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Evaluation of Cultural Ecosystem Service Functions in National Parks from the Perspective of Benefits of Community Residents

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Abstract: The ecosystem of national parks bears some cultural features. How the cultural ecosystem service functions are perceived by the public and how the cultural ecosystem service functions shape the public's cognition have become urgent scientific questions. This paper performs a case analysis on the Qianjiangyuan National Park System Pilot Area, a representative national park in China, which clarifies the main types of cultural ecosystem service functions from the perspective of the landscape aesthetics benefits of community residents, and analyze the varied impacts of demographics on functional cognition. On this basis, the entropy weight method was adopted to evaluate the importance of each function. Fuzzy comprehensive evaluation was employed to assess the composite level of the cultural service functions. The results show that: (1) the community residents value the benefits brought by the national park the most in terms of the ecological improvement function, and the situation is consistent across the four towns/townships; by contrast, the community residents attach the least importance to the benefits in terms of system governance function. (2) Except for the years of local residence, the community residents' cognition of different cultural ecosystem service functions may vary significantly, owing to factors like gender, age, education level, occupation, and annual mean income. (3) Concerning the importance of functional indices, the importance scores of the natural experience functions, humanistic concern functions, and social service functions are 0.3286, 0.3503, and 0.3211, respectively. The community residents had a moderate to high level of cognition for the cultural ecosystem service functions (3.99). The different types of functions can be sorted by effectiveness as: the social service functions (4.11) > natural experience functions (4.03) > humanistic concern functions (3.86). The research results provide a reference for improving the management level of national parks, and ease the increasingly prominent contradiction between people and land.

Keywords: national park; cultural ecosystem service; community resident; function evaluation; landscape

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1. Introduction

More and more people perceive the traditional way of natural protection negatively, mostly owing to the overlook of cultural factors in the protection process [1]. The philosophy of binary opposition contributes greatly to the frequent occurrence of social, economic, and ecological crises in the international community [2]. Under the influence of this philosophy, the national parks of the United States (US) initially excluded indigenous residents from the natural protection program, treating them as an obstacle to ecological protection [3,4]. That is why the indigenous Indians were driven away from the Yellowstone National Park [5,6]. This kind of protection model disregards humanistic factors, separates humans from nature, and leads to the failure of the traditional way of natural protection. Rotherham called this protection model "cultural severance" and proved that the model accelerates ecological destruction [1]. For a long time, human factors were considered detrimental to the stability of the ecosystem. National parks (or protected areas) are often regarded as a system completely independent of humans. Thus, all human interference

needs to be eliminated during natural protection [4]. This thinking mode, which separates nature from culture and detaches material from spirit, adds twists and turns to the construction of national parks, especially those in densely populated areas [7]. In fact, except for a few that are in absolute wildernesses, the ecosystem in most national parks (including other types of protected areas) constantly interacts and merges with the human society. As a result, the ecosystem of national parks bears some cultural features and exhibits as a social ecosystem that integrates humans and nature. Such a social ecosystem is a concentrated embodiment of the authenticity of the ecosystem of different national parks [8,9].

The cultural features of a national park are deeply rooted in the local eco-environment, forming a sense of the place unique to locals, and, in return, affects the ecosystem. Against this backdrop, governments around the world have started incorporating cultural factors into natural protection. For example, Japan formed the concept of community governance in the field of natural protection as early as the 1980s. National parks in Japan, a narrow and densely populated country, face a complicated land ownership. Due to the dense population in national parks, there are often complex relationships between property rights, financial rights, industries, and management. To sort out the relationships, the Japanese government issued the *Japans System of Natural Park (Zoning-System)*, which manages and zones park land from the perspective of resource preservation and sustainable utilization. This system is mainly implemented by signing landscape protection agreement with residents. For landowners, the original residents can sign agreements to obtain tax benefits and reduce the cost of land management, thereby reducing the burden of land management [10,11]. In the US, the National Park Service included public participation in multiple links of national parks, ranging from establishment, planning, decision making, management, to operation, and passed the Civic Engagement and Public Involvement and the National Environmental Policy Act (NEPA). These legislations allow the public to participate in at least three phases of national park development: scope delineation, environmental impact assessment (EIA) drafting, and EIA finalization [12,13]. Taking the Yellowstone National Park as an example, one fourths of the scientific research programs ratified each year are completed by foundations and other social organizations [14,15]. India, the world's most populous country, faces similar socioeconomic pressures as China does in the management of national parks. To cope with the pressures, the Indian government has established community reserve management committees and introduced joint community co-ownership programs in an attempt to solve the contradiction between ecological protection and community economic development [16]. Some indigenous Indians naturally worship forests. The concept of "sacred forest" stems from the ancient tradition of nature conservation. In ancient times, indigenous people ringfenced a specific area as a sacred forest, and protected it as a holy land [17]. Their efforts subtly contribute to the protection of forest resources and the maintenance of local biodiversity. In 2006, India enacted the *Forest Act*, which assured that local communities could manage nearby forests. In recent years, the ancient term of "scared forest" has gained prominence among ecological researchers [18,19].

There are diverse research methods and technologies for cultural ecosystem services which involve multiple disciplines [20]. The mainstream approaches include a questionnaire survey, participatory mapping, geographic information, and social media photographs. The evaluation methods for cultural ecosystem services include index system evaluation and value assessment. Plieninger et al. carried out a questionnaire survey on the perception patterns of cultural services among German respondents of different social and demographic backgrounds, and concluded that the respondents tend to associate cultural services and local places with personal happiness [21]. Brown et al. performed participatory mapping to identify areas of significant conservation value in New Zealand [22]. Raymond (2009) mapped the distribution of community values in Australia, and identified the areas threatening the ecosystem services [23]. With the orderly advancement of the national park system reform in China, many theorists and practitioners have shifted their attention to national parks. The problems in the system construction of national parks are explored from multiple angles, namely, biological diversity monitoring, ecological compensation,

and endangered species protection, as well as planning and evaluation [24–26]. On the whole, the evaluation methods for cultural ecosystem services are still being explored, without forming mature research methods or paradigms. The research of cultural ecosystem services is closely related to social sciences. At present, ecological experts attach great importance to the regulation and support services of ecosystem services, while paying little attention to the cultural services related to human perception. As a result, the ecosystem assessment in key areas is not objective enough. The systematic study of cultural ecosystem services needs inspiration from disciplines focusing on human well-being, public health, and psychological change, such as social science, psychology, and behavioral science.

Ecosystem services refer to the conditions and efficacies of the natural environment, which are formulated and maintained by the ecosystem, are essential to human survival, and represent all the benefits obtained by humans from the ecosystem [27]. The research focus of ecosystem services is shifting from the accounting of service values to the coupling between humans and their well-being [28–30]. Ecosystem services mainly include the supply service, regulation service, supporting service, and cultural service. Among them, the cultural service has the closest bond to humans. In this background, the cultural ecosystem service functions both intermingle and conflict with the supply, regulation, and supporting services. The cognition of the cultural ecosystem service functions directly bears on the success of the pilot program of the national park. China began to construct national parks in 2015. National parks are established in batches; they are managed by levels and controlled by zones. Following the participatory community management, the original residents are encouraged and supported to engage in environmentally friendly business activities and participate in the management of national park affairs. The difficulty of national park management lies in the trade-off and synergy between the various ecosystem services such as service functions like the ecological supply, regulation and support, and cultural functions like the aesthetic service and recreation. These services are provided to different stakeholders, which affects their behavior. The overemphasis on a particular ecosystem service will definitely affect and damage other ecosystem services [31]. The scientific management of national parks hinges on clear ecosystem services, which are reflected in many national park management policies. Ecosystem services are important indices in many current standards and codes of China, including the *National park functional zoning specification* (LY/T 2933—2018), *Technical specification for the national park master plan* (GB/T 39736-2020), *Specification for monitoring of the national park* (B/T 39738-2020), and *Specification for assessment of the national park* (GB/T 39739-2020). Their importance is reflected primarily in the links between background surveys, analysis, and evaluation, as well as scheme comparison. Based on ecological protection, it is highly necessary to study the cognition and evaluation of the cultural ecosystem services of national parks from the perspective of the community residents.

For the national park system pilot area's cultural ecosystem, the background is not clear, the service function evaluation methods are not perfect, and a lack of cultural values means a realization mechanism to solve practical problems is required. The purpose of this study is to ensure a cultural ecosystem service of the cognitive evaluation is applied to the national park service management, to promote the consideration of cultural factors in planning decisions, and to satisfy the current social growing demand for a better life. Hence, this research is urgently needed to answer the following scientific questions: how are cultural ecosystem service functions perceived by the public? How do cultural ecosystem service functions shape public cognition? What should we do to promote the refined management decision making of national parks through the cognition of cultural services? The research results promote the integration between multiple disciplines and expand the breadth and depth of applying landscape science to the research on cultural services of national park ecosystems. It is suffice to say that our research lays a scientific basis for the rational planning, construction management, policy formulation, protection, and utilization of national parks after the completion of the pilot system reform.

