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Protecting Rural Large Old Trees with Multi-Scale Strategies: Integrating Spatial Analysis and the Contingent Valuation Method (CVM) for Socio-Cultural Value Assessment

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Abstract: Governments are faced with the unique challenge of implementing large-scale and targeted protection against the global decline of large old trees. Incorporating socio-cultural values and encouraging public involvement are important parts of conservation policy. However, current studies on the socio-cultural valuation of large old trees are still limited, and how rural residents perceive the human-related value of large old trees remains largely unknown. Using a quantitative, spatial analysis and the contingent valuation method (CVM), we tried to explore a multi-scale socio-cultural valuation and protection framework based on a case study of Baoding City and Xiongan New Area in North China. The results showed that (1) the scattered large old trees in the study area were generally at a relatively younger stage, showing normal growth performance but having poor living environments. Some 96.99% of the trees resided in the countryside. Their distribution showed an agglomerative pattern with several clusters. (2) The species richness was relatively lower than that reported in urban areas. The species diversity had an obvious high–low gradient from the mountain to plain areas. Most endemic species were found in habitats of the village fringe (VF) and government/community/institutional ground (GC). (3) The mean willingness to pay (WTP) for the socio-cultural value of scattered large old trees was CNY 132.48 per year per person (1 US dollar equals about 7.2 CNY) of all the respondents, and CNY 84.30 per year per person with regard to farmers, which is relatively higher than that reported in large cities. (4) Economic income, gender, age, education level, place of residence, diameter at breast height, and tree habitat were factors that significantly influenced the WTP, among which economic income was the most significant. (5) The importance ranking of socio-cultural value connotations perceived by rural residents was as follows: spiritual attachment and homesickness > fengshui > social bond > witnessing history > education > creative inspiration. (6) The annual gross value was estimated to be CNY 349 million in the study area, and CNY 169,500 for a single tree on average. Based on the case study, a conceptual framework for socio-cultural value assessment and multi-scale protection of large old trees was proposed, which can provide references for the improvement of current conservation policies from both quantitative and qualitative perspectives, and give insights into rural revitalization strategies in China.

Keywords: large old trees; socio-cultural value; contingent valuation method; willingness to pay; spatial analysis; biocultural diversity

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Citation: Yao, N.; Gu, C.; Qi, J.; Shen, S.; Nan, B.; Wang, H. Protecting Rural Large Old Trees with Multi-Scale Strategies: Integrating Spatial Analysis and the Contingent Valuation Method (CVM) for Socio-Cultural Value Assessment. *Forests* **2024**, *15*, 18. https://doi.org/10.3390/f15010018

Academic Editor: Pablo Vergara

Received: 16 November 2023
Revised: 17 December 2023
Accepted: 18 December 2023
Published: 20 December 2023

1. Introduction

As "life-history lottery winners", large old trees have shown strong adaptiveness to environmental changes, being the most iconic organisms of human settlements, important anchors of biodiversity networks, and a substantial inheritance of ecological civilizations [1–4]. However, their global decline has been a prominent issue that needs to be addressed appropriately [5]. While clustered large old trees are mainly found as small natural features in primitive forests, scattered large old trees usually occur in human-dominated landscapes as spatially isolated individual trees. In comparison, scattered large old trees are more susceptible to a range of threats such as climate change, diseases, pests, natural disasters, poor living environments, and human disturbance [6–8]. Therefore, targeted fine-scale strategies are required for the conservation and management of this ancient natural heritage [6,9,10].

Identifying the location and growing conditions of large old trees is vital work for their strategic management. Once this information is acquired, specific measures can be taken for protection, for example, setting up guardrails and identity cards, conducting rejuvenation and pest control, etc. [11]. However, these activities are challenging for the government due to the scattered distribution and complicated situations of individual trees. Tree growth stress and influential factors need to be figured out one by one. Another way that trees may be protected is at the community level, by exploring their distribution patterns and driving factors, setting aside large reserves, and paying attention to the dynamic of key influential factors to conduction strategic protection. Such explorations have been made frequently in the literature, at different scales such as worldwide [12], nationwides [7,13], citywide [14,15], within forest parks [16], within ethnic minority settlements [17,18], and within agricultural landscapes [19], which and have provided important information for understanding and conserving of large old trees. For example, it was revealed that the distribution density of scattered large old trees in China was positively correlated with mean annual rainfall and human population density, while the distribution density of clustered large old trees was negatively influenced by human population density [7]. A few studies conducted within large- or medium-size cities in China found that the spatial distribution of large old trees showed a state of "scattered and multiple clusters" [14,20], and districts with more scenic resort and historic site (SRHS) and higher gross domestic product (GDP) tend to accommodate more heritage trees [21].

In addition to governmental protection actions, encouraging public support and participation by incorporating socio-cultural values of the large old trees is an important part of conservation policy, because it may strengthen the inherent motivation for conservation by highlighting the potential synergies in fostering biocultural diversity and natural capital circulation [17,22,23]. The concept of "socio-cultural values" is within the ecosystem services (ES) assessment framework, which consists of three domains of ecological, economic, and socio-cultural services [24,25]. The socio-cultural values provided by large old trees include aesthetic, symbolic, religious, and historic aspects [23], as well as "Fengshui", which in the Chinese tradition has symbolic meanings of health, longevity, flourishing populations, fortune, and wealth [26]. For example, a cultural mechanism was developed in Central Himalaya through an intelligent practice of locating protected tree species within sacred boundaries [27]. In this way, religious philosophy can contribute as a valuable tool for bioresources' conservation.

The contingent valuation method (CVM) is a widely used nonmarket valuation method, especially in the area of environmental economics [28,29]. By creating a questionnaire survey to assess the willingness to pay (WTP) of respondents, information about the preference-related value of non-marketed environmental goods (the socio-cultural services provided by scattered large old trees, in this case) can be generated. For example, Chen [30] conducted contingent valuation and discovered that the mean public WTP for conserving heritage trees in Guangzhou, south China, in 2013 was about CNY 24.67 per year, and CNY 31.26 per year per household (1 US dollar equals about 7.2 CNY) for common and rare heritage tree species, respectively, and economic income was the only significant factor influencing WTP; Lin et al. [31] revealed that the WTP per person for the 1000-year-old tree of Qiedong-Wang-Gong in Taichung City, Taiwan was NTD 246.80 (about CNY 55.96) CNY per year when protest responses were excluded, and that middle-aged people were likely to pay more than others. Son et al. [32] estimated that the total value of an old giant tree of

Zelkova Serrata in Gyeongju of Korea was KRW 491,503,300 (about CNY 2,660,658), including economic, aesthetic, ecological, scientific, and social value; Wang et al. [33] followed the millennium ancient banyan in Fuzhou National Forest Park, and found that its economic, historical, cultural, social and ecological value was evaluated to be CNY 1.9 billion.

By clarifying the interior value of large old trees, social concern and conservation policies such as ecological compensation and value realization of gross ecosystem product (GEP) can be promoted [34,35]. However, studies on the socio-cultural valuation of large old trees are still limited, and the factors influencing public WTP for large old tree conservation have rarely been explored. Moreover, current studies in this field have mostly been conducted in urban areas, whereas very few investigations have focused on the socio-cultural value perception of rural residents, especially farmers. Hartel et al. [36] assessed the importance of different values of scattered trees (mature and old) from oak wood pastures appreciated by traditional farmers in a rural region of Transylvania (Romania), but monetary valuation was not conducted. In China, according to the results of the second national survey of ancient and famous tree resources, among the 5.08 million old trees of China, 95.15% of them were distributed in rural areas [37]. It is therefore significant to fill the gap of how rural residents, especially Chinese farmers in rural areas, perceive the socio-cultural value of scattered large old trees.

This paper reports the findings of an integrated study of the spatial distribution and contingent socio-cultural valuation of scattered large old trees. The study is unique from previous works, as it was conducted at multiple scales, intending to support a multi-scale conservation strategy of rural large old trees from both quantitative and qualitative perspectives. We focused on a typical area in North China of the ancient city of Baoding and the adjacent national economic zone of Xiongan New Area. Our study (1) analyzed the quantitative characteristics and distribution pattern of scattered large old trees in the study area; (2) investigated public WTP for the socio-cultural value of scattered large old trees and discussed the influencing factors; and (3) estimated the multi-scale socio-cultural value of scattered large old trees. The results can contribute to providing a reference for a multi-scale strategy of large old tree conservation with up-down hierarchical and targeted protection, as well as bottom-up socio-cultural value inspiration and realization.

2. Materials and Methods

2.1. Study Area

Baoding City and Xiongan New Area is located in the northern part of the North China Plain and the central part of the Beijing–Tianjin–Hebei (BTH) region, spanning a 114°32′–116°20′ East longitude and a 38°14′–39°36′ North latitude, with a total area of about 21,089 km² (Figure 1). The overall topography is characterized by a slope from northwest to southeast, featuring middle mountains, low mountains and hills, plains, and puddle precipitation areas. The Baiyangdian Lake, which is the largest freshwater lake in the North China Plain, lies in the east. The study area is in the temperate continental monsoon climate zone characterized by four distinct seasons, the average annual temperature is about 12.6 °C, and the average annual precipitation is around 550 mm. The permanent resident population of the study area was about 11.44 million in 2020 [38].

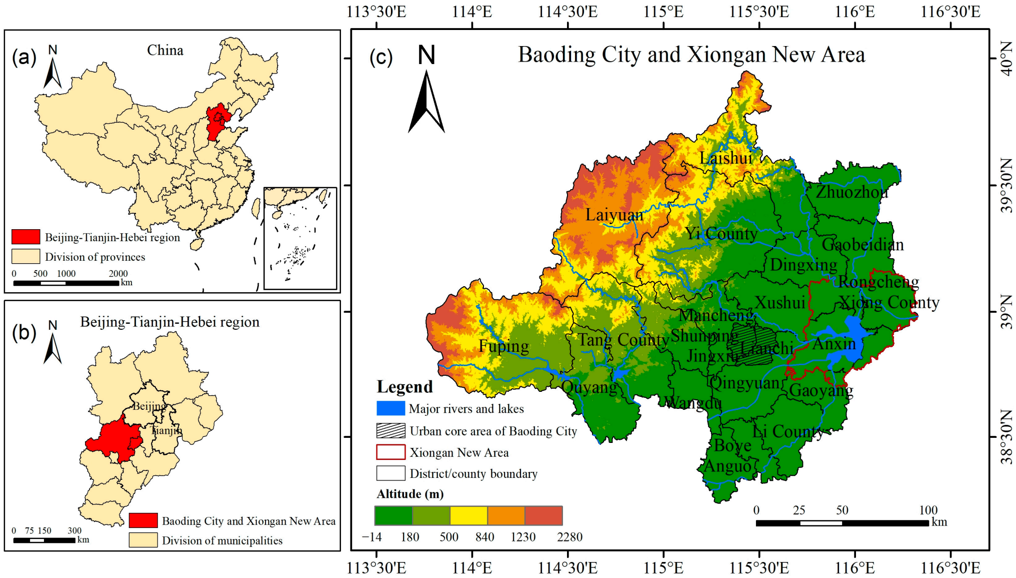

Figure 1. Overview of the study area: (**a**) Location of the Beijing–Tianjin–Hebei (BTH) region in China; (**b**) location of Baoding City and Xiongan New Area in the BTH region; (**c**) the altitude and administrative division of districts and counties of Baoding City and Xiongan New Area.

