard deviation to test the robustness of the results (Table 7). Although there were differences in the estimated coefficients of the variables, it seemed that the significance level and influence direction of the variables were

consistent with the benchmark regression results in Table 6. Therefore, the results of this study are robust and reliable.

Table 7. Robustness of test results.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
B_1	0.184 **			0.241 **		
	(0.175)			(0.016)		
B_2		0.158 *			0.157 *	
		(0.098)			(0.096)	
B_3			0.002			0.042
			(0.128)			(0.122)
C_{18}	0.346 ***	0.342 ***	0.355 ***	0.357 ***	0.345 ***	0.366 ***
	(0.065)	(0.066)	(0.065)	(0.073)	(0.074)	(0.074)
C_8				0.128	0.105	0.111
				(0.086)	(0.089)	(0.086)
C_9				−0.304	−0.288	−0.315
				(0.200)	(0.202)	(0.199)
C_3				−0.003 **	−0.003 **	−0.003 **
				(0.001)	(0.001)	(0.001)
C_{27}				0.698 ***	0.723 ***	0.701 ***
				(0.183)	(0.179)	(0.184)
Constant	1.514 ***	1.325 ***	1.639 ***	2.378 ***	2.143 ***	2.415 ***
	(0.230)	(0.284)	(0.379)	(0.351)	(0.409)	(0.446)
R^2	0.101	0.109	0.096	0.200	0.205	0.193

Note: ***, **, and * indicate the 1%, 5%, and 10% significance levels, respectively. The values in brackets are standard errors.

5. Discussion

The research on sustainable livelihoods can not only provide solutions for poverty alleviation but also help reduce farmers' livelihood vulnerability. At present, there have been few studies undertaken on the sustainable livelihood of rural households in ecological conservation areas and less developed rural communities at the fringe of the city. As an ecological barrier to urban development, the ecological conservation areas of Beijing have been committed to improving ecological security and increasing employment. However, after being designated as ECAs, the livelihood of rural households in the region suffered a certain policy-originated shock. They are facing the demand to adjust livelihood strategies and enhance livelihood stability. Therefore, this study takes the ECAs of Beijing as the subject of a case study, which theoretically enriched the existing studies on rural household livelihood in urban–rural integration development areas where ecology is closely related to livelihood, and it is helpful to solve the problem of the sustainable development of rural livelihood existing in the process of regional development planning and urbanization and realize the coordinated development of regional ecology and economy.

As for the research methods employed in this paper, firstly, by carrying out the field investigation, the local farmers' cognition of sustainable livelihood and the administration's awareness of sustainable development have been enhanced, which is helpful for improving the scientificity and practicability of decision making. Secondly, there have currently been few unified quantitative indicators and systematic evaluation systems for measuring the sustainability of livelihood. Thus, we tried to adopt the combination weighting method and TOPSIS method to compose a set of suitable quantitative evaluation methods for livelihood sustainability. Thirdly, previous studies have pointed out that livelihood capital is an important material basis to realize sustainable livelihood, which has been confirmed in our study. Furthermore, after investigating the direct influence, we deeply analyze the driving mechanism of each independent variable on the dependent variable using the methodology of mediation effects, which provides a more realistic reference basis for policy intervention with respect to the ECAs in Beijing. More importantly, the paper is conducive to achieving the global Sustainable Development Goals (SDGs) in metropolitan areas and

provides experience for other areas with a relatively large gap in regional development to achieve balanced development, ensuring that the purpose of the 2030 Agenda can be realized in similar regions.

Nevertheless, there are still some shortcomings in this paper that need to be further explored. Firstly, because the sample data of this study were obtained using the field questionnaire survey in the study area at a point in time, we assumed that AHP and entropy methods had the same importance when employing the combination weighting method. The optimal combination of weighted results can be verified by using more panel data in the future. Also, long-term observation should be further studied using comparative analysis to reflect the evolution rules of rural households' livelihood sustainability. Secondly, referring to the composition of livelihood capitals proposed by DFID, this paper constructed the evaluation index system of livelihood sustainability. However, it can be improved in future studies by adding more influencing factors to fully illustrate the livelihood portfolio, including livelihood strategy, psychological capital, and cultural capital. Thirdly, although the TOPSIS method can measure the development level systematically, it cannot fully reflect the dynamic relationship and changing trend of each index, which indicated the possibility of applying various multi-criteria decision-making techniques. And in the process of dividing the evaluation grades of livelihood sustainability, the interval lengths were divided equally in an idealized way, which may affect the evaluation's results, and the method of natural breaks could be used for classification in the following studies.

In terms of future studies, there are several perspectives to consider. Firstly, the proposed approaches could involve more case studies and investigations on a wider population to verify practicability and effectiveness in study areas. One pathway of future research is to carry out the temporal–spatial analysis according to the types of ecological service functions of ecological conservation areas in order to verify livelihood security and the changing trend of the entire area. Secondly, the scalability and adaptability of these methods could be extended to other regions, such as poverty-stricken areas and marginal land areas affected by global climate change and natural disasters and thus contribute to the process of global poverty reduction. Thirdly, current studies mostly focus on the elements of livelihood capital to evaluate the related attributes of livelihood. However, exploring the synergy with related research fields and investigating the possibility of interdisciplinary cooperation can help expand the scope and influence of this study. For such kinds of research, the discussion of in-depth ecological industry, ecological security, and ecological compensation would better provide information for related policy makers in order to implement more reasonable policies regarding rural household livelihoods. Furthermore, based on systematic thinking, it is essential to dynamically analyze and evaluate the process of ecological construction, socio-economic development, and policy making in the future.