In the light of the above analysis, this paper performs a case analysis on the Qianjiangyuan National Park System Pilot Area (QNPSPA), a representative national park in China, clarifies the main types of cultural ecosystem service functions from the perspective of the landscape aesthetics benefits of the community residents, and scientifically evaluates the importance and overall level of each function, laying the basis for improving the management level of national parks and the ecological welfare of residents. Note that the community residents in the study area, who are generally poorly educated and aged, may understand the concept of cultural ecosystem services differently, as their cognition is strongly affected by direct perception of landscapes. To facilitate field surveys and interviews, our surveys and analyses on the cultural ecosystem service functions of the QNPSPA were carried out mainly from the angle of landscape aesthetics benefits, which are easily felt by the residents. This research perspective was determined in reference to Hatan et al. (2020) and Booth et al. (2017), who also evaluated cultural ecosystem service functions from the angle of landscape aesthetics [32,33].

2. Materials and Methods

2.1. Classification of Cultural Ecosystem Service Functions

Cultural ecosystem services appeared along with ecosystem services in the mid to late 1960s. In the 1990s, cultural services gradually attracted attention from scholars [20]. In 1997, Costanza defined cultural services as the aesthetic, artistic, educational, and scientific values of an ecosystem [34]. In the 21st century, with the publication of the Millennium Ecosystem Assessment report, the definition of cultural ecosystem services was expanded to include human well-being. The classification of cultural services was extended from recreation to more areas, such as aesthetic value, recreation and ecotourism, spirituality and religion, inspiration, sense of place, cultural heritage, social relations, and education, to name but a few. Chan et al. believed that the cultural ecosystem services of natural resources bring non-material benefits to humans, e.g., experience and ability [35]. Russell et al. regarded cultural ecosystem services as the spiritual and cultural well-being that ecosystems contribute to humans through immaterial processes [36]. Considering the actual situation of the study area, and the opinions of experts in the relevant fields, the QNPSPA cultural ecosystem services were divided into natural experience functions, humanistic concern functions, and social service functions, from the perspective of the landscape aesthetics benefits of the community residents.

Specifically, the natural experience functions include the ecological improvement, wilderness protection, and system governance functions, highlighting that the national park ecosystem protects landscape ecology for the community residents. The humanistic concern functions cover the spiritual worship, folk culture popularization, and art inspiration functions, stressing that the national park ecosystem provides the community residents with the landscape art functions, social service functions, involving living environment improvement, science education, and health care functions, reflecting on the fact that the national park ecosystem offers social or ecological public services to the community residents.

Our evaluation system for the cultural ecosystem service functions of national parks consists of a goal layer, a criteria layer, and an index layer. To evaluate the cognition and functions, the indices were transformed into quantitative indices by Likert quantification standards. The cognition was measured by a 3-point scale, with strongly agree and strongly disagree being assigned 3 points and 1 point, respectively. The functions were measured by a 5-point scale, with very high score and very low score being assigned 5 points and 1 point, respectively. The evaluation index system is presented in Table 1.

Table 1. Evaluation index system.

Goal Layer (A)	Criteria Layer (B)	Index Layer (C)
Cultural ecosystem service functions (A)	Natural experience functions (B1)	Ecological improvement function (C1)
		Wilderness protection function (C2)
		System governance function (C3)
	Humanistic concern functions (B2)	Spiritual worship function (C4)
		Folk culture popularization function (C5)
		Art inspiration function (C6)
	Social service functions (B3)	Living environment improvement function (C7)
		Science education function (C8)
		Health care function (C9)

Unlike the functions of ecosystem regulation services and support services, the function of natural experience is a non-material benefit from natural resources to humans [35]. The function of ecological improvement refers to the landscape services that community residents obtain from natural resources, such as air, water, land, forests, and organisms. The function stresses that people achieve ecological well-being through a natural experience of the ecosystem [36]. The function of wilderness protection refers to the concrete protection of the landscape in the natural ecosystem and highlights a human cognition and appreciation of wild natural values, namely virgin forests, and cultural values in areas with little human interference. The function of system governance reflects the integrity of the elements and processes of the national park ecosystem, and the governance features of living communities. It involves mountains, rivers, forests, fields, lakes, and grasslands and emphasizes the cultural values of ecosystem diversity and integrity.

On the humanistic concern functions, spiritual worship refers to the landscape cultural functions formed through the pious appreciation and worship of natural landscapes, mainly including holy mountains, divine trees, and feng-shui forests; the folk culture popularization function stands for the cultural identity with historically significant material and non-material products, such as historical sites, famous ancient trees, legends, and the long tradition of ecological protection; and the art inspiration function refers to the art aesthetic function of the national park landscapes as it is often said that the national park is as beautiful as a landscape painting.

On the social service functions, the living environment improvement function refers to the landscape attributes of the national park in terms of the beautification and greening of the environment; the science education function stands for the science promotion and education functions of the national park, as well as the social values generated by these functions, relative to the residents; the health care function, focusing on the health care of the natural environment in the national park, mainly refers to the delightful feeling generated through the regulation of mental and physical health, as well as the resulting cultural services.

2.2. Study Area and Sample Selection

The QNPSPA is one of the first ten system pilot areas (SPAs) for Chinese national parks. Located in the west of the Zhejiang Province, it is a 252 km^2 area at the junction of three provinces, namely, Zhejiang, Jiangxi, and Anhui (Figure 1). The QNPSA is home to 9744 people living in four towns/townships: Suzhuang Town (1030 people in 383 households), Qixi Town (2621 people in 659 households), Hetian Township (2068 people in 587 households), and Changhong Township (3825 people in 1044 households).

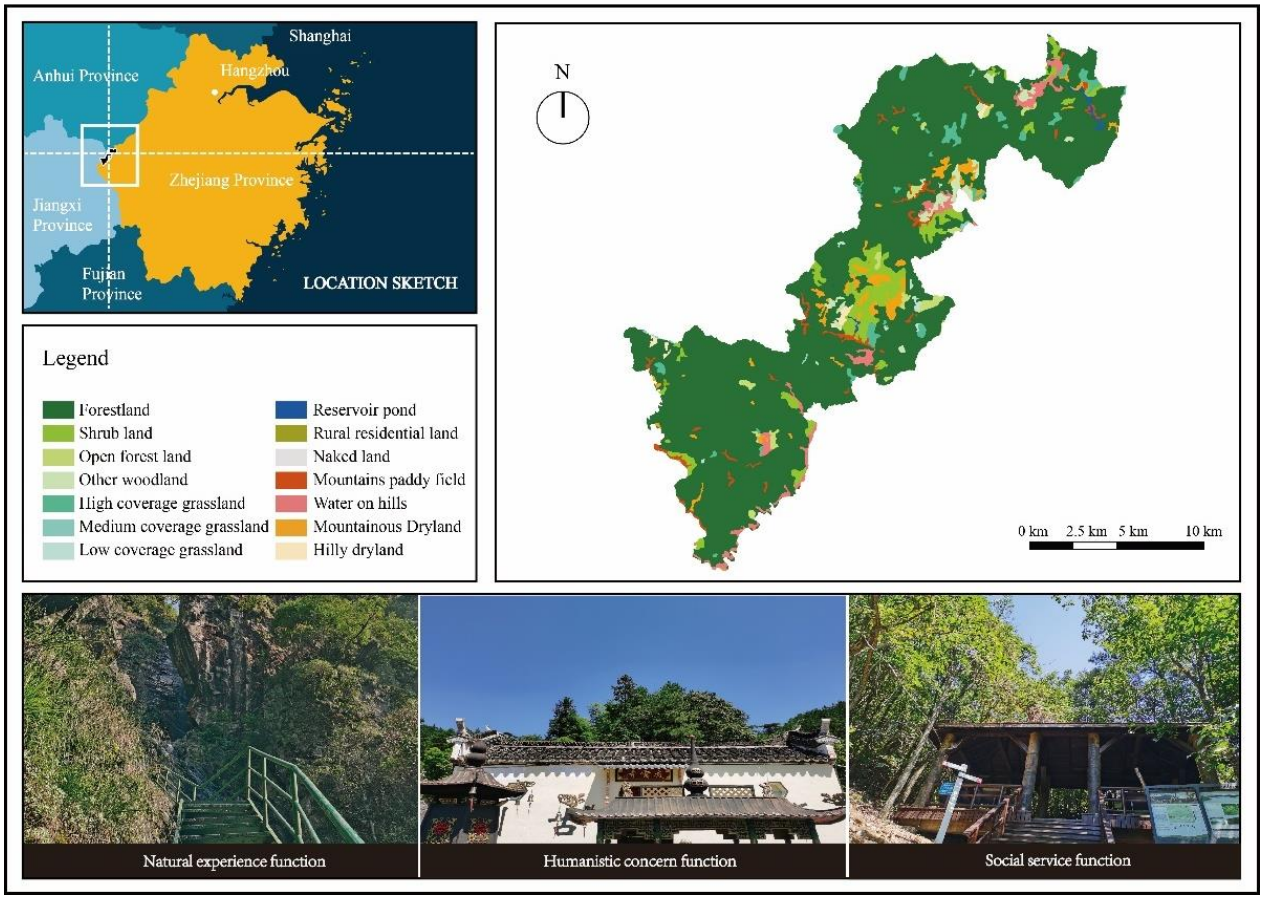

Figure 1. Land use map and cultural ecosystem service functions of the study area. Note: land use data are from the Resources and Environmental Science and Data Center, Chinese Academy of Sciences (https://www.resdc.cn/, accessed on 3 July 2022).