Baoding is a famous historical city with a history of more than 3000 years of civilization. It is the birth and enthronement place of the ancient Emperor Yao [39], and was the cradleland of the Yan dynasty during the Warring States period in ancient China [40]. In the modern era, Baoding has played an empirical geographic role in safeguarding the capital of Beijing. The establishment of Xiongan New Area in 2017 was a major decision made by the Communist Party of China (CPC) Central Committee, with Comrade Xi Jinping at its core, to push forward the synergistic development of the BTH region and to ease the non-capital functions of Beijing. Its planning scope involves the three counties of Xiong County, Rongcheng, and Anxin, which were formerly administrated by Baoding City, as well as part of the surrounding areas formerly administrated by Cangzhou City. We neglected the Cangzhou part in this study, as the census data of large old trees were unavailable in this area.

2.2. Data Collection

2.2.1. The Census Data

In China, two rounds of the national survey of ancient and famous tree resources were conducted in 2001 and 2015, respectively. Normative guidance for the survey includes the Chinese government's national-level document "Technical Guidelines for the Document Establishment of a General Survey of National Ancient and Famous Trees", issued in 2001, as well as the "Technical regulation for the Surveying of Old and Notable Trees", released in 2016 [37,41]. According to the above guidance and relevant articles [10,17,21], a scattered large old tree in this study was defined as a tree or shrub over 100 years of age and distributed in human-dominated landscapes (excluding national forest farms, natural forests, and protected areas). Before our study, the Baoding Forestry Department of the Natural Resources and Planning Bureau had carried out a second round of investigation of all the large old trees in the city. Investigation items included geographical location, elevation, habitat, ownership, tree species, tree age, diameter at breast height (DBH), canopy size, and growth potential, etc. The survey tools included a GPS, compass meter, tree altimeter, measuring ropes, perimeter rulers, and cameras. Tree ages were generally identified based on historical literature records or legends provided by local elders, or by empirical estimation according to tree growth parameters. Based on tree ages, three categories were classified for protection, i.e., tier 3 (100~299 years of age), tier 2 (300~499 years of age), and tier 1 ($\geq$500 years of age).

The census data of scattered large old trees in this study were derived from the official website of the Natural Resources and Planning Bureau of Baoding in May 2022 (https://zrgh.baoding.gov.cn/ (accessed on 21 May 2022)), which came from the second round of national ancient trees' investigation. The original census data were recorded in the form of investigation reports on each administrative county/district. We converted the database into point elements in ArcGIS 10.2. A geographic database including the census data of scattered large old trees and other relevant spatial data from the study area was established using the WGS_1984_Web_Mercator_Auxiliary_Sphere projection in ArcGIS 10.2, Environmental Systems Research Institute (Esri), Inc., Redlands, CA, USA.

Township-level population data of Baoding City and Xiongan New Area was obtained from the Seventh National Population Census Bulletin. To conduct village-level calculations, a publicly available China Land Cover Dataset (CLCD) land cover product [42] (2020) from Wuhan University was used. As previous researchers found that impervious surfaces had a strong linear relationship with population [43], we estimated the village-level population by distributing the total township number to each administrative village/urban street according to the weighted impervious surface area calculated based on the CLCD land cover product.

2.2.2. Questionnaire Survey

Following standard guidelines for the CVM [28], we designed a questionnaire to generate information about the perceived socio-cultural value of scattered large old trees oflocal residents (Table S1). The questionnaire starts with a brief introduction to the survey, and the main section consists of three parts. The first part gathers the respondents' demographic and socio-economic characteristics, including gender, age, occupation, education level, and personal monthly fixed income. The second part investigates the respondents' WTP for the socio-cultural value of scattered large old trees by listing six connotations used to explain what socio-cultural value means, including social bond, spiritual attachment and homesickness, fengshui, witnessing history, creative inspiration, and education [23,44,45] (Table 1). If the respondents had difficulties giving answers, semi-structured interviews could occasionally be conducted by asking about his/her life-related experiences or stories of the large old trees to remind the respondents. The third part of the survey pertains to the willingness to allocate the above amount of WTP to the six types of socio-cultural values, which represents the degree of recognition and appreciation of respondents for each of the six types of socio-cultural value connotation.

Table 1. Classification and connotations of the socio-cultural value of scattered large old trees.

Classification	Connotations
Social bond	The large old trees can facilitate social bonds by providing a place or landmark to get together, enjoy shade, and communicate [46].
Spiritual attachment and homesickness	The large old trees can witness the growth of generations and protect them like divinities, bringing spiritual attachment and nostalgia to people who leave their hometown [47].
Fengshui	The large old trees bear "fengshui" symbolism, which has the symbolic meanings of health, longevity, blessings and good fortune [44].
Witnessing history	The large old trees are "living relics" that have witnessed the local history, and there are some historical stories associated with them [48].
Creative inspiration	The large old trees can bring cultural creativity or inspiration that can appeal to our aesthetic sentiments, for example, drawing, photographing, and short video creation on social media, etc. [49].
Education	The large old trees can be used as a good subject for conducting scientific research, popular science activities, or liberal education [22].

Considering the workload and disparity of socio-cultural backgrounds in the study area, we selected Laiyuan County, the urban core area of Baoding City, and Xiongan New Area as three typical territories on which to conduct a random sampling of scattered large old trees for the questionnaire survey. A total of 56 large old trees were randomly chosen in ArcGIS 10.2 using a tool for the random sampling of point elements (Figure S1, 40 in Laiyuan County, 2 in the urban core area of Baoding City, and 14 in Xiongan New Area). These 56 trees are intended to represent the total 2062 scattered large old trees for the investigation of the socio-cultural perceptions of local residents. The field investigation was conducted in October of 2022, and April to May of 2023. For each visited tree, 15~25 residents nearby were asked to fill out the questionnaires. A total of 1114 respondents were approached, and it took about 15~20 minutes for each respondent to complete the questionnaire on average. After investigation, the collected questionnaires were visually screened to ensure integrality and reliability.

2.3. Statistical and Spatial Analysis of the Scattered Large Old Trees

Firstly, descriptive statistics of the species' composition and growth indicators were obtained to figure out the structural background of the large old tree community. Adjusted species richness [50] was calculated using the following equation:

$$D = \frac{N}{\ln A} \tag{1}$$

where D is the modified species diversity index, N is the number of total species for a given region, and A is the area of the region.

Secondly, three indicators of the nearest neighbor index, kernel density estimation, and Lorenz curve were calculated to reveal the distribution pattern of the scattered large old trees at the county/district level.

The nearest neighbor index (R) is defined as the ratio of the actual nearest neighbor distance to the theoretical nearest neighbor distance [14]. Here, it was used to discover the distribution patterns (including random, uniform, or cohesive) of scattered large old trees in Baoding City and Xiongan New Area. "Average Nearest Neighbor" in ArcGIS Toolbox 10.2 was used for calculation, and the formula is as follows [14]:

$$R = \frac{\overline{R_i}}{\overline{R_{\overline{E}}}} \tag{2}$$

$$\overline{R}_E = \frac{1}{2\sqrt{m/A}} = \frac{1}{2\sqrt{D}} \tag{3}$$

where, $\overline{R_i}$ represents the average of the distance between each point and its nearest neighbor; $\overline{R}_{\overline{E}}$ is the theoretical nearest neighbor distance when the point-like elements are randomly distributed; m represents the number of point elements; A represents the study area; and D represents the number of point elements per unit area. When R = 1, the point elements tend to be randomly distributed; when R > 1, the point elements tend to be uniformly distributed; when R < 1, the point elements tend to be cohesively distributed.

The kernel density analysis is often used to estimate the unknown density function, which can reveal the density of the neighborhood around each point element [51,52]. The higher its spatial point density, the greater the probability of occurrence in this spatial region, which can visually reflect the degree of concentration and dispersion of large old trees. The "Kernal Density Estimation" function in ArcGIS Toolbox 10.2 was used in this study, and the formula is as follows [51]:

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right) \tag{4}$$

where k is the kernel density function; h is the bandwidth; n is the number of points in the range of values; and $(x - x_i)$ denotes the distance from the valuation point x to event x_i.

The Lorenz curve method measures fairness, which uses a curve drawn by frequency accumulation to portray its degree of inequality (concentration or dispersion) [53]. In this study, the Lorenz curve was plotted in Excel. The degree of deviation between the Lorenz curve and the uniform distribution line was used to determine whether the distribution of scattered large old trees in each district and county was balanced.

Thirdly, the distribution of scattered large old trees at the habitat level was analyzed in a combined consideration of the census data, field investigation, and literature reviews. The habitats of scattered large old trees in the study area were classified into seven categories, including government/community/institutional ground (GC), residential district (RD), temple (TE), village fringe (VF), scenic resort/historic site (SRHS), hillside (HI), and cemetery (CE). The number of trees in each habitat was calculated.

Fourthly, a downtrend correspondence analysis was conducted to demonstrate species distribution properties. DCA is derived from CA (correspondence analysis). But DCA eliminates the "arch effect" by ordering old growth habitats so that similar species are close together and dissimilar species are farther apart within the same sample, thus revealing the ecological relationships between species and their environments [21,41,54]. The results of the DCA analysis plot the species or environment on two axes, each corresponding to a dimension in space [55]. In this study, we conducted the DCA analysis using the Canoco 5.0 software, Microcomputer Power Corporation, Ithaca, NY, USA. A counties/districts $\times$ species matrix and a habitats $\times$ species matrix were established to analyze the species distribution of scattered large old trees in the study area.

2.4. Contingent Valuation and Driving Factor Analysis

Based on the results of the questionnaire survey, a comparative analysis of mean WTP and the significance of differences within groups of respondents from different backgrounds was conducted. Meanwhile, the corresponding divided WTP of each socio-cultural connotation was also analyzed in groups. The descriptive statistical analysis of the data was conducted using IBM SPSS Statistics 26, International Business Machines Corporation, Armonk, NY, USA.

Three regression models including Model 1 (ordered logit), Model 2 (ordered probit), and Model 3 (random forest) were tested to explore the effects of different factors on residents' WTP for the socio-cultural value of scattered large old trees. A total of 12 independent variables were selected for model analysis, including demographic characteristics of gender, age, education level, occupation, personal monthly fixed income, and place of residence, as well as tree characteristics of species, grade of tree age, height, diameter at breast height (DBH), canopy size, and habitat. In addition to three continuous variables of tree height, DBH, and canopy size, the description and coding of nine categorical variables with a range of attribution levels can be found in Table S2.

The ordered logit and probit models are both regression models for an ordinal response variable based on cumulative probabilities [56]. The difference between the two models is that the random disturbance of the logit model is assumed to be a cumulative standard logistic distribution, while the probit model is assumed to be a cumulative standard normal distribution. Both of the two models have been widely used for influential factor studies [57,58]. It has been observed in a former study that the effect of excluding protest responses on the economic valuation of large old trees is relatively low [59]. Therefore, samples of WTP = 0 in this study were excluded during the regression analysis, considering that only 2.31% of the respondents gave protest responses or had no economic ability during the survey. The dependent variable of WTP was classified into six categories of CNY 1~5, 5~10, 10~50, 50~100, 100~500, and >500, numbered from 1 to 6. The two models of ordered logit and probit were established using Stata 17 software.