6. Conclusions and Suggestions

6.1. Conclusions

Generally speaking, the findings showed that the livelihood of rural households in the ecological conservation areas of Beijing was at a moderate level of sustainable development, in which the cultivated land area understood as natural capital had the lowest score, and the road condition in terms of social capital had the highest score. In the measurement of the sub-item livelihood sustainability, rural households had abundant social capital and basic human and physical capital to make a living, but financial capital was relatively low, and natural capital was even lower. This implies the necessity of increasing the accumulation of the financial capital of rural residents and improving the efficiency of farmland allocation to ensure the steady improvement of financial capital and natural capital.

In terms of the influencing factors of rural households' livelihood sustainability, the sanitation conditions of the community were demonstrated to have a significant role in promoting rural households' sustainable livelihood. Under the condition that other variables remained unchanged, the mean value of rural households' livelihood sustainability increased by 46.6% for each unit of improvement in the community sanitation condi-

tions. Afterward, household expenditure, the management ability of village cadres, the frequency of online shopping, and the distance from home to the nearest stores also had positive impacts.

From the test results of the mediating effect model, income satisfaction played a significant mediating role in the influencing mechanism of the rural household family situation and rural governing capabilities on their livelihood sustainability. Furthermore, the factor displayed partial mediation; i.e., rural household family conditions and rural governance ability could indirectly affect livelihood sustainability via income satisfaction to some degree. In addition, the positive effect of the rural household family situation–income satisfaction–livelihood sustainability path was more obvious. However, there was no intermediary role with respect to income satisfaction in the process of infrastructure construction affecting livelihood sustainability.

6.2. Policy Suggestions

Based on the above analysis and the actual situation of the study area, recommendations are proposed as follows:

1. In terms of diversifying rural employment and improving rural households' income, the government authorities should first formulate a reasonable ecological compensation mechanism for rural residents in ecological conservation areas and adopt a combination of government subsidies, credit concessions, corporate compensation, and other financial forms of support to increase the financial capital of rural households. Second, by making full use of the natural resource endowment of rural areas and the dividend of the digital economy, managers should organize the targeted training of farmers' professional skills and vocational education, as well as cultivate high-quality local peasant talents.
2. With the development of the information era, the potential of the online market in rural areas has further increased. The development of the logistics industry and the widening of shopping channels can promote the circulation of goods and services between urban and rural areas, as well as improve the convenience of online shopping and life in rural households. Thus, there is a need to upgrade the operating model of rural logistics and transportation and to reasonably increase the coverage of rural courier stations.
3. Considering the important role of sanitation conditions in the community with respect to a sustainable livelihood, administrators should concentrate on basic public service needs. They should also further promote the construction of rural public service systems by rationally arranging community healthcare service centers and garbage disposal stations. In addition, by promoting the use of clean energy and building innovative platforms and carriers for rural ecological construction, we can improve the enthusiasm and initiative of farmers in order to protect the environment and realize harmonious coexistence between humans and nature.

Author Contributions: Conceptualization, M.G. and M.X.; formal analysis, M.G. and M.X.; funding acquisition, G.X.; investigation, M.G. and M.X.; methodology, M.G. and M.X.; resources, M.X. and G.X.; software, M.X., M.G. and G.X.; writing—original draft, M.G. and M.X.; writing—review and editing, M.G. and G.X. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the key Planning Project of the Beijing Social Science Fund (Grant number: 21GLA009).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data that support the conclusions of the current article can be supplied by the authors upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Variable descriptions of the evaluation index system.

Indicators	References	Indicators Assignment
Farmland area	[19,22–24,35,36]	The land area owned by families includes cultivated land, woodland, and garden land.
Land quality	[23,35,36]	Farmers' evaluation according to the actual output of farming.
Homestead area	[22,23,35]	According to the standards and management methods of rural residential land in China, the data obtained from the questionnaire survey are divided into four categories.
Family living fixed assets	[23,35,37]	Number of fixed assets to meet the needs of rural households' life.
Livestock and poultry breeding	[13,23,38]	Whether rural households' family engage in livestock and poultry breeding that may cause pollution to the environment.
Family members	[19,36,38]	The number of permanent residents in the family.
Skill training	[22,23,38]	Whether the family labor forces have participated in agricultural or non-agricultural skills training.
Education level	[22,24,37,38]	The education level of the interviewee.
Physical health condition	[13,24,35,36]	0: Suffering from serious illness, life can hardly take care of themselves; 1: good health condition, no major diseases.
Annual frequency of seeking medical treatment	[38,40]	The number of hospital visits by the interviewee every year.
Off-farm management	[24,39]	Whether the family owns a self-operated business or shop.
Annual family income	[24,35,37]	Annual household income level.
Agricultural cooperative organization	[22,37,39]	Whether the interviewee is a member of specialized farmers' cooperatives.
Relatives' relations	[24,35,37]	1: Less communication on weekdays; 2: frequent contact; 3: you can borrow money from each other.
Road condition	[13,35]	0: Dirt roads with difficulties in pedestrian traffic and cargo transportation, especially in severe weather; 1: stable and convenient cement road.
Transportation convenience	[35,36]	Respondents' evaluation according to the distance between the village and the bus stop, and the interval between bus shifts.
Neighborhood relations	[35,36]	1: Less communication on weekdays; 2: frequent contact; 3: regular mutual assistance.

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