The QNPSPA carries the typical features of t**he** collective forest areas in southern China: a high proportion of collective forest lands and a complex ownership. The industrial structure in the area is relatively simple; the residents mainly make a living by selling agricultural and forestry products, or working as migrant workers. The primary agricultural crops are rice and corn, while the dominant product of economic forests is tea seed oil. The economic development of the community relies on the production of bamboo and wood, tea, and other agricultural and forestry by-products. Agritainment and other forms of leisure tourism are still in their infancy. Most of the leisure tourism projects in the area are operated spontaneously on a small scale. According to the *Overall Plan for Qianjiangyuan National Park System Pilot Area (2016–2025)*, the Qianjiangyuan National Park Administration Bureau will develop community industries in an orderly manner and reasonably guide the industrial upgrading process. The communities within the boundaries of the national park will be allowed to carry out the following activities: eco-agriculture, eco-forestry, and rural tourism. These activities involve such industries as organic tea production, freshwater fish farming, creative agriculture, camellia oleifera economic forest, moso bamboo, and rural tourism. Among them, the primary industries like tea production, freshwater fish farming, and camellia oleifera economic forest are relatively large.

Drawing on the previous research [32,33], the empirical questionnaire mainly involves personal conditions, the cognition of the cultural service functions, and value evaluation (Appendix A). Three pre-surveys were carried out from August to September, 2020. The residents are mostly middle-aged and elderly. The pre-surveys found that the residents did not fully understand the concepts of cultural ecosystem services, landscape aesthetics,

and functional values (Appendix B, Figure A1). Therefore, the residents were surveyed one after another through face-to-face interviews.

Based on the community and population data provided by Qianjiangyuan National Park Administration Bureau, the research team conducted a field investigation of the 19 administrative villages in the 4 towns/townships (i.e., Suzhuang, Changhong, Hetian, and Qixi) within the QNPSPA, namely, Hengzhong, Yucun, Tangtou, Xixi, Maotan, Suzhuang, Gutian, Xiachuan, Zhenzikeng, Kukeng, Gaosheng, Lulian, Tianfan, Longkeng, Liyangtian, Renzongkeng, Shangcun, Zuoxi, and Qixi. Owing to ecological migration and the relocation policies, there was no permanent resident in Gaosheng.

The research team was led by the staff of Qianjiangyuan National Park Administration Bureau, the staff of the law enforcement office in the relevant towns/townships, the cadres of the said administrative villages, and the forest rangers, and explained the details of the questionnaire survey to community residents in public venues like cultural halls, ancestral temples, village committee offices, and party and public service centers. The residents were invited to fill out the questionnaire. In addition, household visits were paid by the research team under the guidance of village cadres and forest rangers.

A total of 531 questionnaires were released, and 457 (86.06%) effective responses were obtained, including 145 from Suzhuang Town, 79 from Changhong Township, 124 from Hetian Township, and 109 from Qixi Town (Table 2). On the whole, the survey results of this study are basically consistent with the sample survey results conducted before the establishment of the national park.

Table 2. Statistics on valid samples.

Towns/ Townships	Administrative Villages	Village Code	Number of Households	Population	Sample Size
Suzhuang Town	Hengzhong	HZ	174	578	25
	Yucun	YC	44	118	18
	Tangtou	TT	— —	— —	22
	Xixi	XX	— —	— —	9
	Maotan	MT	— —	— —	40
Changhong Township	Suzhuang	SZ	38	106	20
	Gutian	GT	137	428	11
	Xiachuan	XC	438	1487	25
	Zhenzikeng	ZXK	229	815	34
	Kukeng	KK	377	1523	20
	Gaosheng	GS	— —	— —	— —
Hetian Township	Lulian	LL	154	493	46
	Tianfan	TF	140	496	31
	Longkeng	LK	293	1079	47
	Liyangtian	LYT	110	337	26
	Renzongkeng	RZK	192	634	19
Qixi Town	Shangcun	SC	219	670	9
	Zuoxi	ZX	119	612	28
	Qixi	QX	119	368	27
Total	19		2783	9744	457

Note: The dash line in the column of population indicates that the administrative village does not fall in the QNPSPA, yet the land owned by the village collective (e.g., farmlands and forests) belong to that area. The residents of these villages were also surveyed.

2.3. Entropy Weight Method (EWM)

The predecessors held that indices for the cognition of cultural services contribute differently to the composite score of the cultural ecosystem service functions [37]. Before comprehensive evaluation, it is necessary to assign a proper weight to each index. The EWM, an objective weighting approach for composite index evaluation, eliminates the effects of subjective human factors and outshines the traditional subjective weighting methods in terms of reliability. The EWM is primarily based on the information volume of each index. Entropy can be regarded as a measure of uncertainty. The greater the

information volume, the lower the uncertainty of the index, the smaller the entropy, and the larger the index weight. The inverse is also true. The EWM can be implemented in the following steps:

Step 1. Data normalization

The original data x_{ij} are nondimensionalized through the normalization of the deviance, producing the initial matrix for comprehensive evaluation $Y = (y_{ij})_{n\times m}$ $(0 \le i \le m, 0 \le j \le n)$. Under the j-th index, the index weight $z_{ij}(0 \le z_{ij} \le 1)$ of the i-th resident can be calculated by:

$$z_{ij} = y_{ij} / \sum_{i=1}^{m} y_{ij} \tag{1}$$

On this basis, the proportion matrix $Z = (z_{ij})_{m\times n}$ is established for the survey data. The information entropy e and information utility d are computed for each index of cognition of cultural services. The information entropy e_j of the j-th cognition index can be calculated by:

$$e_j = -K \sum_{i=1}^{m} z_{ij} In(z_{ij}) \tag{2}$$

where $K = 1/(In(m))$ is a constant. The information utility d_j of the j-th cognition index depends on the difference between the entropy e_j and 1. The greater the d_j, the larger the weight of that cognition index. The information utility d_j can be calculated by:

$$d_j = 1 - e_j \tag{3}$$

Step 2. Index weighting

The greater the information utility d_j, the larger the weight of the index of cognition of cultural services, and the more prominent the contribution of the index to the composite cognition. The weight of the j-th cognition index can be calculated by:

$$w_j = d_j / \sum_{j=1}^{n} d_j \tag{4}$$

Step 3. Composite score calculation

The composite score U is obtained by weighted summation. The greater the U, the better the effect of the samples. Let w_j be the weight of the j-th index. Then, the composite score U can be calculated by:

$$U = \sum_{i=1}^{n} y_{ij} w_j \times 100 \tag{5}$$

2.4. Fuzzy Comprehensive Evaluation (FCE)

Utilizing the membership theory of fuzzy mathematics, the FCE is a comprehensive evaluation method for quantitative analysis. For the QNPSPA, the cognition evaluation of the cultural ecosystem service functions is a fuzzy task. Based on fuzzy mathematics, the qualitative evaluation for the cultural ecosystem service functions of the QNPSPA was transformed into quantitative evaluation, which is more pertinent and systematic than traditional approaches like analytic hierarchy process (AHP). Inspired by existing studies, the cultural ecosystem service functions of the QNPSPA were evaluated through primary FCE and the overall cognitive value of these functions was assessed by secondary FCE [37].

The primary FCE includes the following steps:

Step 1. Setting up the FCE index set

The sets of primary indices are established as $B_1 = \{C_1, C_2, C_3\}$, $B_2 = \{C_4, C_5, C_6\}$, and $B_3 = \{C_7, C_8, C_9\}$; the set of secondary indices is established as $A = \{B_1, B_2, B_3\}$.

Step 2. Setting up the comment set

The comment set can be established as $V = \{V_1, V_2, V_3, V_4, V_5\}$: {strongly high, slightly high, neutral, slightly low, strongly low}.

Step 3. Setting up the FCE matrix

The weight set vector K is calculated for each index by the EMV. Then, m residents are invited to evaluate the index set A, forming a fuzzy mapping. The relevant results are summarized into the FCE matrix R:

$$R = \begin{bmatrix} r_1 \\ r_2 \\ \vdots \\ r_m \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{6}$$

where r_{ij} is the degree of comments $V_1, V_2, \cdots, V_5$ made by each resident on each index ($0 \leq i \leq m$, $0 \leq j \leq n$). According to the principle of maximum membership, the maximum r_{ij} is set to 1.

Step 4. Setting up the primary FCE set

The primary FCE set is derived from the weight set vector K and the FCE matrix R. For the three types of cultural service functions, the primary FCE sets S_{B1}, S_{B2}, and S_{B3} can be calculated by:

$$S_{Bi} = K_{Bi} * R_{Bi} = (b_{1i}, b_{2i}, \ldots b_{ni}) \tag{7}$$

where $*$ is the generalized fuzzy synthetic operation.