Random forest is a flexible, easy-to-use machine learning algorithm that can be used for classification and regression tasks, and is one of the most commonly used algorithms in influential factors studies [60,61]. Random forest randomly selects some of the variables each time it creates a model, so the correlation between variables has less impact on model accuracy. In this study, it was used to further explore the importance of influential factors in determining residents' WTP. The simulation was conducted using the "randomForest" function of the "randomForest" package in R for windows 4.2.2. The importance of independent variables can be revealed via the node impurity among the modeling results, which is weighted by the probability of reaching that node [62].

2.5. Multi-Scale Socio-Cultural Value Assessment

Based on our survey data, an average WTP/person/tree can be generated. We assumed that the socio-cultural value provided by the scattered large old trees was within the village/urban street area wherein they were located. This is because most of the scattered large old trees in the study area were located in the countryside, and 90.9% of the trees were collectively owned by the village (64.1%) or state-owned (26.8%), while the remaining 9.1% were privately owned. So, firstly, we calculated the village-level gross socio-cultural value (V) according to the following formula:

$$V = \overline{WTP} \times P \times n \quad (5)$$

where $\overline{WTP}$ is the average willingness to pay; P is village population; and n is the number of scattered large old trees in that administrative village/urban street.

The $\overline{WTP}$ in this study was only generated in the three districts of Laiyuan County, the urban core area of Baoding City, and Xiongan New Area. The social economic development level of the left counties was more similar to that of Laiyuan County, and the $\overline{WTP}$ of Laiyuan was used as a substitute in the left areas.

Secondly, township-level gross value was collected based on the above results; thirdly, county/district-level gross values were further generated. The distribution of the multi-scale socio-cultural value of scattered large old trees was plotted using ArcGIS 10.2.

3. Results

3.1. Community Characteristics and Spatial Distribution of the Scattered Large Old Trees in the Study Area

3.1.1. Community Characteristics

A total of 2062 scattered large old trees were identified in Baoding City and Xiongan New Area, belonging to 52 species, 35 genera, and 22 families (Table 2). The ratio of evergreen species and deciduous species was 7:45, and the adjusted species richness was 5.22. At the family level, *Pinaceae*, *Cupressacea*, and *Papilionacea* were the most abundant, accounting for 22.36%, 14.45%, and 14.21% of the total scattered large old trees, respectively. At the genus level, *Pinus*, *Sophora*, and *Platycladus* appeared the most frequently, accounting for 21.77%, 14.21%, and 14.11% of the total, respectively. At the species level, *Pinus tabulaeformis* Carr., *Sophora japonica* L., *Platycladus orientalis* (L.) Franco, *Diospyros kaki* Thun., and *Ziziphus jujuba* Mill. ranked at the top, accounting for 21.29%, 14.21%, 14.11%, 12.17%, and 11.01% of the total, respectively (Tables S3 and S4).

Table 2. Family ranking of scattered large old trees in Baoding City and Xiongan New Area.

Rank	Family	Number of Genera	Number of Species	Number of Trees	Percentage of Trees (%)
1	*Pinaceae*	2	4	461	22.36
2	*Cupressaceae*	3	4	298	14.45
3	*Papilionaceae*	1	1	293	14.21
4	*Ebenaceae*	1	2	256	12.42
5	*Rhamnaceae*	1	2	231	11.20
6	*Rosaceae*	3	5	215	10.43
7	*Fagaceae*	2	5	99	4.80
8	*Salicaceae*	2	5	42	2.04
9	*Anacardiaceae*	1	1	29	1.41
10	*Ulmaceae*	3	3	29	1.41
11	*Juglandaceae*	1	3	24	1.16
12	*Leguminosae*	3	3	20	0.97
13	*Bignoniaceae*	1	1	16	0.78
14	*Oleaceae*	3	4	12	0.58
15	*Moraceae*	1	1	12	0.58
16	*Aceraceae*	1	2	10	0.48
17	*Simaroubaceae*	1	1	5	0.24
18	*Ginkgoaceae*	1	1	4	0.19
19	*Meliaceae*	1	1	3	0.15
20	*Elaeagnaceae*	1	1	1	0.05
21	*Solanaceae*	1	1	1	0.05
22	*Sapindaceae*	1	1	1	0.05
23	Total	35	52	2062	100.00

As shown in Table 3, most of the scattered large old trees in the study area were 10~20 m in height, lower than 1 m in DBH, less than 10 m in canopy size, and aged 100~299 years in Tier 3. The growth performances were generally normal, but the living environments were not promising, with more than 80% of the trees more or less living under environmental stress. Some examples of these stresses are extensive impervious cover around the trees, human disturbance, severe tree diseases, or natural damage without rejuvenation strategies, which represent a challenging management task for the future.

Table 3. Growth conditions of scattered large old trees in Baoding City and Xiongan New Area.

Statistical Items	Quantitative/Qualitative Categories	Number of Trees	Percentage of Trees (%)
Tree height	≤10 m	943	45.73
	10~20 m	1008	48.88
	≥20 m	111	5.38
Diameter at breast height (DBH)	<1 m	1905	92.39
	≥1 m	157	7.61
Canopy size	≤10 m	1370	66.44
	10~20 m	642	31.14
	≥20 m	50	2.42
Grade of tree age	Tier 1 (≥500 years)	109	5.29
	Tier 2 (300~499 years)	173	8.39
	Tier 3 (100~299 years)	1780	86.32
Growth potential	Normal	1977	95.88
	Weak	73	3.54
	Endangered	12	0.58
Living environment	Poor	31	1.50
	Fair	1649	79.97
	Moderate	382	18.53

3.1.2. Spatial Distribution

The result of nearest-neighbor index calculation of scattered large old trees in the study area is illustrated in Figure 2. It shows that the nearest-neighbor ratio was 0.330784 (less than 1), which means the distribution pattern of scattered large old trees in the study area was agglomerative. The *p*-value and z-score manifested that the probability of randomly generating this clustering pattern was less than 1%.

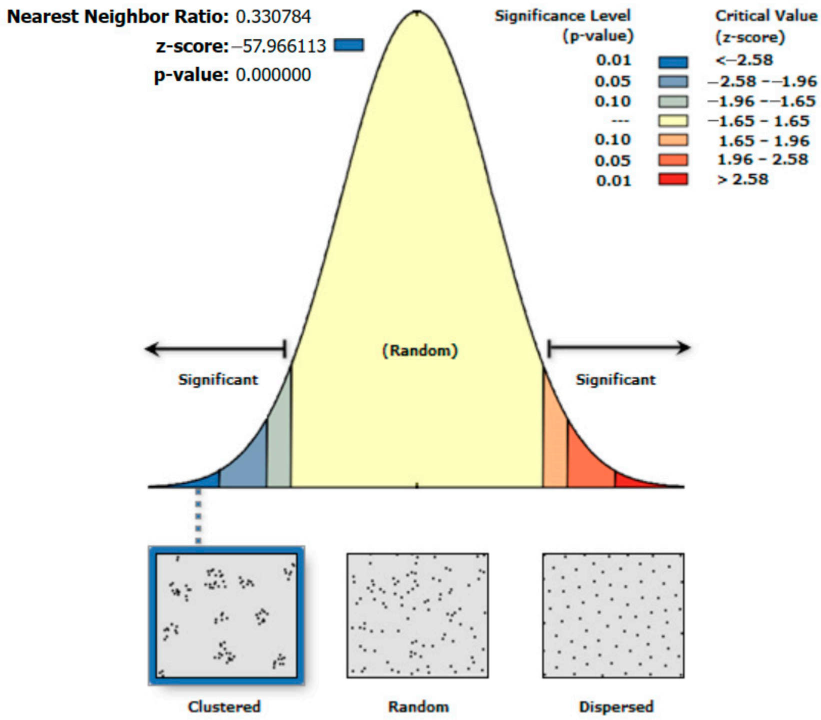

Figure 2. Nearest neighbor index of scattered large old trees in Baoding City and Xiongan New Area.

The distribution pattern of scattered large old trees in the 23 counties/districts of Baoding City and Xiongan New Area is further demonstrated in Figure 3. The kernel density estimation result within a 30 km search radius is shown in Figure 3a. We found a high-density agglomeration center in Yi County, with a kernel density of 0.27–0.40 plants/km^2, and three sub-agglomerations in Laiyuan County, Quyang County, and Xiong County, with a kernel density of 0.09–0.15 plants/km^2, showing a significant regional difference in the abundance of scattered large old trees. The hot spot in Yi County was located at the Western Tombs of Qing Dynasty, which is a famous scenic resort and historic site; therefore, more heritage trees were protected and reserved at this place.

The Lorenz curve and tree density in each county/district are displayed in Figure 3b. These show that the deviation of Lorenz from the uniform distribution line was obvious, indicating that there was an uneven distribution of scattered large old trees. Among them, Yi County, Quyang County, Laiyuan County, and Xiong County had more heritage trees, with a combined proportion of 71.78%. However, Yi County, Xiong County, and Lianchi District ranked the highest in tree density, at 0.20, 0.19, and 0.17 trees/km^2, respectively. The mean density of scattered large old trees in the whole study area was 0.10 trees/km^2.

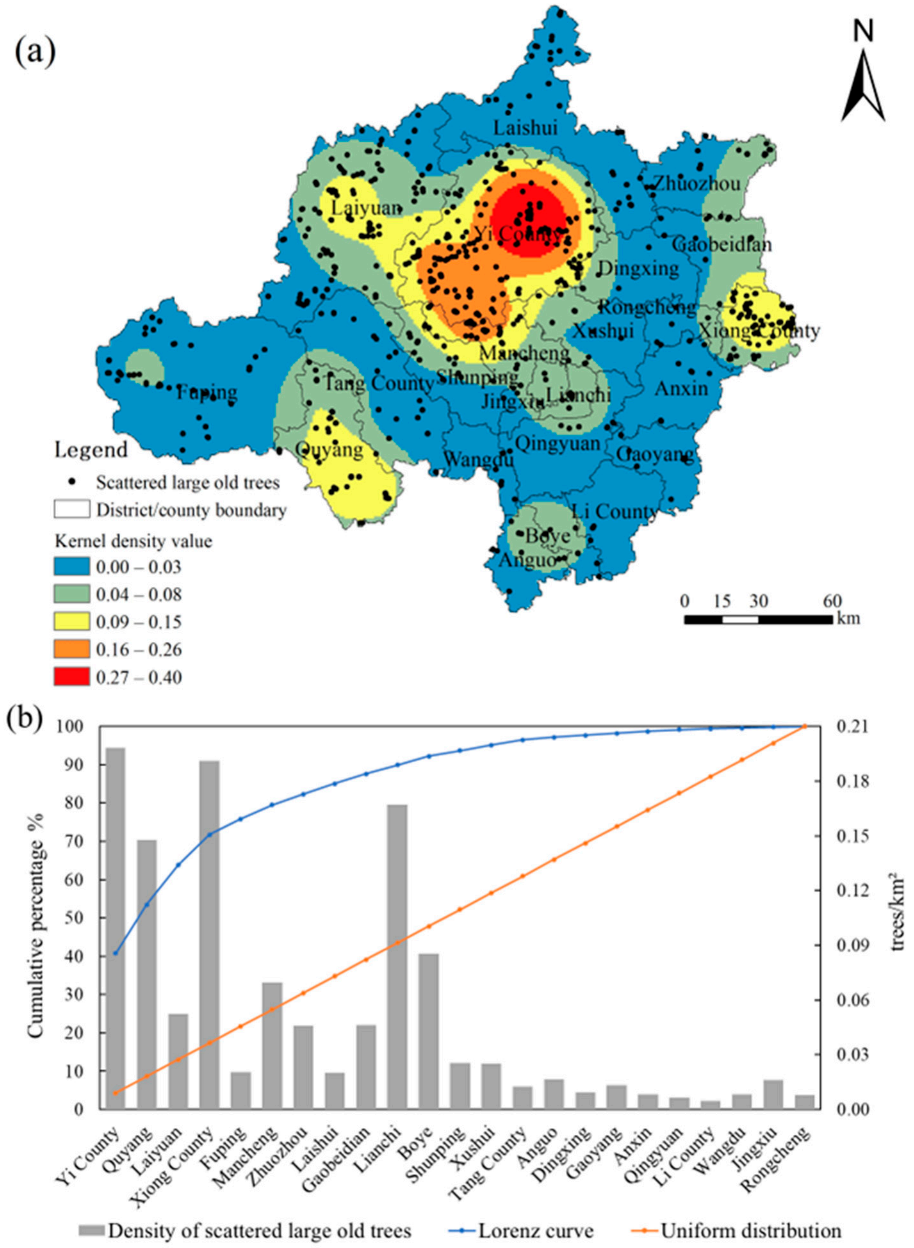

Figure 3. Distribution pattern of scattered large old trees in the 23 counties/districts of Baoding City and Xiongan New Area: (**a**) kernel density estimation; (**b**) Lorenz curve and regional tree density.

According to the census data, 96.99% of the scattered large old trees in the study area reside in the countryside. As displayed in Figure 4, the greatest number of scattered large old trees were found in the village fringe (VF), government/community/institutional ground (GC), and scenic resort/historic sites (SRHS), accounting for 35.2%, 21.1%, and 19.7%, respectively; meanwhile, the lowest number were found in cemetery in folk (CE), residential district (RD), and temple (TE). The distribution seemed to be negatively corelated with the degree of privacy of the habitats.

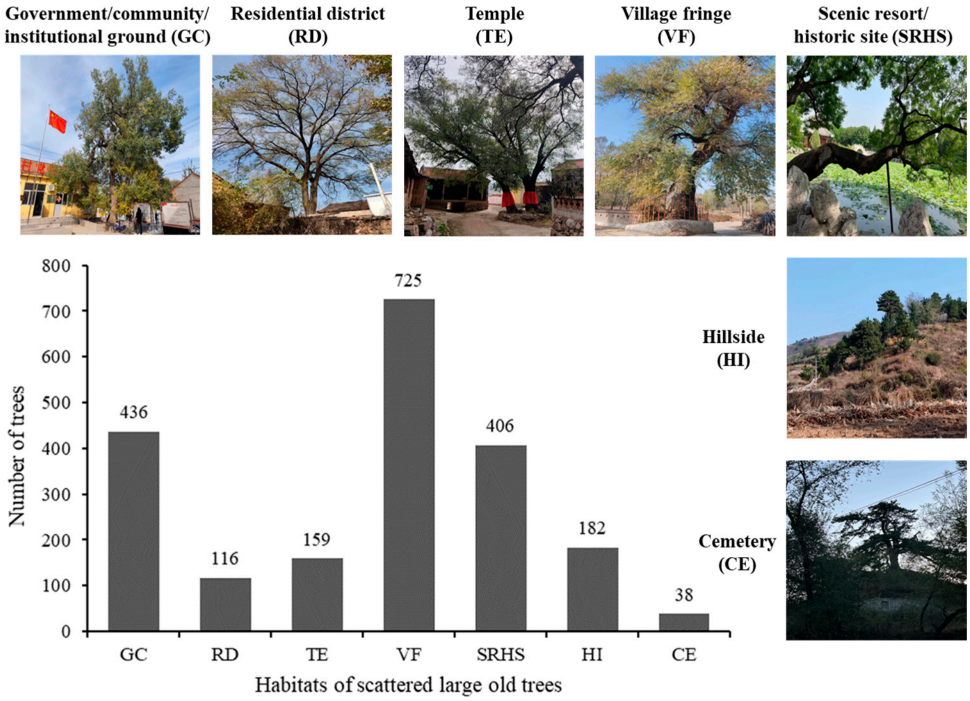

Figure 4. Habitat distribution of scattered large old trees in Baoding City and Xiongan New Area. (photos taken by the authors during the survey).

The species distribution of scattered large old trees by districts/counties in the study area is shown in Figure 5a, with DCA explaining 88.03% of the total variance (51.79% for axis 1 and 36.23% for axis 2). Overall, the distribution varied considerably among the 23 districts/counties, and had an obvious gradient differentiation from the mountain to plain areas. Fewer species were found in the plain areas probably due to a lower tree density. Moreover, it was found that only one tree species, *Sophora japonica* Linn., appeared in all of the 23 districts and counties. In addition, 70% of all the districts or counties had their unique tree species, among which Yi County had the most, including *Acer trumcalum*, *Armeniaca sibirica* (L.) Lam., *Castanea mollissima* BL., and another five species, followed by Laiyuan, with *Juniperus rigida* S. et Z., *Koelreuteria Paniculata* Laxm., *Populus cathayana* Rehd., and four other species.

The species distribution of scattered large old trees by habitats is shown in Figure 5b, with DCA explaining 45.65% of the total variance (39.18% on axis 1 and 6.47% on axis 2). More species appeared in the village fringe (VF) and on government/community/institutional ground (GC), and government/community/institutional ground (GC) had the most unique tree species, including *Juglans hopeiensis* Hu, *Juniperus rigida* S. et Z., *Melia azedarach* Linn., *Pteroceltis tatarinowii* Maxim., *Wisteria sinensis* (Sims) Sweet and *Ziziphus jujuba* Mill. var. spinosa (Bunge) Hu ex H.F. Chow. *Pinus tabulaeformis* Carr., *Platycladus orientalis* (Linn.) Franco and *Sophora japonica* Linn. were found in all seven habitats. Two unique species were found in residential districts (RD), temples (TE), scenic resort/historic sites (SRHS), and the village fringe (VF), respectively, and only one unique species of *Koelreuteria paniculata* Laxm was found in hillside (HI) habitat. *Pinus tabulaeformis* Carr. was the dominant species of scenic resort/historic sites (SRHS) and cemeteries (CE); and *Platycladus orientalis* (Linn.) Franco. was the dominant species in the temples (TE) and hillsides (HI). These two evergreen species were typical culturally representative species not only due to their ornamental, stress-tolerance properties, but also because they symbolized the eternal spirit of the deceased [63]. The dominant species of government/community/institutional ground (GC) was *Sophora japonica* Linn, which usually provides a place for residents to relax and shade.

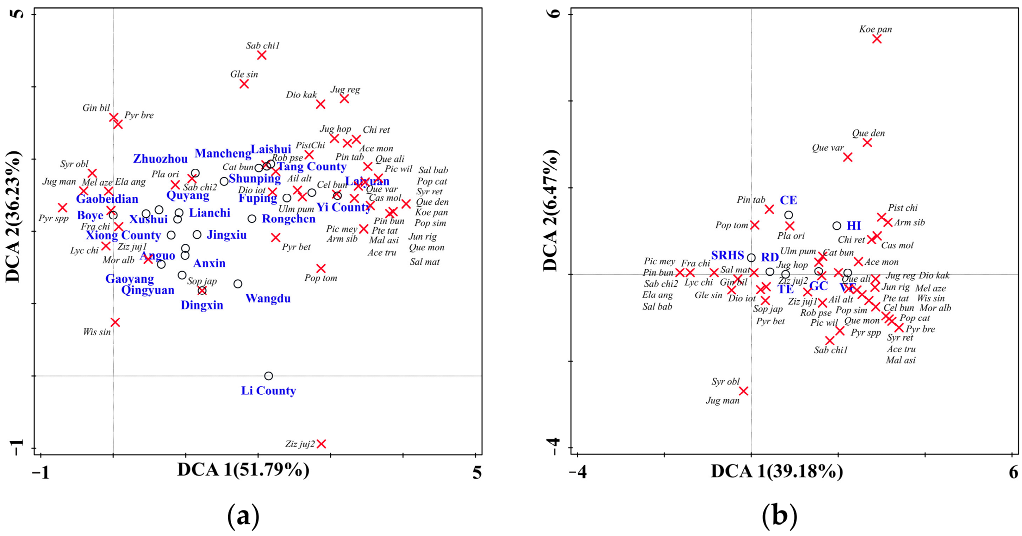

Figure 5. The first two axes of the DCA ordination of environments and the composition of scattered large old tree species in Baoding City and Xiongan New Area. Districts and habitat types are presented as circles, and species as crosses. (**a**) DCA results for 23 districts and tree species; (**b**) DCA results for 7 habitats and tree species. Note: Please refer to Table S5 in the Supplementary Materials for the abbreviated species names. Abbreviated habitat categories: GC, government/community/institutional ground; RD, residential district; TE, temple; VF, village fringe; SRHS, scenic resort/historic site; HI, hillside; and CE, cemetery.

3.2. Socio-Cultural Valuation of the Scattered Large Old Trees by Local Residents and a Driving Factors Analysis

3.2.1. The Average WTP of Respondents for the Socio-Cultural Value of Scattered Large Old Trees

Among the 1114 questionnaires we issued, 1082 (97.13%) valid samples were collected, and 25 (2.31%) of the valid samples were counted as objectors, as they were unwilling to pay or could not pay for economic reasons. All the valid responses were included for a statistical analysis of the average WTP of respondents of different backgrounds (Table 4). The analysis showed that the mean WTP of males was significantly higher than that of females. The mean WTP of young and middle-aged (18~60 years old) respondents was much higher than others, and 49.82% of our respondents were over 60 years old. Regarding education levels, it seemed that respondents with a higher education level were more willing to pay for scattered large old trees' conservation, and the mean WTP of respondents with postgraduate degrees or higher even reached CNY 1112.00. The mean WTP of respondents that worked as corporate staff was the highest among occupations. But a majority of the respondents we encountered were farmers (67.47%), and their average WTP was CNY 84.30. Respondents with higher incomes generally had more WTP, except for the interval of 1000~1500, which was mainly caused by three particular cases that were willing to pay CNY 2000, 3000, and 5000, as we found. The average WTPs of respondents in the three investigated areas did not show a significant difference, but the mean WTP in Xiongan New Area was relatively lower than others, probably affected by ongoing large-scale reconstruction [64].

Table 4. Statistics of the average willingness to pay (WTP) of respondents for the socio-cultural value of scattered large old trees.