By the principle of maximum membership in FCE, the comment set V_j corresponding to maximum b_j is the optimal result of our primary FCE. Let $*^{\wedge}$ be the generalized fuzzy AND operation; $*^{\vee}$ be the fuzzy OR operation. Then, b_j can be calculated by:

$$b_j = (a_1 *^{\wedge} r_{1j}) *^{\vee} (a_2 *^{\wedge} r_{2j}) *^{\vee \cdots} *^{\vee} (a_m *^{\wedge} r_{mj}) \tag{8}$$

The evaluation is one-sided, when only S_{Bi} is taken as the evaluation index. For comprehensiveness, S_{Bi} was sorted out to obtain the secondary index S_B for secondary FCE. The secondary FCE includes the following steps:

Step 1. Setting up the secondary judgement matrix

Based on the secondary fuzzy index set A, S_{B1}, S_{B2}, and S_{B3} can be organized into the secondary judgement matrix S_B:

$$R_B = \begin{bmatrix} S_{B1} \\ S_{B2} \\ S_{B3} \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \tag{9}$$

Step 2. Setting up the secondary FCE set

The latter part of the secondary FCE is consistent with that of the primary FCE. The secondary FCE set S_B can be established as:

$$S_B = K_B * R_B = (b_1, b_2, \cdots, b_n) \tag{10}$$

Since the QNPSPA cultural ecosystem service functions are fuzzy, the idea of fuzzy mathematics was drawn to comprehensively consider the fuzzy comment subsets S_B and S_{Bi}. In this way, the cognitive aesthetic values of the QNPSPA were depicted quantitatively, making the evaluation more realistic. Specifically, the level was determined for each comment in the comment set V. The column vectors of the lines were compiled into the score set $N = (N_1, N_2, N_3, N_4, N_5)^T = (5, 4, 3, 2, 1)^T$ corresponding to the comment set. Based on the score set N, the levels can be solved through the inner product operation of the vectors:

$$S_B \cdot N = \sum_{j=1}^{n} b_j \cdot N_j \tag{11}$$

where S_B is a fuzzy comment subset; N is the score set. Note that the specific levels P are real numbers. In this paper, the result of secondary FCE S_B is normalized such that $0 \leq b \leq 1$ and $\sum b_j = 1$. Thus, the value of real number P is the weighted mean of the secondary FCE set S_B as the weight vector is relative to N_1, N_2, N_3, N_4, and N_5. In other words, the value of real number P reflects the comprehensive information from the secondary FCE set S_B and the score set N, laying the basis for solving the actual composite score for the QNPSPA cultural ecosystem service functions.

3. Results

3.1. Demographics

To ensure the data quality of the questionnaire survey, the sample data were subjected to reliability and validity tests on IBM SPSS Statistics. It was calculated that the Cronbach's alpha (0.805) was greater than 0.8, and the Kaiser–Meyer–Olkin (KMO) statistic (0.873) fell between 0.8 and 0.9 and achieved significance at the level of 95%, and even 99%. Referring to the standards of reliability and validity, the survey data on the community residents in the QNPSPA are of good internal consistency and structural validity.

As shown in Table 3, more male residents (50.33%) were surveyed than females (49.67%). The middle-aged (41–55) group was the largest age group among the respondents (39.82%), followed by the middle-aged and elderly (56–70) (32.39%). The smallest group was young people of 25 and below (2.84%). Among the respondents, 45.30% were either illiterate or graduates of primary schools; 34.79% and 19.91% had graduated from junior high schools and senior high schools and above, respectively. In terms of occupation, most of the respondents were farmers (62.58%). The second largest group (20.35%) worked in individual service industries, such as agritainment, homestays, and sales. Quite a few respondents worked in factories (7.44%) or worked in other cities (5.91%). The majority of the respondents earned CNY 50,000 and below. Notably, 188 (41.14%) of the respondents had an annual mean income of CNY 20,000 and below; 35.89% had an annual mean income of CNY 30,000–CNY 50,000; only 3.50% earned an average of CNY 160,000–CNY 300,000; and 1.53% earned CNY 310,000 and above, respectively, each year. The respondents (87.53%) had largely been living in the study area for 20 years or more. Only 2.19% had been living there for five years or less.

Table 3. Demographics of the respondents.

Demographics		Number (People)	Proportion (%)
Gender	Male	230	50.33
	Female	227	49.67
Age	≤25	13	2.84
	26–40	57	12.47
	41–55	182	39.82
	56–70	148	32.38
	≥71	57	12.47
Education level	Primary school and below	207	45.30
	Junior high school	159	34.79
	Senior high school and secondary technical school	67	14.66
	Higher vocational school and junior college	21	4.60
	Ordinary college and above	3	0.66
Occupation	Farmers	286	62.58
	Individual service workers	93	20.35
	Enterprise employees	34	7.44
	Migrant workers	27	5.91
	Students	8	1.75
	Others	9	1.97

Table 3. *Cont.*

Demographics		Number (People)	Proportion (%)
Annual mean income	≤CNY 20,000	188	41.14
	CNY 30,000–CNY 50,000	164	35.89
	CNY 60,000–CNY 150,000	82	17.94
	CNY 160,000–CNY 300,000	16	3.50
	≥CNY 310,000	7	1.53
Years of local residence	5 years and below	10	2.19
	6–10 years	23	5.03
	11–20 years	24	5.25
	21 years and above	400	87.53

3.2. Cognition of Cultural Ecosystem Services

As shown in Figure 2, more residents (91.68%) perceived the ecological improvement function in the QNPSPA than the other aesthetic values. More than 80% of the responds perceived the living environment improvement function (89.72%) and art inspiration function (86.43%). The following aesthetic values were cognized by more than 70% of the respondents: art inspiration function (78.77%), spiritual worship (75.05%), health care (75.05%), and wilderness protection (74.84%). System governance (69.37%) and folk culture popularization (68.71%) were perceived by over 60% of the respondents.

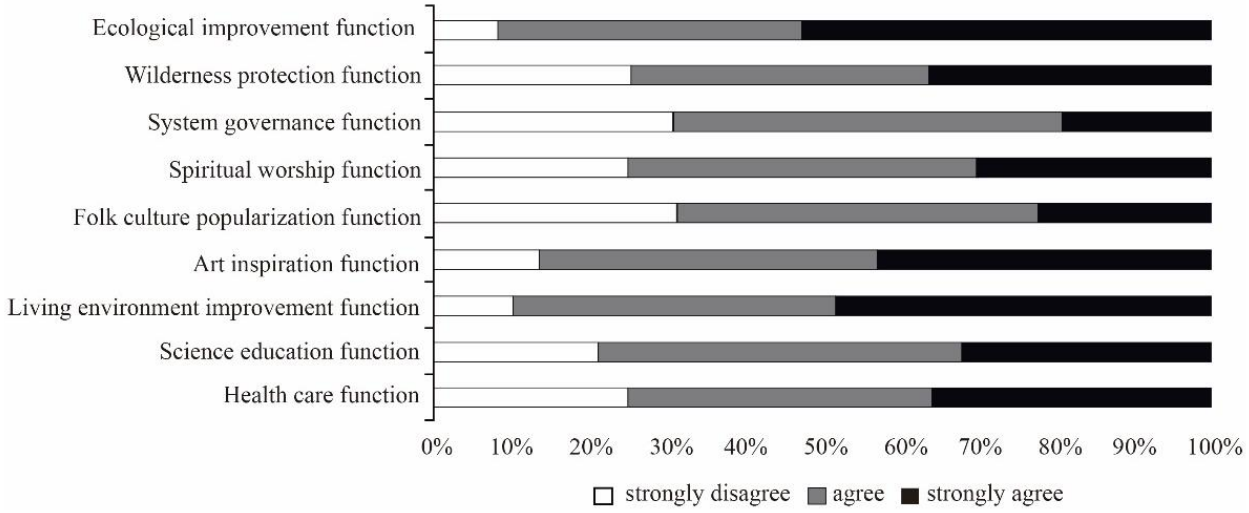

Figure 2. Proportion of community residents with different cognition degrees of cultural service functions.

Over 50% of the respondents strongly agreed that the QNPSPA had the ecological improvement function. Over 40% strongly agreed that the QNPSPA had the living environment improvement function and art inspiration function. Over 30% perceived wilderness protection, health care, the art inspiration function, and spiritual worship significantly. Over 20% found the folk culture popularization very prominent. In addition, over 10% strongly perceived the system governance function.

The QNPSPA covers four towns/townships in different functional zones. The different management methods lead to variations in how the residents of different towns/townships perceive cultural ecosystem services. The cognition of cultural ecosystem services in Suzhuang Town, Hetian Township, Changhong Township, and Qixi Township is displayed in Figure 3.