Variables	Categories	Proportion of Respondents (%)	Average Willingness to Pay (WTP) (CNY /Person/Tree)	*p* Value of Significance Test of Group Difference	Divided WTPs for Different Connotations of the Socio-Cultural Value (CNY /Person/Tree)					
					Social Bond	Spiritual Attachment and Homesickness	Fengshui	Witnessing History	Creative Inspiration	Education
Gender	Male	56.84	169.72 ± 30.58	0.022 *	28.26 ± 4.39	**51.80 ± 17.25**	38.96 ± 0.36	25.27 ± 6.19	11.18 ± 1.74	13.98 ± 2.80
	Female	43.16	83.45 ± 15.92		18.33 ± 4.31	**21.00 ± 3.65**	13.66 ± 0.09	15.61 ± 5.29	6.97 ± 1.63	8.23 ± 2.49
Age	Under 18 years old	2.03	61.86 ± 10.45	0.001 **	12.39 ± 4.20	10.10 ± 2.38	9.30 ± 2.62	**15.51 ± 5.24**	7.00 ± 2.20	7.58 ± 2.65
	18–40 years old	13.68	255.05 ± 76.03		43.83 ± 9.86	**72.75 ± 22.88**	42.36 ± 18.52	52.24 ± 19.27	19.91 ± 4.92	23.95 ± 7.25
	41–60 years old	34.47	185.34 ± 42.08		29.64 ± 6.53	**61.03 ± 27.19**	44.36 ± 12.82	25.59 ± 8.53	10.55 ± 2.01	13.77 ± 3.82
	Over 60 years old	49.82	65.13 ± 10.63		**15.06 ± 3.32**	14.68 ± 1.71	13.58 ± 1.80	9.67 ± 2.74	5.74 ± 1.45	6.66 ± 1.95
Education level	Primary school	43.53	106.34 ± 26.70	0.000 ***	18.82 ± 4.34	**39.11 ± 21.32**	18.85 ± 4.00	12.39 ± 3.44	7.95 ± 1.96	9.53 ± 3.22
	Middle/high school	48.71	113.03 ± 21.03		22.85 ± 4.28	25.77 ± 3.33	**28.77 ± 8.49**	18.42 ± 5.89	7.62 ± 1.07	9.33 ± 1.75
	Bachelor's degree	7.30	356.09 ± 128.36		50.11 ± 13.20	**101.31 ± 38.78**	78.32 ± 35.34	65.38 ± 26.23	29.34 ± 9.20	31.62 ± 11.98
	Postgraduate degree or higher	0.46	1112.00 ± 974.42		214.68 ± 196.58	331.98 ± 292.69	22.98 ± 14.00	**424.48 ± 394.25**	10.40 ± 7.50	107.48 ± 98.16
Occupation	Student	3.60	67.46 ± 9.13	0.000 ***	15.04 ± 3.34	**18.25 ± 3.51**	6.54 ± 1.44	15.91 ± 4.21	5.15 ± 1.28	6.58 ± 2.05
	Corporate staff	2.77	554.80 ± 329.31		87.99 ± 30.85	**152.16 ± 98.75**	124.04 ± 89.87	102.28 ± 66.30	37.38 ± 21.10	50.95 ± 30.22
	Civil servant/institutional officer	2.87	359.03 ± 161.45		64.59 ± 34.16	**111.75 ± 50.08**	35.52 ± 16.49	91.43 ± 64.11	20.91 ± 5.87	34.84 ± 16.41
	Self-employed	6.65	121.81 ± 24.75		20.17 ± 6.49	**32.32 ± 7.65**	13.20 ± 3.11	29.37 ± 7.23	13.95 ± 4.24	13.36 ± 3.95
	Retiree	3.51	99.21 ± 35.68		20.09 ± 7.03	**28.63 ± 13.21**	16.97 ± 10.53	24.37 ± 11.43	5.42 ± 1.71	3.73 ± 1.10
	Unemployed	7.30	75.41 ± 20.44		16.91 ± 5.88	16.63 ± 4.00	**18.96 ± 7.50**	7.74 ± 2.57	10.25 ± 4.12	4.92 ± 2.04
	Farmer	67.47	84.30 ± 10.07		16.51 ± 1.96	20.25 ± 2.26	**23.15 ± 3.73**	9.58 ± 1.49	6.29 ± 1.02	8.46 ± 1.96
	Other	5.82	522.25 ± 232.60		80.97 ± 40.60	**212.90 ± 158.86**	83.69 ± 63.38	89.81 ± 51.75	24.62 ± 11.26	30.27 ± 16.06
Personal monthly fixed income	0–200	28.84	45.94 ± 4.75	0.000 ***	11.06 ± 1.52	**11.07 ± 1.20**	10.98 ± 1.88	5.36 ± 0.83	4.83 ± 1.28	3.84 ± 0.61
	200–500	17.38	56.67 ± 9.11		11.26 ± 2.22	14.75 ± 2.51	**16.92 ± 3.65**	5.17 ± 0.86	3.98 ± 1.16	4.58 ± 0.93
	500–1000	16.45	80.56 ± 15.08		**18.94 ± 3.34**	17.43 ± 3.40	16.86 ± 5.75	8.23 ± 1.93	6.32 ± 1.69	13.29 ± 4.80
	1000–1500	6.65	241.44 ± 85.24		46.34 ± 16.82	55.23 ± 17.68	**80.38 ± 30.85**	23.25 ± 11.10	15.71 ± 7.26	19.97 ± 15.27
	1500–2000	6.10	80.58 ± 18.59		14.12 ± 3.03	**17.68 ± 4.23**	10.56 ± 3.05	13.81 ± 5.01	10.47 ± 3.50	6.82 ± 2.28
	2000–3000	10.63	187.23 ± 47.68		38.62 ± 14.83	**40.50 ± 6.93**	32.40 ± 8.10	36.24 ± 12.50	19.05 ± 6.50	20.44 ± 9.03
	3000–5000	8.04	217.41 ± 61.35		41.11 ± 12.85	56.17 ± 18.49	21.39 ± 5.76	**58.17 ± 23.78**	15.07 ± 3.88	25.51 ± 6.92
	≥5000	5.91	638.59 ± 263.04		73.59 ± 33.96	**275.74 ± 162.02**	135.32 ± 74.72	107.91 ± 55.81	22.32 ± 9.92	24.33 ± 14.11
Place of residence	Laiyuan County	71.44	142.27 ± 25.15	0.604	26.28 ± 4.06	**40.10 ± 13.71**	32.70 ± 7.17	20.08 ± 5.20	9.93 ± 1.62	13.17 ± 2.58
	Urban core area of Baoding	4.90	151.89 ± 93.76		26.74 ± 18.81	43.78 ± 28.18	6.50 ± 1.66	**53.65 ± 37.57**	7.88 ± 1.50	13.34 ± 9.41
	Xiongan New Area	23.66	98.91 ± 11.14		16.43 ± 2.80	**32.61 ± 4.27**	18.42 ± 3.43	17.42 ± 2.79	7.97 ± 1.54	6.06 ± 1.19
Total	-	100.00	132.48 ± 18.73		23.97 ± 3.11	**38.51 ± 9.94**	28.04 ± 5.19	21.10 ± 4.19	9.36 ± 1.21	11.50 ± 1.92

t statistics with * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$. Mean ± standard error. The top-valued socio-cultural connotation was emphasized in bold.

As revealed in Table 4, the overall mean WTP for the socio-cultural value of scattered large old trees in the study area was CNY 132.48 per year per person. The divisions of WTP following six types of socio-cultural value connotations were ranked as follows: spiritual attachment and homesickness (38.51) > fengshui (28.04) > social bonds (23.97) > witnessing history (21.01) > education (11.5) > creative inspiration (9.36). Respondents over 60 years old attached more importance to the "social bond" connotation that was closely related to their casual activities of shading and gathering under the trees. In addition, though "spiritual attachment and homesickness" was appreciated by most of the respondents, farmers valued "fengshui" most in their perceptions.

3.2.2. Factors Determining Local Residents' WTP for the Socio-Cultural Value of Scattered Large Old Trees

As displayed in Table 5, factors determining local residents' WTP for the socio-cultural value of scattered large old trees were consistent based on the results of Model 1 (ordered logit) and Model 2 (ordered probit). Gender, age, and personal monthly fixed income showed extremely significant correlations to WTP, which means that male, younger, and higher-income residents were willing to pay more. The other significant factors were education level, place of residence, DBH, and habitat; occupation, species, grade of tree age, tree height, and canopy size were insignificant factors. The model validity of model 3 (Random Forest) was not ideal, probably because of a high proportion of categorical variables in this study. The top-ranking factor of WTP was also personal monthly fixed income. But the second and third ranked factors of species and occupation were insignificant according to the other two models.

Table 5. Results of the three models of factors determining local residents' WTP for the socio-cultural value of scattered large old trees.

	Explanatory Variables	Model 1: Ordered Logit		Model 2: Ordered Probit		Model 3: Random Forest	
		Coefficient	Standard Error	Coefficient	Standard Error	IncNodePurity	Importance Ranking
Demographic characteristics	Gender	−0.450 ***	0.117	−0.282 ***	0.067	0.014	10
	Age	−0.565 ***	0.086	−0.322 ***	0.049	0.031	9
	Education level	0.282 **	0.102	0.149 *	0.059	0.107	5
	Occupation	0.027	0.040	0.015	0.023	0.132	3
	Personal monthly fixed income	0.192 ***	0.028	0.110 ***	0.016	0.200	1
	Place of residence	0.199 *	0.081	0.109 *	0.047	0.014	11
Characteristics of scattered large old trees	Species	−0.009	0.015	−0.007	0.008	0.152	2
	Grade of tree age	0.192	0.101	0.099	0.058	0.009	12
	Tree height	−0.020	0.014	−0.013	0.008	0.064	8
	DBH	0.002 *	0.001	0.001 *	0.000	0.109	4
	Canopy size	−0.001	0.016	0.001	0.009	0.088	6
	Habitat	−0.107 **	0.038	−0.057 **	0.022	0.080	7
Model validation		Log likelihood: −1549.63 Pseudo R^2: 0.0670 Prob > chi2: 0.000		Log likelihood: −1550.84 Pseudo R^2: 0.0663 Prob > chi2: 0.000		% Var explained: 5.08	

t statistics with * $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$.

3.3. *Socio-Cultural Value Mapping of Scattered Large Old Trees at Different Scales*

As illustrated in Figure 6a, the village-level population was mainly concentrated in the southeast of the study area. Some 7.88% of the villages and 42.39% of the towns possessed scattered large old trees, and most of them were in the northwest area (Figure 6b,c). The average annual gross socio-cultural values of scattered large old trees were CNY 0.77 million on the village scale and CNY 2.24 million on the township scale. On the county/district scale, the annual gross socio-cultural value of scattered large old trees was highest in Yi County (CNY 93.59 million), with Western Qing Tombs that harbor a high density of large old trees, and lowest in Anxin County (CNY 0.10 million), where most of the Baiyandian

Lake is located. The annual gross socio-cultural value of scattered large old trees in the whole study area amounted to CNY 349 million. For a single scattered large old tree, the average annual socio-cultural value was CNY 169,500.

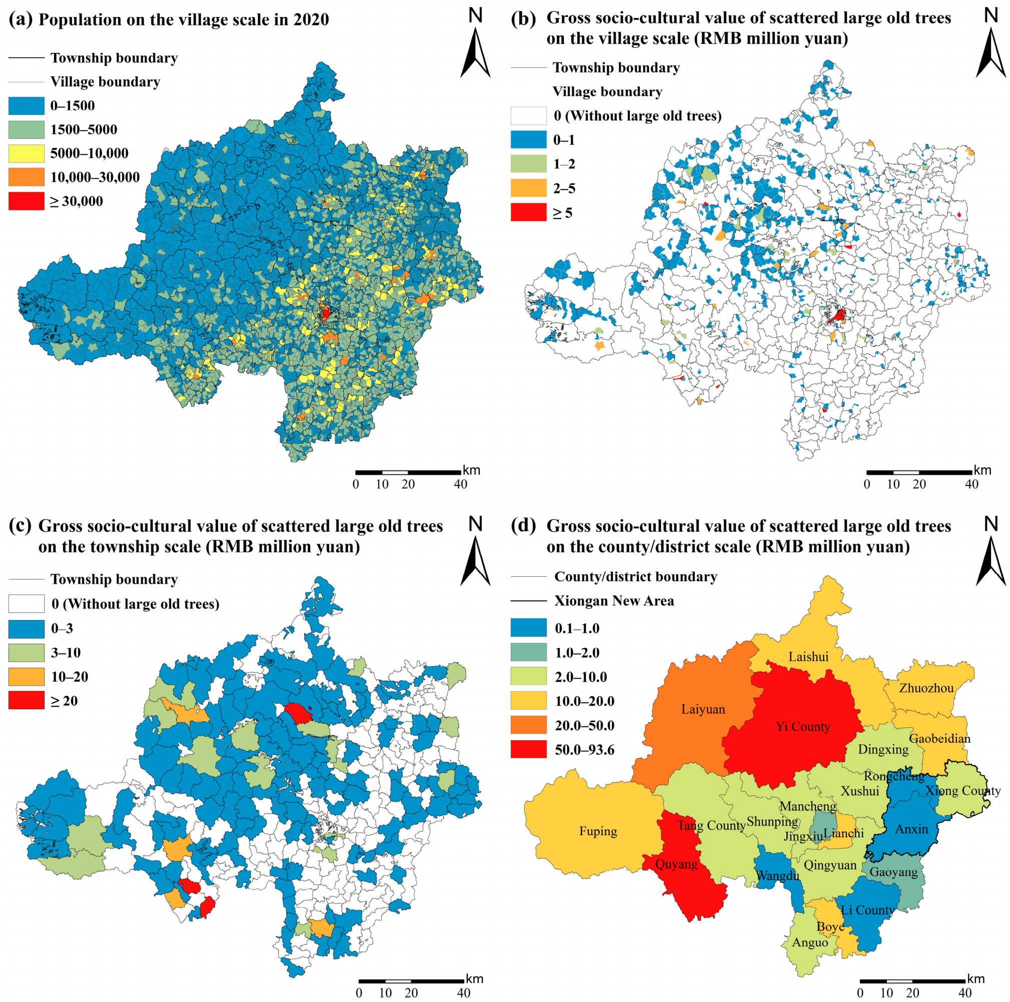

Figure 6. Estimation of gross socio-cultural value of scattered large old trees in Baoding City and Xiongan New Area. (**a**) Population distribution on the village scale in 2020; (**b**) value distribution on the village scale; (**c**) value distribution on the township scale; (**d**) value distribution on the county/district scale.

4. Discussion

4.1. Rural Large Old Tree Protection Is Faced with More Challenges

Our study revealed that the large old trees in Baoding City and Xiongan New Area were generally at a relatively younger stage, with normal growth performance but poor living environments, in accordance with the results reported in Hebei Province in China [65]. Some 96.99% of the trees resided in the countryside, and the tree density was 0.10 trees/km^2, which is very close to the nationwide statistical result of 95.15% and 0.13 trees/km^2, respectively [7,37]. Similar to previous studies [14,20,66], the distribution of scattered large old trees showed an agglomerative pattern, with several clusters in Yi County, Laiyuan, and Quyang. A greater tree number was found in habitats of village fringe (VF), government/community/institutional ground (GC), and scenic resort/historic site (SRHS). The top-ranking habitat of village fringe (VF) was in accordance with the results of a study conducted in Jiangsu Province that showed villages and farmland accommodated more heritage trees [41]. But in the mega-cities of Beijing [21] and Macau [15], studies revealed that parks and gardens accommodated the most large old trees. The difference may be due to a discrepancy of driving forces in urban and rural areas concerning the long-term persistence of large old trees.

Higher levels of species diversity in large old trees enhance resistance to environmental changes [67]. The adjusted species richness of our study area was 5.22, relatively lower than that in Beijing City (7.42) [21], Luoyang City (10.07) [14], and Jiangsu Province (18.56) [41]. This may be partly due to an absence of data on clustered large old trees in this study, but could also imply a diversity loss in rural large old trees. The top-ranking species were all indigenous, with strong physiological resistance to local environmental stress (such as drought and frost), or could bear edible fruits enjoyed by local residents. This finding confirmed the former perspective that species' biological traits and human utilization attributes drive the long-term persistence of old trees [12,68]. The species distribution varied considerably among the 23 districts/counties and had an obvious gradient differentiation from the mountain to plain areas, and plain areas had fewer species. This phenomenon was consistent with the conclusion generated by Li et al. [41] that elevation range shift was the strongest explanatory variable for the species diversity variation of heritage trees. More tree numbers and species appeared in the habitats of village fringe (VF) and government/community/institutional ground (GC) in this study, and government/community/institutional ground (GC) had the most unique tree species. This result was different from former findings in Jiangsu Province [41] and Hong Kong [69] that parks and gardens had the most unique species. Compared with parks and gardens, the habitats of village fringe (VF) and government/community/institutional ground (GC) are more diversely distributed and inconvenient for management, so large old tree protection in rural areas faces more difficulties than in urban areas.

4.2. Socio-Cultural Valuation of Rural Large Old Trees and Driving Factors

The ratio of unwillingness to pay (un-WTP) for the socio-cultural value of scattered large old trees was only 2.31% in this study, which was relatively low compared with former studies that revealed that 55.6% were unwilling to pay for urban heritage tree conservation in Guangzhou [30], 27.36% were unwilling to pay in Taiwan [31]) and 44.1% were unwilling to pay for urban green space conservation in Beijing [70]). The hidden causes of this may be that the above three studies were all conducted in urban areas. The reported reasons for urban objectors mainly include the desired responsibility of the municipal government for management, and distrust of authorities' performance. But in rural areas, where scattered large old trees are usually collectively owned by the village, it seems that their socio-cultural connections with local residents are closer, and the willingness for autonomous management of large old trees is stronger for rural residents. Thus, most of the respondents in this study showed a positive attitude toward the contingent socio-cultural valuation.

We also showed that the mean WTP of males was significantly higher than that of females in this study, which is different from former research that found the WTP of male respondents for protection of an urban iconic tree was significantly lower than that of females [59]. The mean WTP of young and middle-aged (18~60 years old) respondents was much higher than others, which is similar to the findings of Lin et al. [31]. But 67.47% of the respondents we encountered were farmers, and 59.3% of the farmers were aged over 60, which is a typical reflection of rural population aging in China [71]. The mean WTP of our respondents was CNY 132.48, and CNY 84.30 for the farmer group; the two figures were all relatively higher in comparison to previous studies that reported mean WTPs of CNY 24.67 per year per household for conserving heritage trees of common tree species in Guangzhou [30], CNY 55.96 per year per person for a 1000-year-old tree in Taichung [31], and CNY 40.06 per year per person for urban green space conservation in Beijing [70]. According to our survey, 73.6% of the farmers' personal monthly fixed income was below 1000 CNY, much lower than that of the urban residents. Therefore, this study showed the stronger individual willingness of rural residents (especially farmers) to pay for large old tree conservation.

A previous study by Hartel et al. [72] used network analysis to understand farmers' value perception of large old trees, and found that socio-cultural values such as identity and history were most highly valued. The results of our study provide further understanding of the way rural residents rank different connotations, which was as follows: spiritual attachment and homesickness > fengshui > social bond > witnessing history > education > creative inspiration. Hartel et al. [72] also discovered that the "shade" value for large old trees is only indicated by older farmers, and this study found that respondents over 60 years old attached more importance to the "social bond" connotation that was closely related to shading. Moreover, farmers attached more importance to "fengshui" in their value perceptions.

The driving factors analysis showed that demographic characteristics influence WTP more than the community characteristics of large old trees. Both the ordered logit and probit models showed that gender, age, and personal monthly fixed income were significantly correlated to WTP. Male, younger, and higher-income residents were willing to pay more. A few former studies have also reported similar results considering the factors of age and income, but the influence of gender was biased [30,59,73]. Among the factors of large old tree community characteristics, only DBH and habitat were correlated with the WTP, which means that the socio-cultural value of bigger trees and those growing in certain habitats is more appreciated by rural residents.

This study, for the first time, gave a multi-scale assessment and geographic mapping of the gross socio-cultural value of rural scattered large old trees. According to our assessment, the average annual socio-cultural value for a single scattered large old tree was CNY 169,500, while Yang [74] evaluated the historical and cultural value of an 800-year-old tree in Beijing and found a result of CNY 3.04 million. The disparity may be due to the discrepancy in the economic background of the respondents, as well as the difference in the number of people that the large old trees were related to. The annual gross socio-cultural value of scattered large old trees within the whole study area amounted to CNY 349 million. According to a news report on the issue of the Beijing local standard, "Specification for the Routine Maintenance and Management of Ancient and Famous Woody Plants" [75], the annual budget for the management and protection of ancient and famous trees of Tier 1 and Tier 2 was CNY 1400 and 900, respectively (http://www.agronet.com.cn/tech/442972.html (accessed on 15 December 2023)). It can be estimated that the total annual budget for the protection of the large old trees is about CNY 1 million, which is far below the gross socio-cultural value they provide. Therefore, the protection situation of large old trees can be much improved if their socio-cultural value is fully recognized and utilized by the public.

4.3. Implications for Rural Large Old Trees' Protection with Multi-Scale Strategies

Though experiencing rapid urbanization during the recent decades, the Chinese government has made great efforts to conserve large old tree resources. Actions such as forest law revision by adding articles on large old tree conservation, conducting national-level ancient and famous tree investigations, and issuing technical regulations for the management and conservation of old and notable trees, etc., have been taken. However, the protection situation is still unbalanced, as a number of large old trees, especially those in rural areas, still lack management, and local governments are faced with excessive pressures under the conventional government-dominant model. Based on the results of this study, we proposed a conceptual framework by integrating spatial analysis and contingent valuation for a socio-cultural value assessment and the multi-scale protection of large old trees (Figure 7), which consists of five steps, as follows.

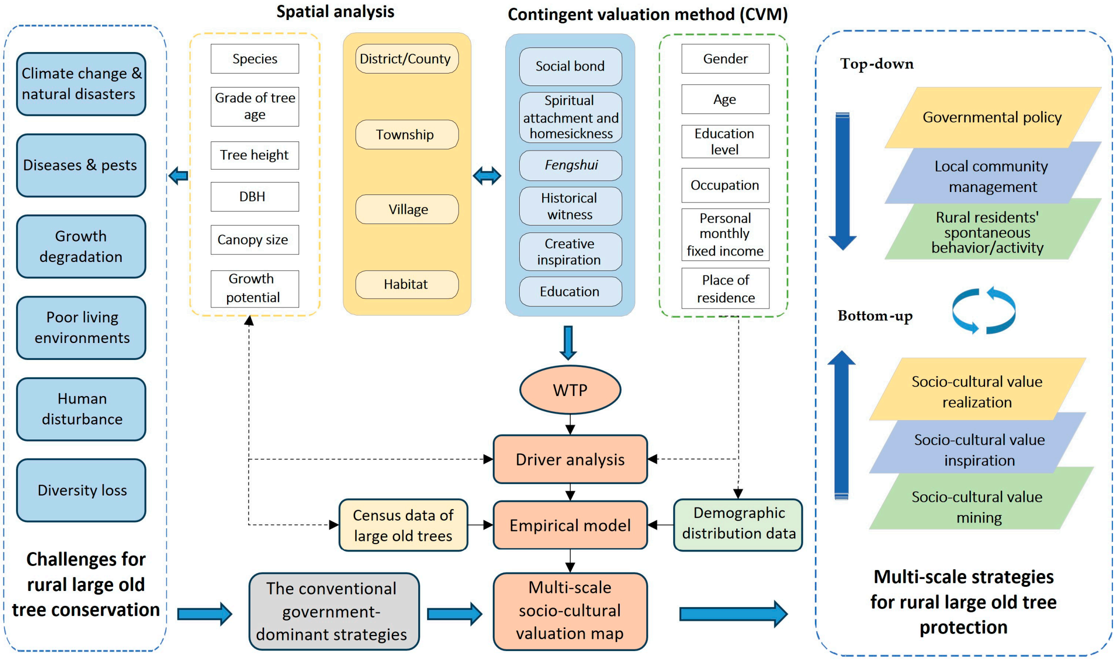

Figure 7. A conceptual framework for the integrated socio-cultural value assessment and multi-scale protection of large old trees.