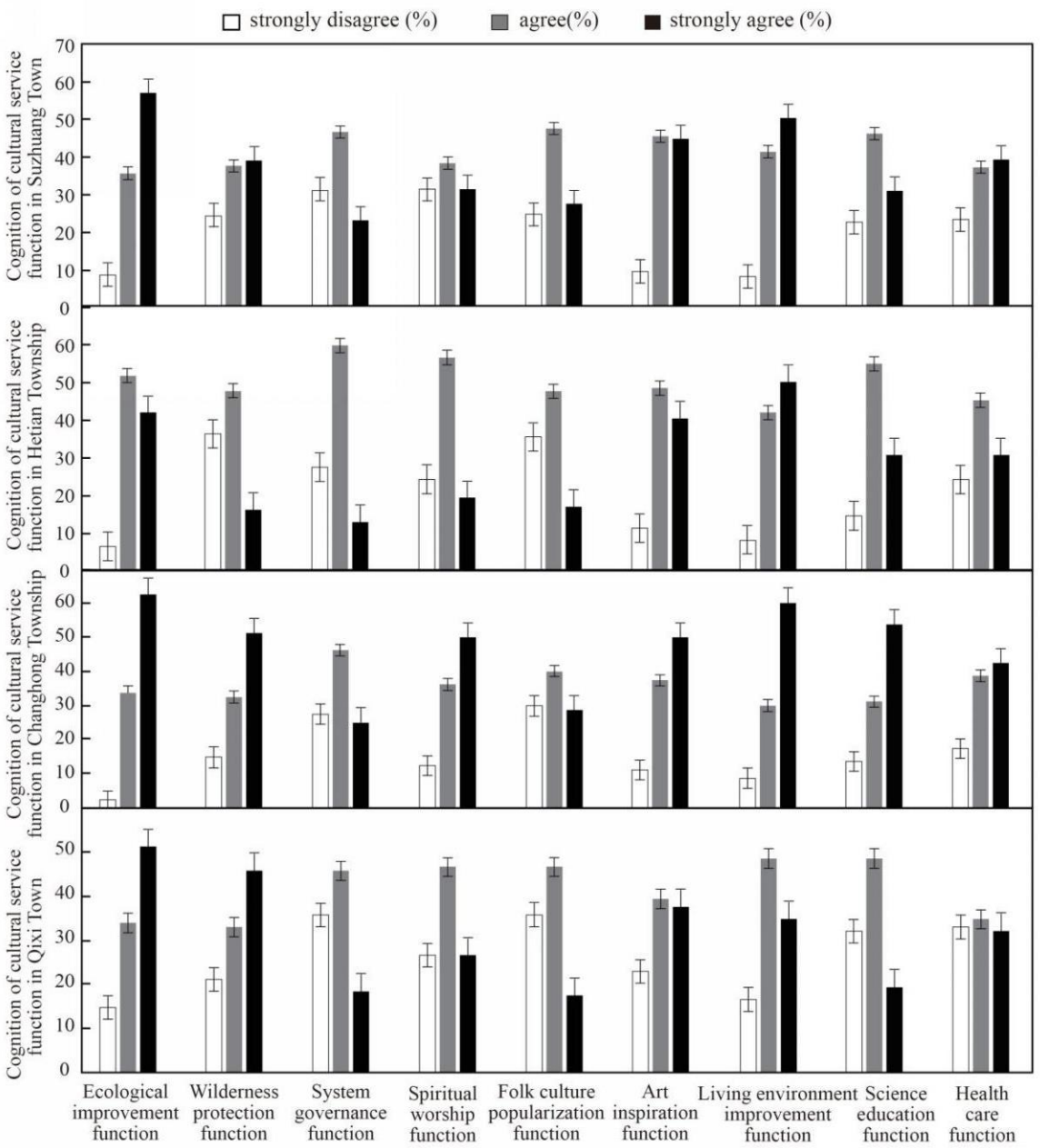

Figure 3. Cognition of cultural service function in different towns.

Among the residents of Suzhuang Town, over 90% held the view that the QNPSPA had ecological improvement, art inspiration, and living environment improvement functions. Around 75% believed that the area had wilderness protection, folk culture popularization, and science education functions. Sixty-eight percent claimed that the area had system governance and spiritual worship functions. Every cultural ecosystem service of the QNPSPA was recognized by more than 60% among the residents of Hetian Township. The ecological improvement function won the most beholders (93.55%), while that of wilderness protection was perceived by the fewest respondents (63.71%). Every cultural ecosystem service of the QNPSPA was recognized by more than 40% among the residents of Changhong Township. The ecological improvement function was cognized by the largest group of respondents (97.47%), while that of folk culture popularization was perceived by the smallest group (69.62%). Every cultural ecosystem service of the QNPSPA was recognized by more than 50% among the residents of Qixi Town. More than 80% of the respondents agreed that the QNPSPA boasts the functions of ecological improvement

and living environment improvement. By contrast, system governance and folk culture popularization were the least perceived functions, but the recognizers still took up more than 60% of the respondents.

As shown in Table 4, the cultural ecosystem services of the QNPSPA can be ranked by the community residents' cognitive score as: the ecological improvement function (2.44) > living environment improvement function (2.38) > art inspiration function (2.29) > wilderness protection/science education/health care function (2.11) > spiritual worship function (2.05) > folk culture popularization function (1.91) > system governance function (1.89). In general, the residents of different administrative villages had a high cognition of ecological improvement, living environment improvement, and art inspiration functions, and a low cognition of folk culture popularization and system governance functions. The ecological improvement function was the most cognized cultural service function in all the villages of Suzhuang Town, Changhong Township, and Qixi Town, while living environment improvement was the most perceived function among the residents of Hetian Township. The system governance function was the least perceived function among those living in Suzhuang Town and Changhong Township, while folk culture popularization was that among the residents in Hetian Township and Qixi Town.

Table 4. Community residents' cognitive scores of cultural service functions.

Cultural Service Function	Suzhuang	Hetian	Changhong	Qixi	Total
Ecological improvement	2.48	2.35	2.61	2.37	2.44
Wilderness protection	2.14	1.8	2.37	2.25	2.11
System governance	1.92	1.85	1.97	1.83	1.89
Spiritual worship	2.00	1.95	2.38	2.00	2.05
Folk culture popularization	2.03	1.81	1.99	1.82	1.91
Art inspiration	2.35	2.29	2.39	2.15	2.29
Living environment improvement	2.42	2.42	2.52	2.18	2.38
Science education	2.08	2.16	2.41	1.87	2.11
Health care	2.16	2.06	2.25	1.99	2.11

The cognitive scores of the cultural service functions in 18 administrative villages (residents of Gaosheng had been entirely relocated) were subjected to cluster analysis. The resulting spatial distribution of the cultural service functions cognized in different villages is displayed in Figure 4.

The living environment improvement function was perceived as neutral and strongly high in 17 administrative villages; the ecological improvement and wilderness protection functions were cognized as neutral and strongly high in 15 administrative villages; the folk culture popularization and science education functions were cognized as neutral and strongly high in 14 administrative villages; the health care function was cognized as neutral and strongly high in 13 administrative villages; the system governance and art inspiration functions were cognized as neutral and strongly high in 11 administrative villages; and the spiritual worship function was cognized as neutral and strongly high in 10 administrative villages. The spiritual worship function received a strongly low cognition in more administrative villages (eight) than any other function, followed by the system governance and art inspiration functions, each of which received a strongly low cognition in only seven villages. Overall, at the spatial pattern level, the residents in different communities (administrative villages) differed significantly in the cognition of different cultural service functions.

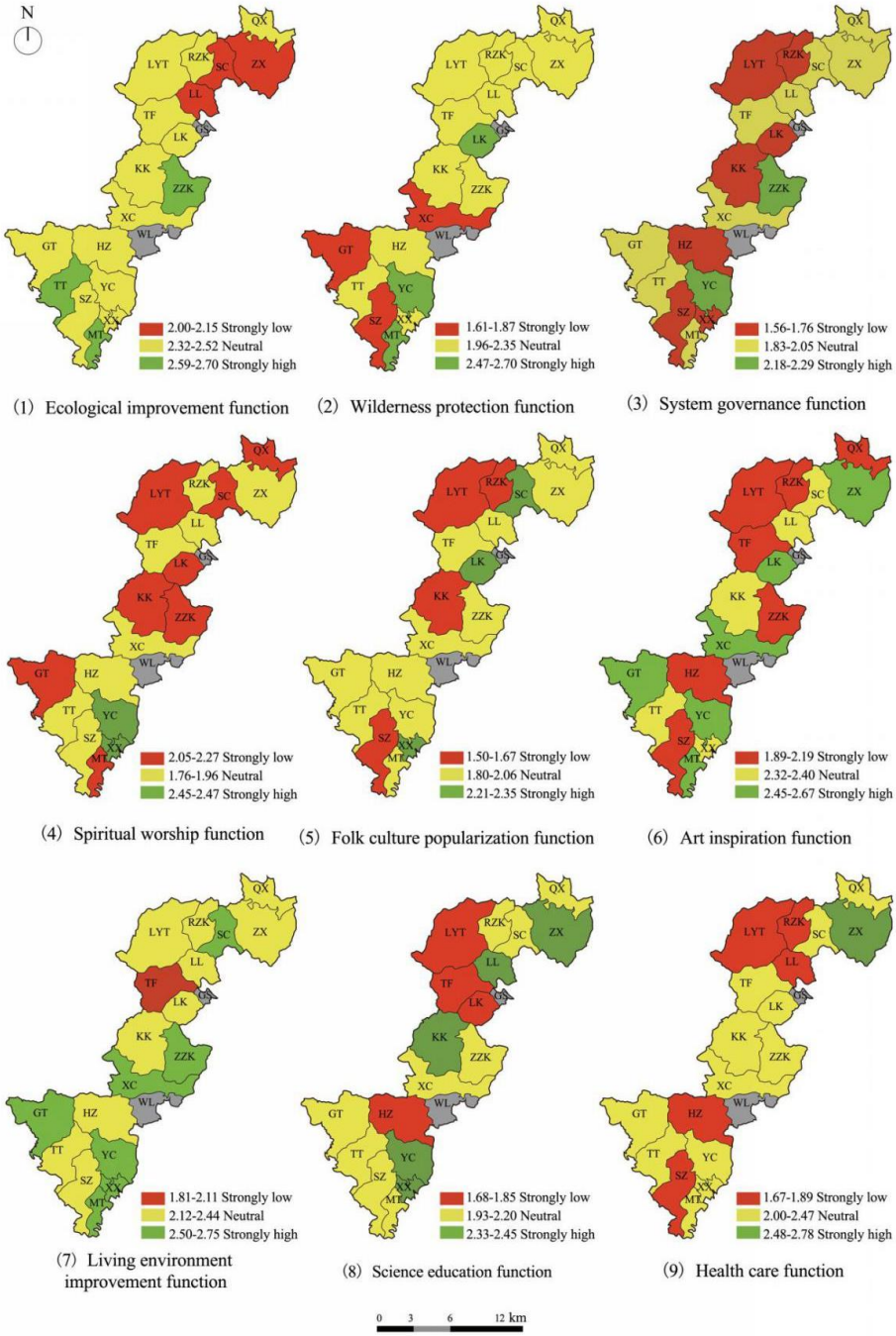

Figure 4. Spatial distribution of cultural service functions cognized by different villages. Note: the code of each administrative village is given in Table 2.