Firstly, statistical and spatial analyses of local large old tree resources should be conducted based on census data. This will provide a full understanding of the protection situation and potential challenges of the trees. For example, in this study, the distribution clusters of Yi County, Laiyuan, and Quyang, and the most-accommodated habitats of village fringe (VF) and government/community/institutional ground (GC) were identified, challenges of diversity loss and poor living environments were uncovered.

Secondly, perceptions of the socio-cultural value of large old trees by local residents can be generated using CVM, based on which a comparative analysis of the mean WTP for the socio-cultural and divided connotations among groups can be conducted.

Thirdly, demographic characteristics and large old tree community indicators that have influence on the WTP can be analyzed by selecting key variables and constructing empirical models [76]. As in this study, the key variables were gender, age, personal monthly fixed income, education level, DBH, and tree habitat.

Fourthly, local data of the key variables should be generated and put into the empirical model for a further simulation of WTP in unsurveyed areas. In this case study, however, we omitted this step and used the mean WTP of Laiyuan County as a substitute because of a deficiency of village-level demographic data. This problem can be solved with governmental support in other cases. After this step, a socio-cultural value map of large old trees can be generated at different scales of county level, township level, village level, and individuals.

Lastly, based on the above analysis and socio-cultural valuation map, multi-scale rural large old tree protection strategies can be proposed. From a top-down perspective, the hotspot areas (e.g., Yi County, Laiyuan, and Quyang in this case study) can be assisted by issuing official titles of heritage tree cultural benchmarks. Local communities should pay more attention to key habitat protection and management areas that harbor the most trees and species; for rural residents, strategies such as tree adoption can be implemented to support residents' spontaneous willingness to pay for tree conservation. From a bottom-up perspective, we suggest incorporating the socio-cultural value of large old trees into the indicator system of GEP accounting, as issued by the National Development and Reform Commission and National Bureau of Statistics in China [77]. This non-use value, if properly circulated as a typical exploration of GEP value realization, will be profitable not only for tree conservation, but also for the national strategy of rural revitalization. In addition, the socio-cultural value should be strengthened according to the importance ranking of different connotations. For example, this study found that spiritual attachment and homesickness was the most recognized value type, but the values of education and creative inspiration appeared to be neglected. Therefore, on one hand, the highly valued spiritual attachment to large old trees should be used rationally, following the case of Central Himalaya [27]; on the other hand, strategies can be made to enrich biocultural diversity as it relates to large old trees, e.g., by setting up popular science centers in relation to ancient trees for children and young people, constructing ancient tree art creation parks, and expanding culturally valuable output by organizing short video competitions, etc. The optimized conservation strategies can be updated at a five- or ten-years interval, starting from the first step following the conceptual framework [78].

5. Conclusions

Governments are faced with the unique challenge of fulfilling large-scale targeted protection within the context of the global decline in large old tree populations. However, the human value of large old trees is often neglected in this conservation [22]. In this study, we conducted an integrated study of the spatial distribution and contingent valuation of scattered large old trees in Baoding City and Xiongan New Area, intending to support a multi-scale conservation strategy; the main conclusions are as follows:

(1) The scattered large old trees in the study were generally at a relatively younger stage, with normal growth performance, but poor living environments. Some 96.99% of the trees resided in the countryside, and the tree density was 0.10 trees/km^2, which is similar to the situation reported in former studies focused on a larger provincial and national scope. The distribution of scattered large old trees showed an agglomerative pattern, with several clusters in Yi County, Laiyuan, and Quyang, and a greater tree number was found in the habitats of village fringe (VF), government/community/institutional ground (GC), and scenic resort/historic sites (SRHS).

(2) The adjusted species richness of scattered large old trees in the study area was 5.22, which is relatively lower than that in urban places, which may imply a loss of diversity in rural large old trees. The species distribution varied considerably among the 23 districts/counties, and had an obvious gradient differentiation from the mountain to plain areas, and plain areas had fewer species. The habitats of village fringe (VF) and government/community/institutional ground (GC) had the most unique tree species, which was different from the urban findings that parks and gardens had the highest diversity of large old trees.

(3) The ratio of unwillingness to pay (un-WTP) for the socio-cultural value of scattered large old trees was relatively low compared with former studies in urban areas. The overall average WTP for the socio-cultural value of scattered large old trees in this study was CNY 132.48 per year per person, and CNY 84.30 per year per person for the farmer group. The amount was much higher than similar studies conducted in larger cities, which indicated the closer spiritual connection of rural residents to large old trees. The influence of demographic characteristics was stronger than that of community characteristics on the WTP for large old trees' socio-cultural value. Economic income was the most significant factor determining residents' WTP. In addition, gender, age, education level, place of residence, DBH, and tree habitat were also factors that significantly influenced WTP. This study provides further understanding of the ranking of six socio-cultural value connotations, in terms of importance, by rural residents: spiritual attachment and homesickness > fengshui > social bond > witnessing history > education > creative inspiration.

(4) This study, for the first time, conducted a multi-scale assessment and geographic mapping of the gross socio-cultural value of rural scattered large old trees. The annual gross socio-cultural value of scattered large old trees in the study area was estimated to be CNY 349 million, CNY 0.77 million on the village scale, and CNY 2.24 million on the township scale on average. For a single scattered large old tree, the average annual

socio-cultural value amounted to CNY 169,500. Based on the case study, a conceptual framework integrating spatial analysis and contingent valuation for a socio-cultural value assessment and the multi-scale protection of large old trees was proposed. Following the five main steps, a socio-cultural value map of large old trees can be generated at different scales, and conventional government-dominated large old tree protection can be improved by promoting strategies of top-down multilevel participation and bottom-up socio-cultural value recognition. Further research is required, however, on aspects of empirical model utilization and economic/political routes to value recognition.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/f15010018/s1, Table S1. Content of the questionnaire survey; Table S2. Description and coding of independent variables; Table S3. Genera ranking of scattered large old trees in Baoding City and Xiongan New Area; Table S4. Species ranking of scattered large old trees in Baoding City and Xiongan New Area; Table S5. Abbreviated species names of scattered large old trees in Baoding City and Xiongan New Area; Figure S1. Distribution of the sampled scattered large old trees for socio-cultural value investigation; Data sharing of the census data of scattered large old trees in Baoding City and Xiongan New Area.

Author Contributions: N.Y.: Conceptualization, Data curation, Investigation, Formal analysis, Writing—original draft, Writing—review and editing. C.G.: Data curation, Investigation, Formal analysis, Writing—original draft. J.Q.: Conceptualization, Validation, Writing—review and editing. S.S.: Conceptualization, Funding acquisition, Validation. B.N.: Conceptualization, Investigation. H.W.: Conceptualization, Funding acquisition, Validation, Writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Natural Science Foundation of Hebei Province (Grant No. number D2022201004); the Science and Technology Plan Project of Hebei Province (Grant No. 225A4802D); the Scientific Research Project for the Ecological Product Value Realization Mechanism Pilot Construction in Baoding City (Grant No. 13060022P00JR2610037W); the Advanced Talents Incubation Program of Hebei University (Grant No. 521100223217); and the Collaborative Innovation Center for Baiyangdian Basin Ecological Protection and Beijing–Tianjin–Hebei Sustainable Development.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to a third party (the Baoding Natural Resources and Municipal Planning Bureau (Forestry Bureau)) data ownership.

Acknowledgments: We would like to thank the Baoding Natural Resources and Municipal Planning Bureau (Forestry Bureau) for providing open access census data of large old trees.

Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Cannon, C.H.; Piovesan, G.; Munné-Bosch, S. Old and ancient trees are life history lottery winners and vital evolutionary resources for long-term adaptive capacity. *Nat. Plants* **2022**, *8*, 136–145. [CrossRef] [PubMed]
2. Gilhen-Baker, M.; Roviello, V.; Beresford-Kroeger, D.; Roviello, G.N. Old growth forests and large old trees as critical or-ganisms connecting ecosystems and human health. A review. *Environ. Chem. Lett.* **2022**, *20*, 1529–1538. [CrossRef] [PubMed]
3. Jones, G.M.; Keane, J.J.; Gutiérrez, R.J.; Peery, M.Z. Declining old-forest species as a legacy of large trees lost. *Divers. Distrib.* **2018**, *24*, 341–351. [CrossRef]
4. Piovesan, G.; Cannon, C.H.; Liu, J.; Munné-Bosch, S. Ancient trees: Irreplaceable conservation resource for ecosystem restoration. *Trends Ecol. Evol.* **2022**, *37*, 1025–1028. [CrossRef] [PubMed]
5. Lindenmayer, D.B.; Laurance, W.F.; Franklin, J.F. Global Decline in Large Old Trees. *Science* **2012**, *338*, 1305–1306. [CrossRef] [PubMed]
6. Lindenmayer, D.B. Conserving large old trees as small natural features. *Biol. Conserv.* **2017**, *211*, 51–59. [CrossRef]
7. Liu, J.; Lindenmayer, D.B.; Yang, W.; Ren, Y.; Campbell, M.J.; Wu, C.; Luo, Y.; Zhong, L.; Yu, M. Diversity and density patterns of large old trees in China. *Sci. Total Environ.* **2019**, *655*, 255–262. [CrossRef]
8. Zhang, X.; Wang, L.; Liu, Z.; Zheng, T.; Cao, Y.; Liu, X. The current situation and countermeasures for conservation of ancient and famous trees in Laoshan, Qingdao, China. *Ciência Rural* **2019**, *49*, 1–13. [CrossRef]