3.3. Influence of Demographics on the Cognition of Cultural Ecosystem Services

As shown in Table 5, gender had a significant impact on the respondents' cognition of the system governance function. Age prominently influenced the ecological improvement, wilderness protection, system governance, folk culture popularization, art inspiration, science education, and health care functions. Education level directly bore on the cognition of the ecological improvement, wilderness protection, system governance, spiritual worship, folk culture popularization, science education, and health care functions. Occupation had a prominent effect on the cognition of the ecological improvement, folk culture popularization, art inspiration, science education, and health care functions. The annual mean income exerted a major impact on the cognition of the ecological improvement, system governance, and science education functions.

Table 5. Influence of demographics on the cognition of cultural ecosystem services.

Demographics		Natural Experience Functions						Humanistic Concern Functions						Social Service Functions					
		Ecological Improvement		Wilderness Protection		System Governance		Spiritual Worship		Folk Culture Popularization		Art Inspiration		Living Environment Improvement		Science Education		Health Care	
		Mean	*F*	Mean	*F*	Mean	*F*	Mean	*F*	Mean	*F*	Mean	*F*	Mean	*F*	Mean	*F*	Mean	F
Gender	Male	2.45	0.14	2.10	0.08	1.95	6.49 **	2.10	0.05	1.97	2.40	2.33	2.69	2.41	0.17	2.22	0.31	2.12	1.59
	Female	2.44		2.13		1.83		2.00		1.85		2.26		2.35		1.10		2.10	
Years of residence	6–10 years	2.22	1.65	2.00	0.24	1.96	0.78	1.91	1.01	2.04	0.30	2.57	1.44	2.43	1.20	2.43	1.90	2.39	1.28
	11–20 years	2.38		2.13		2.08		2.04		1.96		2.38		2.33		2.21		2.21	
	≥21 years	2.47		2.12		1.88		2.06		1.90		2.27		2.39		2.08		2.09	
Age	≤25	2.29	6.94 ***	1.86	4.32 ***	2.07	3.58 ***	2.36	1.84	1.79	3.83 ***	2.93	3.28 **	2.71	1.93	2.86	15.80 ***	2.14	5.24 ***
	26–40	2.61		2.48		2.09		2.21		2.23		2.48		2.46		2.39		2.38	
	41–55	2.57		2.12		1.93		2.07		1.93		2.28		2.40		2.23		2.21	
	56–70	2.34		2.03		1.83		1.97		1.84		2.20		2.34		1.94		1.97	
	≥71	2.16		2.02		1.65		1.98		1.77		2.23		2.25		1.68		1.88	
Education level	Primary school and below	2.32	4.20 ***	2.01	2.50 **	1.74	4.84 **	1.89	5.42 ***	1.72	7.70 ***	2.21	1.85	2.32	1.18	1.94	6.49 ***	1.94	5.20 ***
	Junior high school	2.50		2.18		2.01		2.17		2.03		2.31		2.39		2.23		2.28	
	Senior high school and secondary technical school	2.61		2.15		2.00		2.27		2.16		2.45		2.48		2.22		2.13	
	Higher vocational school and junior college	2.67		2.48		2.14		2.14		2.14		2.52		2.57		2.52		2.38	
	Ordinary college and above	2.33		2.33		1.67		1.67		1.67		2.33		2.33		2.33		2.33	
Occupation	Farmers	2.36	3.88 ***	2.08	1.55	1.84	1.05	2.03	0.97	1.83	2.76 **	2.26	2.56 **	2.33	1.99 *	1.99	6.13 ***	2.03	2.29 **
	Individual service workers	2.58		2.22		1.90		2.08		2.02		2.25		2.41		2.20		2.21	
	Enterprise employees	2.47		2.06		2.00		2.00		2.18		2.50		2.56		2.35		2.41	
	Migrant workers	2.74		2.22		2.11		2.11		2.11		2.33		2.56		2.48		2.26	
	Students	2.13		1.63		2.00		2.00		1.88		3.00		2.75		2.88		2.00	
	Others	2.78		2.44		2.00		2.56		2.11		2.33		2.11		2.22		2.22	
Annual mean income	≤CNY 20,000	2.35	3.55 ***	2.11	0.52	1.78	3.55 ***	1.99	0.98	1.81	2.12 *	2.24	0.52	2.31	1.47	1.91	6.55 ***	2.10	0.27
	CNY 30,000—50,000	2.48		2.16		2.02		2.07		1.95		2.32		2.40		2.24		2.08	
	CNY60,000—150,000	2.57		2.05		1.91		2.17		2.07		2.35		2.46		2.24		2.18	
	CNY 160,000—300,000	2.69		2.06		1.81		2.00		2.00		2.25		2.50		2.31		2.13	
	≥CNY310,000	2.00		1.86		1.43		1.86		1.86		2.43		2.71		2.43		2.00	

Note: ***, **, and * are significance levels of 1%, 5%, and 10%, respectively.

The demographic differences in the cognition of cultural ecosystem services are summarized below: males generally perceived cultural ecosystem services better than females. Natural experience functions were the best recognized aesthetic value among those aged 26–40; the young residents at 40 and below, plus the middle-aged and elderly aged over 41, had a relatively high cognition degree of the social service functions and humanistic concern functions. The natural experience functions and humanistic concern functions were the best recognized aesthetic values among the residents who had graduated from higher vocational schools and junior colleges, while the humanistic concern functions were the best recognized functions among the residents who had graduated from senior high schools and secondary technical schools. Farmers failed to perceive any of the cultural ecosystem services highly. The ecological improvement function was the best cognized function among the respondents earning CNY 160,000–300,000 each year. System governance was the best cognized function among those with an annual mean income of CNY 60,000–150,000. The science education function was better recognized than any other function among those earning CNY 310,000–500,000 per year.

3.4. Importance of Cultural Ecosystem Service Functions

The weights of the evaluation indices for the cultural service functions were solved by the EWM (Table 6). The cognitive weights of the natural experience functions, humanistic concern functions, and social service functions were 0.3286, 0.3503, and 0.3211, respectively.

Table 6. Index weights for cognition evaluation of cultural ecosystem services of community residents.

Criteria Layer	Weight	Index Value	Index Layer	Global Weight	Intra-Class Weight	Index Value
Natural experience (B1)	0.3286	0.6885	Ecological improvement (C1)	0.0695	0.2115	0.1697
			Wilderness protection (C2)	0.1314	0.3998	0.2777
			System governance (C3)	0.1277	0.3887	0.2412
Humanistic concern (B2)	0.3503	0.7218	Spiritual worship (C4)	0.1248	0.3562	0.2561
			Folk culture popularization (C5)	0.1355	0.3867	0.2591
			Art inspiration (C6)	0.0901	0.2572	0.2066
Social service (B3)	0.3211	0.6985	Living environment improvement (C7)	0.0778	0.2421	0.1851
			Science education (C8)	0.1133	0.3529	0.2390
			Health care (C9)	0.1300	0.4050	0.2743

By the importance of each index, the three types of cultural service functions could be ranked as humanistic concern functions > natural experience functions > social service functions, whose index values were 0.6885, 0.7218, and 0.6985, respectively. On the cognition of the community residents, the humanistic concern functions are the most important cultural ecosystem service of the QNPSPA.

In terms of the natural experience functions, wilderness protection was the most important function (cognitive weight: 0.3998), followed by system governance (cognitive weight: 0.3887); ecological improvement was the most unimportant function (cognitive weight: 0.2115).

In terms of the humanistic concern functions, folk culture popularization was the most important function (cognitive weight: 0.3867), followed by spiritual worship (cognitive weight: 0.3562); art inspiration was the least important function (cognitive weight: 0.2572).

In terms of the social service functions, the first and second most important functions were health care (cognitive weight: 0.4050) and social education (cognitive weight: 0.3529); the least important function was the living environment improvement function (cognitive weight: 0.2421).

3.5. Evaluation Results on Cultural Ecosystem Service Functions

Following the FCE procedure, the FCE matrices R_{B1}, R_{B2}, and R_{B3} can be established for the natural experience, humanistic concern, and social service functions of the QNPSPA, respectively:

$$R_{B1} = \begin{bmatrix} 0.5427\ 0.3786\ 0.0613\ 0.0175\ 0.0000 \\ 0.3654\ 0.3829\ 0.1729\ 0.0591\ 0.0197 \\ 0.1947\ 0.4989\ 0.2429\ 0.0481\ 0.0153 \end{bmatrix}$$

$$R_{B2} = \begin{bmatrix} 0.3020\ 0.4486\ 0.1904\ 0.0547\ 0.0044 \\ 0.2254\ 0.4617\ 0.0394\ 0.1160\ 0.1575 \\ 0.4289\ 0.4354\ 0.1072\ 0.0197\ 0.0088 \end{bmatrix}$$

$$R_{B3} = \begin{bmatrix} 0.4902\ 0.4114\ 0.0788\ 0.0131\ 0.0066 \\ 0.3217\ 0.4661\ 0.1357\ 0.0591\ 0.0175 \\ 0.3632\ 0.3961\ 0.1554\ 0.0788\ 0.0066 \end{bmatrix}$$

Through the compound operation of the fuzzy matrices, the primary FCE sets S_{B1}, S_{B2}, and S_{B3} were obtained for the natural experience, humanistic concern, and social service functions, respectively. On this basis, the secondary FCE matrix can be constructed for the cognition evaluation of cultural ecosystem services in the QNPSPA:

$$R_B = \begin{bmatrix} S_{B1} \\ S_{B2} \\ S_{B3} \end{bmatrix} = \begin{bmatrix} 0.3366\ 0.4271\ 0.1765\ 0.0460\ 0.0138 \\ 0.3050\ 0.4503\ 0.1106\ 0.0694\ 0.0647 \\ 0.3793\ 0.4245\ 0.1299\ 0.0559\ 0.0104 \end{bmatrix}$$

Finally, the FCE set can be derived through the compound operation of the fuzzy matrices for the community residents' cognition of cultural ecosystem services:

$$S_B = K_B * R_B = (0.3392\ 0.4344\ 0.1384\ 0.0574\ 0.0306)$$

As shown in Table 7, the community residents had a moderate to high level of cognition for the cultural ecosystem service functions in the study area (3.99), according to the comments in the score set corresponding to the maximum value of the FCE set, and the principle of maximum membership of the FCE.

Table 7. Scores of cultural ecosystem service functions of community residents.

Goal Layer	Score	Criteria	Score	Index Layer	Score
Cultural ecosystem service functions (A)	3.99	Natural experience (B1)	4.03	Ecological improvement (C1)	4.45
				Wilderness protection (C2)	4.02
				System governance (C3)	3.80
		Humanistic concern (B2)	3.86	Spiritual worship (C4)	3.99
				Folk culture popularization(C5)	3.48
				Art inspiration (C6)	4.26
		Social service (B3)	4.11	Living environment improvement (C7)	4.36
				Science education (C8)	4.00
				Health care (C9)	4.03

4. Discussion

4.1. Community Residents Have Different Cognitions of QNPSPA Cultural Ecosystem Service Functions

Considering the realization of cultural functions in national parks, this study scientifically classifies the cultural ecosystem service functions of the QNPSPA from the perspective of the benefits of the community residents. Three kinds of cultural service functions were summarized, namely, natural experience, humanistic concern, and social service. Through the scientific categorization of cultural service functions, we clarified the core research objects and their basic connotations. The understanding of cultural ecosystem services among the community residents is mainly reflected by indices like the ecological improvement,

art inspiration, and living environment improvement functions. These indices are easy for the residents to understand, thanks to their intuitiveness, perceptibility, and visibility. The functions and benefits of these services can be easily perceived by people in their daily life [35]. Nevertheless, the emotional and spiritual benefits of cultural ecosystem services are usually subtle, implicit, and expressed indirectly [38]. Unlike other ecosystem services, cultural ecosystem services are difficult to be felt or seen. To understand cultural ecosystem services, one must be familiar with the ecological processes, which is no easy task for the community residents. Analysis reveals some differences between the community residents in the cognition of the cultural ecosystem service functions. These differences mainly arise from the residents' internal interests and cognition difficulty [39]. Most of the residents have lived in the QNPSPA for over 20 years. Their production and life are closely linked to the QNPSPA ecosystem; it is natural for them to emphasize the cultural service functions provided by the QNPSPA landscapes in terms of the natural eco-environment. In addition, the QNPSPA is an important ecological functional area of the Yangtze River Delta, a population stronghold and socioeconomic high ground of China. The permanent residents in this area view a good eco-environment as a high-quality resource and treat it as a significant advantage over the other areas of the Yangtze River Delta. This is consistent with the results of Ridding et al. (2018), Peng et al. (2019), and Yu (2019) [40–42].

According to the results of the structured interviews, the residents who were interviewed were generally old. Most of the young people in their families seek jobs in nearby cities, such as Hangzhou and Shanghai. The permanent residents in the community are mainly middle-aged and elderly people. The internal demand for better ecological conditions and a beautiful community environment directly affects how the respondents evaluate the functions of cultural services. The functions more in line with their needs attract more attention [43]. In this study, the community residents were interviewed deeply. The results show that, under the wild animal protection policies in the national park, the QNPSPA is overflown with wild boars, which often destroy the production spaces (e.g., farmlands and vegetable fields) of the community residents and disturb their daily life. Therefore, the cultural, ecological, and economic values of forests can promote each other and may conflict with each other. Recent studies have shown that the housing price could be improved if the houses were surrounded by forests or woods, provided that the forests or woods are not too biologically diverse and are highly accessible. Otherwise, the housing price will remain low because most residents fear wild animals [44]. With the growing need for the cultural value of the forests, the contradiction between the cultural value and ecological and economic values becomes increasingly prominent. Then, people start paying attention to the balance between the cultural, ecological, and economic values of forests [45,46].

The natural experience function is highly perceived in Suzhuang Town, but not so in Hetian Township. The wilderness protection function is highly perceived in Changhong Township, but poorly cognized in Hetian Township. The results have much to do with the natural eco-environment of the regions. Suzhuang Town, the site of the original Gutian Mountain Nature Reserve, boasts a high ecological quality. The residents of the town have a natural advantage in perceiving natural experience. By contrast, Hetian Township is densely populated and dominated by farmland. The frequent human interference drags down the perception of the residents of the natural experience function. That is why the wilderness protection function is poorly cognized in Hetian Township. The high cognition of Changhong Township dwellers is possibly due to the complex geology and landform; the unique terrain of the township leads to rich geological landscapes, including hills, valleys, rocks, cliffs, and canyons. These resources push up the perception of locals for the wilderness protection function.

The participation of community, an integral part of national parks, is crucial to the sustainable development of national parks. Community-based co-management, also known as community participatory management, community cooperative management, or community co-management, is a management mode in which local residents and the government share responsibilities and obligations. The main purpose of the mode is to achieve a win-

win between ecological protection and community sustainability. The establishment of a national park has a great impact on those who have been living in the area for a long time. It is particularly important to properly handle the interests of the community residents. Our survey reveals that Qianjiangyuan National Park Administration Bureau provided the community residents with job opportunities, such as rangers, tour conductors, and sanitary workers. The residents are therefore motivated to participate in the joint management. Nonetheless, the community residents generally have not realized their right of supervision over the construction of the national park, nor exercised their supervision power in a wide range. In fact, they have not become the master of national park management. Owing to the complex natural conditions in the study area, long-term dwellers in the region have formed the traditional cultural concept of respecting and conforming to nature, which is very conducive to the ecological protection of the national park. This concept is worthy of further examination and consideration.

4.2. Demographics Significantly Affect the Cognition of QNPSPA Cultural Ecosystem Service Functions

Cultural ecosystem services are the most direct and fastest way for the community residents to enjoy the landscape values of national parks, providing an important way to promote ecosystem management [47]. From the perspective of the landscape aesthetics benefits of the community residents, the cognition of the cultural ecosystem service functions in a national park depends heavily on gender, age, income, and other demographic features. Different cognitions will result in different ecological protection behaviors (positive or negative) for the national park [48].

Except for the years of local residence, the community residents' cognition of different cultural ecosystem service functions in the QNPSPA varied significantly with their demographic features. Among them, age significantly affects all the functions of natural experience (ecological improvement, wilderness protection, and system governance), with the p-value remaining below 0.01. Age could greatly influence service functions like health care and science education ($p < 0.01$). In semi-structured interviews, many residents expressed an unwillingness to leave their community, even if the community has some defects. This complex may be related to the age of the interviewees. According to experience, old people are more nostalgic than young people. Therefore, the construction of the QNPSPA cultural functions should focus on the age differences of the audience. For the community residents of different ages, it is important to strengthen the management of landscape forests, especially the plant landscape (a semi-natural area surrounding the community) configuration and artistic conception around the community.

Meanwhile, the community residents are mainly middle-aged and elderly people. In-depth interviews show that they are very concerned about health. From the perspective of human healthcare, it is necessary to better manage and show a tendency towards "green shower" forests in the QNPSPA. Medial research has proved the health functions of natural factors like forest volatile matters and negative oxygen ions. The forest environment plays a major role in stress relief, immunity boosting, and anxiety mitigation [49]. This study also found that the community residents of different ages vary significantly in their cognition of the health care function. Drawing on field surveys, we suggested developing the forest health and wellness industry, relying on the rich forest resources and convenient traffic of the QNPSPA. It is advised to properly plan a forest health and wellness base in the south of the QNPSPA and cultivate "green shower" forests by planting antioxidant tree species, such as camphor, camphor, metasequoia, Chinese yew, Sakura, and tea.

In addition, occupation significantly affects all the functions of social service (living environment improvement, science education, health care). The significance of the science education function was $p < 0.01$. Moreover, education level significantly affects all the functions of natural experience (ecological improvement, wilderness protection, and system governance), with the p-value remaining below 0.05. Under the premise of protecting natural resources, the audience of different occupations and education levels are recommended

to develop a batch of natural education bases to meet the needs of multiple age groups, based on existing rural schools, community parks, and outdoor activity spaces. In addition, the famous and ancient trees in the surroundings should be utilized to build new forms of science education spaces, e.g., forest classrooms and outdoor blackboard walls.

4.3. Different Cultural Ecosystem Service Functions Differ in Importance and Evaluation Score

When it comes to the importance of the cognition of the cultural ecosystem service functions, the humanistic concern functions were regarded as the most important, followed by the natural experience functions; the social service functions were considered the least important. In terms of specific functional indices, the community residents cognize different cultural service functions. The most important functions in their eyes include folk culture popularization, wilderness protection, and health care. However, the cognition degrees of these functions show that the QNPSPA has not fully mined the traditional aesthetic and cultural values. Deeper research and practice are wanted, combined with different regional functions and the distribution of cultural resources. This corresponds with Xiao's (2018) evaluation of the suitability of the QNPSPA for recreational use [50].

The interviews suggest that the community residents generally have high aesthetic requirements and cultural needs for the QNPSPA landscapes, as evidenced by the general preference for plant landscapes with rich colors and cultural connotations. In China, many ethnic groups and regions have forest culture traditions like holy mountains, divine trees, and feng-shui forests. These culture traditions crystallize the history of various ethnic groups and regions, nurture their survival, development, and growth, and play a vital role in the protection of forests and ecosystems. In India, sacred forests and temple forests symbolize the oldest forms of forest protection. With the overall degradation of forests across the country, these forests and vegetation have been well protected due to religious reasons [51]. Nonetheless, the excessive use of forest cultural services will negatively affect forest resources. This issue has piqued the interest of many scholars [52–54]. The relevant studies concentrate on the effects of tourism, outdoor sports, and other forest activities. The International Union for Conservation of Nature (IUCN) (2016) pointed out that, as outdoor leisure activities gain popularity, the impact of outdoor activities on wild animals invites more attention from those engaged in animal protection. Overall, the QNPSPA boasts a long history and profound cultural deposits. Many villages have preserved a considerable number of feng-shui forests and famous ancient trees, most of which are more than 300 years old. This reflects the value of traditional Chinese culture, and indirectly promotes the ecological protection of the QNPSPA.

More and more scholars have confirmed that various outdoor activities will affect ecosystem stability [55–58]. In addition, intensive recreational activities will cause many ecological problems [59]. Thus, people should not only pay attention to cultural services in national parks (or protected areas), but also look for ways to sustainably utilize cultural service functions, and to maintain their impact on other services. The community structure formed by ancient trees, famous woods, rare or unique tree species, and local tree species presents an ecological landscape in the region. This landscape defines the general features of the region, and may grow into the center of a specific history [60]. In the study area, ancient camphor trees are often considered to have the ability to drive away evil spirits and bless the healthy growth of infants. Thanks to this concept, many ancient camphor trees survive urban construction. Nowadays, these camphor trees retain a certain spiritual connection with residents and become a part of the local cultural landscape that attracts tourists.

According to the FCE of the QNPSPA cultural ecosystem service functions, the community residents, as major beneficiaries of the SPA policy, feel that the most effective functions are the social service functions, while the worst performing functions are the humanistic concern functions. These results directly reflect the interests of the respondents. Studies have shown that professional knowledge is necessary to evaluate cultural service functions [61]. That is why the traditional landscape aesthetics evaluations, e.g., the visual management system (VMS) of the US Forest Service, mostly adopt the expert paradigm

(one of the four major factions of American landscape aesthetic evaluation). For the above reason, this study specially investigates a group of experts who are not core stakeholders and unifies the research methodology, such that the evaluation results can be easily compared with the survey results on the community residents. To ensure the representativeness, the study mainly surveys the experts who used to research in the QNPSPA. For example, some experts are from the National Ecological Positioning Station of Qianjiangyuan Forest Ecosystem, Zhejiang A&F University, and East China Normal University. A total of 71 effective responses were collected. Through FCE, it was learned that the composite score given by the experts to the cultural service functions of the QNPSPA was 3.92, slightly lower than the score rated by residents.

Note that the score of the humanistic concern functions (3.16) was far lower than that of the natural experience functions (4.18) and social service functions (4.30). The situation echoes with the findings of Yu Fei (2019), who studied the forest culture value of Tianmu Mountain (in the same province as the QNPSPA), evaluated by a group of experts [42]. Hence, the cultural functions with rich humanistic connotations are not easily perceived by people. To a certain extent, humanistic concern functions reflect higher spiritual needs than cultural services, a mirror of social and physical attributes. It takes a long time to construct the cultural cognition of humanistic concern functions, as stated by Han et al. [62].

Culture, a product of the interaction between human activities and the natural environment, exerts an influence over the environment and human society. Cultural activities and cultural identity can improve the toughness of rural communities against external shocks [63,64]. Zhang et al. discovered that, among agricultural cultural heritages, culture maintains the stability of traditional landscapes through its attraction and resistance [65]. According to Maslow's Hierarchy of Needs, the higher the composite index of the subject cognitive level, the more difficult it is for such subjects to realize their needs. From this perspective, the community residents have a high demand for the QNPSPA cultural ecosystem services. This means the QNPSPA should step up its efforts in cultural construction.

4.4. Limitations and Future Outlook

Cultural ecosystem services are a cross-disciplinary topic. The indices of such services should be more accurate and complete. Some studies have demonstrated the action of cultural ecosystem services on human well-being, but the action is not clearly quantified. Additionally, the existing studies mostly focus on a global or national scale, failing to tackle specific national parks. What is worse, the evaluation indices are very limited [35,66]. In future, it is important to establish index systems suitable for the cultural ecosystem services of national parks by integrating multiple disciplines and to step up the research on the relationship between cultural services and other service functions and human well-being, highlighting the importance of the application of cultural ecosystem services in planning and management decision making.

The research results provide a reference for improving the management of national parks and ease the growing contradiction between people and land. Drawing on the above conclusions, the authors suggest that regional features should be highlighted in the landscape plans of villages, in the light of the culture of specific villages, and the differences between towns/townships in cultural service functions, in addition to the protection of local ecological resources. For example, Qixi Town could expand the wild alpine azalea into a plant landscape spanning thousands of mus. Referring to the architectural features of residential houses, folk culture tourism villages like Liyangtian could plant fruit trees before and behind houses, creating profound local flavors. The QNPSPA could optimize the tree species configuration in key spaces and strengthen landscape creation in cultural venues like religious sites, red education sites, and cultural public activity spaces.

5. Conclusions

Taking the QNPSPA as the study area, this paper clarifies the main types of cultural ecosystem service functions in the national park and scientifically evaluates the importance

of each function, as well as the overall level of these functions, from the angle of the community residents' functional benefits from cultural services. The main conclusions are as follows:

(1) The community residents value the benefits brought by the QNPSPA the most in terms of the ecological improvement function (2.44), and the situation is consistent across the four towns/townships. By contrast, the community residents attach the least importance in terms of its benefits to the system governance function (1.89), but the situation varies between towns/townships. Specifically, Hetian Township had the lowest cognition of the wilderness protection function (1.80), while Qixi Town had the lowest cognition of the folk culture popularization function (1.82);

(2) Except for the years of local residence, the community residents' cognition of the QNPSPA cultural ecosystem service functions may vary significantly. Among them, age and education level significantly affect all the functions of natural experience, while occupation significantly affects all the functions of social service;

(3) Concerning the importance of functional indices, the importance scores of the natural experience functions, humanistic concern functions, and social service functions are 0.3286, 0.3503, and 0.3211, respectively. Concerning the cognition of the cultural ecosystem service functions, the community residents rated the cultural ecosystem service functions in the QNPSPA as 3.99. By the principle of maximum membership, the community residents had a moderate to high level of cognition for the cultural ecosystem service functions. The different types of functions can be sorted by effectiveness as: the social service functions (4.11) > natural experience functions (4.03) > humanistic concern functions (3.86).

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Appendix A. Questionnaire of Community Residents on Cultural Ecosystem Service Functions in the Qianjiangyuan National Park System Pilot Area

Dear Sir/Madam, Hello!

We are researchers from the Chinese Academy of Forestry, and this survey will only be used for cultural ecosystem services research. Please feel free to fill in. Thank you for your cooperation.

Questionnaire number: _____; Village: _____;
Functional area: _____; Geographic coordinates:_____

I. Basic survey of community residents

(1) Gender:

□ Male □ Female

(2) Age:_____

(3) Your Education level:

□ Primary school and below □ Junior high school

□ Senior high school and secondary technical school

□ Higher vocational school and junior college □ Ordinary college and above
(4) Your occupation type:
□ Farmers □ Individual service workers □ Enterprise employees
□ Migrant workers □ Students □ Others
(5) Your annual income is:
□ ≤CNY 20,000 □ CNY 30,000-CNY 50,000 □ CNY 60,000-CNY 150,000
□ CNY 160,000-CNY 300,000 □ ≥CNY 310,000
(6) How many years have you lived here:
□ 5 years and below □ 6-10 years □ 11-20 years □ 21 years and above
II. Cognition of cultural ecosystem service functions

According to your daily living experience in the System Pilot Area, please score and evaluate your cognition of the following cultural ecosystem service functions.

Table A1. Cognition of cultural ecosystem service functions.

Cultural Ecosystem Service Functions	Cognitive Situation	Function Evaluation
Wilderness protection function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
System governance function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
Spiritual worship function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
Folk culture popularization function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
Art inspiration function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
Living environment improvement function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
Science education function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
Health care function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low
Wilderness protection function	□ strongly agreee □ agree □ strongly disagree	□ very high □ relatively high □ general □ relatively low □ very low

Note: the interpretation of cultural ecosystem services was explained by the investigators to the community residents.

Appendix B. Representative Landscape of Cultural Ecosystem Services

Figure A1. Schematic representation of representative landscapes for cultural ecosystem services.

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