9. Lindenmayer, D.B.; Laurance, W.F. The Unique Challenges of Conserving Large Old Trees. *Trends Ecol. Evol.* **2016**, *31*, 416–418. [CrossRef]
10. Lindenmayer, D.B.; Laurance, W.F. The ecology, distribution, conservation and management of large old trees. *Biol. Rev.* **2017**, *92*, 1434–1458. [CrossRef]
11. Lu, Z.; Zhu, L.; Lu, J.; Shen, N.; Wang, L.; Liu, S.; Wang, Q.; Yu, W.; Kato-Noguchi, H.; Li, W.; et al. Rejuvenation in-creases leaf biomass and flavonoid accumulation in Ginkgo biloba. *Hortic. Res.* **2022**, *9*, uhab018. [CrossRef] [PubMed]
12. Liu, J.; Xia, S.; Zeng, D.; Liu, C.; Li, Y.; Yang, W.; Yang, B.; Zhang, J.; Slik, F.; Lindenmayer, D.B. Age and spatial distribution of the world's oldest trees. *Conserv. Biol.* **2022**, *36*, e13907. [CrossRef] [PubMed]
13. Huang, L.; Jin, C.; Zhen, M.; Zhou, L.; Qian, S.; Jim, C.Y.; Lin, D.; Zhao, L.; Minor, J.; Coggins, C.; et al. Biogeographic and anthropogenic factors shaping the distribution and species assemblage of heritage trees in China. *Urban For. Urban. Green.* **2020**, *50*, 126652. [CrossRef]
14. Hou, H.; Zhang, L.; Bi, H.; He, J.; Cai, E.; Ren, W. Differential characteristics and driving forces of the spatial distribution of heritage trees in Luoyang, an ancient capital of China. *Front. Environ. Sci.* **2022**, *10*, 993333. [CrossRef]
15. Zhang, H.; Lai, P.Y.; Jim, C.Y. Species diversity and spatial pattern of old and precious trees in Macau. *Landsc. Urban. Plan.* **2017**, *162*, 56–67. [CrossRef]
16. Yin, L. Resources Investigation and Characteristic Analysis of Ancient and Famous Trees in Meiling National Forest Park, Jiangxi Province. Master's Thesis, Jiangxi Agricultural University, Nanchang, China, 2019; p. 73. (In Chinese)
17. Huang, L.; Tian, L.; Zhou, L.; Jin, C.; Qian, S.; Jim, C.Y.; Lin, D.; Zhao, L.; Minor, J.; Coggins, C.; et al. Local cultural beliefs and practices promote conservation of large old trees in an ethnic minority region in southwestern China. *Urban For. Urban. Green.* **2020**, *49*, 126584. [CrossRef]
18. Lijuan, T. The Composition and Characteristics of Heritage Trees in Ethnic Minority Areas in Southwest China: A Case Study of Guizhou Wuchuan Gelao and Miao Ethnic Autonomous County. Master's Thesis, Chongqing University, Chongqing, China, 2018. (In Chinese)
19. Orłowski, G.; Nowak, L. The importance of marginal habitats for the conservation of old trees in agricultural landscapes. *Landsc. Urban. Plan.* **2007**, *79*, 77–83. [CrossRef]
20. Qiu, Z.; Hu, X.; Qian, H.; Wei, B.; Liao, K. Analysis of spatial distribution characteristics of ancient and famous trees in Xintian County. *J. Cent. South Univ. For. Technol.* **2022**, *42*, 1–11. (In Chinese)
21. Fu, Q.; Qiu, E.; Zhang, Y.; Huang, L.; Wang, H.; Jiang, S. Discussion of the Distribution Pattern and Driving Factors of Large Old Tree Resources in Beijing. *Forests* **2022**, *13*, 1500. [CrossRef]
22. Blicharska, M.; Mikusinski, G. Old Trees: Cultural Value. *Science* **2013**, *339*, 904. [CrossRef]
23. Blicharska, M.; Mikusiński, G. Incorporating Social and Cultural Significance of Large Old Trees in Conservation Policy. *Conserv. Biol.* **2014**, *28*, 1558–1567. [CrossRef] [PubMed]
24. Breyne, J.; Dufrêne, M.; Maréchal, K. How integrating 'socio-cultural values' into ecosystem services evaluations can give meaning to value indicators. *Ecosyst. Serv.* **2021**, *49*, 101278. [CrossRef]
25. Reid, W.V.; Mooney, H.A.; Cropper, A.; Capistrano, D.; Carpenter, S.R.; Chopra, K.; Dasgupta, P.; Dietz, T.; Duraiappah, A.K.; Hassan, R. *Ecosystems and Human Well-Being-Synthesis: A Report of the Millennium Ecosystem Assessment*; Island Press: Washington, DC, USA, 2005.
26. Chen, J.; Lin, W.; Zhang, Y.; Dai, Y.; Chen, B. Village Fengshui Forests as Forms of Cultural and Ecological Heritage: Interpretations and Conservation Policy Implications from Southern China. *Forests* **2020**, *11*, 1286. [CrossRef]
27. Subrat Sharma, H.C.R.L. Conservation of Natural Resources Through Religion: A Case Study from Central Himalaya. *Soc. Nat. Resour.* **1999**, *12*, 599–612. [CrossRef]
28. Venkatachalam, L. The contingent valuation method: A review. *Environ. Impact Assess. Rev.* **2004**, *24*, 89–124. [CrossRef]
29. Vo, N.X.; Huyen Nguyen, T.T.; Van Nguyen, P.; Tran, Q.V.; Vo, T.Q. Using contingent valuation method to estimate adults' willingness to pay for a future coronavirus 2019 vaccination. *Value Health Reg. Issues* **2021**, *24*, 240–246. [CrossRef] [PubMed]
30. Chen, W.Y. Public willingness-to-pay for conserving urban heritage trees in Guangzhou, south China. *Urban For. Urban. Green.* **2015**, *14*, 796–805. [CrossRef]
31. Lin, H.; Chuang, Y.; Liu, W. Assessing the economic value of an iconic urban heritage tree. *Forest Policy Econ.* **2020**, *118*, 102216. [CrossRef]
32. Son, H.; Xia, T.; Kim, Y.; Kang, T. A Value Evaluation Research of the Old-growth and Giant Tree—Focus on Gyeongju Gyerim's Zelkova Serrata. *J. Korean Inst. Tradit. Landsc. Archit.* **2016**, *34*, 51–56. [CrossRef]
33. Wang, B.; Xiu, X.; Lan, S. Monetary Valuation of the Cultural Value of Ancient and Famous Trees. *Issues For. Econ.* **2016**, *36*, 565–570. (In Chinese)
34. Wang, J.; Yu, F.; Ma, G.; Peng, F.; Zhou, X.; Wu, C.; Yang, W.; Wang, C.; Cao, D.; Jiang, H.; et al. Gross economic-ecological product as an integrated measure for ecological service and economic products. *Resour. Conserv. Recycl.* **2021**, *171*, 105566. [CrossRef]
35. Yang, H.; Gou, X.; Ma, W.; Xue, B. Research and application of GEP: China' s experience in natural capital accounting. *Front. Environ. Sci.* **2023**, *11*, 75. [CrossRef]
36. Hartel, T.; Réti, K.; Craioveanu, C. Valuing scattered trees from wood-pastures by farmers in a traditional rural region of Eastern Europe. *Agric. Ecosyst. Environ.* **2017**, *236*, 304–311. [CrossRef]

37. Yamin, Z. The results of the second national survey of ancient and famous tree resources were announced. *Land. Green.* **2022**, *9*, 16–17. (In Chinese)
38. Baoding Bureau Of Statistics. *Baoding Economy Statistical Yearbook*; China Statistics Press: Beijing, China, 2020.
39. Wu, J. The Supernova Remnant of More than 4100 Years Ago Was Discovered—Emperor Yao's Jingxing (PKS 1209-52). *Chin. Astron. Astrophys.* **2023**, *47*, 309–334.
40. Lu, P.; Li, M.; Fu, S.; Henrietta Onyebuchi, C.; Zhang, Z. Modeling the warring states period: History dynamics of initial unified empire in China (475 BC to 221 BC). *Expert Syst. Appl.* **2023**, *230*, 120560. [CrossRef]
41. Li, K.; Zhang, G. Species Diversity and Distribution Pattern of Heritage Trees in the Rapidly-Urbanizing Province of Jiangsu, China. *Forests* **2021**, *12*, 1543. [CrossRef]
42. Yang, J.; Huang, X. The 30 m annual land cover dataset and its dynamics in China from 1990 to 2019. *Earth Syst. Sci. Data* **2021**, *13*, 3907–3925. [CrossRef]
43. Zhu, H.; Li, Y.; Liu, Z.; Fu, B. Estimating the population distribution in a county area in China based on impervious surfaces. *Photogramm. Eng. Remote Sens.* **2015**, *81*, 155–163. [CrossRef]
44. Chen, B.; Coggins, C.; Minor, J.; Zhang, Y. Fengshui forests and village landscapes in China: Geographic extent, socioecological significance, and conservation prospects. *Urban For. Urban. Green.* **2018**, *31*, 79–92. [CrossRef]
45. Wang, X.; Fan, B.; Li, Z.; Song, J.; Liu, S.; Chen, L.; Cai, D.; Yin, G.; Jiang, Z. Forest cultural value evaluation index system and methodology. *Acta Ecol. Sin.* **2021**, *41*, 202–212. (In Chinese)
46. Wan, C.; Shen, G.Q.; Choi, S. Underlying relationships between public urban green spaces and social cohesion: A systematic literature review. *City Cult. Soc.* **2021**, *24*, 100383. [CrossRef]
47. Zhao, P.; Ren, Z. Distribution and cultural value of old tree resources in Xinzhou city. *J. Arid. Land. Resour. Environ.* **2023**, *37*, 150–156. (In Chinese)
48. Hartl, C.; St. George, S.; Konter, O.; Harr, L.; Scholz, D.; Kirchhefer, A.; Esper, J. Warfare dendrochronology: Trees witness the deployment of the German battleship Tirpitz in Norway. *Anthropocene* **2019**, *27*, 100212. [CrossRef]
49. Senetra, A. Forests as an important spatial element in elaboration of the esthetic value maps for rural landscapes. *Sylwan* **2015**, *159*, 757–766.
50. Qian, H. Large-scale biogeographic patterns of vascular plant richness in North America: An analysis at the generic level. *J. Biogeogr.* **1998**, *25*, 829–836. [CrossRef]
51. Simon, J.S. Density Estimation. *Stat. Sci.* **2004**, *19*, 588–597.
52. Guo, L.; Cheng, S.; Liu, J.; Wang, Y.; Cai, Y.; Hong, X. Does social perception data express the spatio-temporal pattern of perceived urban noise? A case study based on 3,137 noise complaints in Fuzhou, China. *Appl. Acoust.* **2022**, *201*, 109129.
53. Wang, Z.; Smyth, R. A hybrid method for creating Lorenz curves. *Econ. Lett.* **2015**, *133*, 59–63. [CrossRef]
54. Yang, Y.; Bao, G.; Zhang, D.; Zhai, C. Spatial Distribution and Driving Factors of Old and Notable Trees in a Fast-Developing City, Northeast China. *Sustainability* **2022**, *14*, 7937. [CrossRef]
55. Lai, P.Y.; Jim, C.Y.; Da Tang, G.; Hong, W.J.; Zhang, H. Spatial differentiation of heritage trees in the rapidly-urbanizing city of Shenzhen, China. *Landsc. Urban. Plan.* **2019**, *181*, 148–156. [CrossRef]
56. Grilli, L.; Rampichini, C. Ordered Logit Model. In *Encyclopedia of Quality of Life and Well-Being Research*; Maggino F, Ed.; Springer International Publishing: Cham, Switzerland, 2020; pp. 1–4.
57. Bellizzi, M.G.; Eboli, L.; Forciniti, C.; Mazzulla, G. Air Transport Passengers' Satisfaction: An Ordered Logit Model. *Transp. Res. Procedia* **2018**, *33*, 147–154. [CrossRef]
58. Piedra-Bonilla, E.B.; Da Cunha, D.A.; Braga, M.J. Climate variability and crop diversification in Brazil: An ordered probit analysis. *J. Clean. Prod.* **2020**, *256*, 120252. [CrossRef]
59. Liu, W.; Chuang, Y. To exclude or not to exclude? The effect of protest responses on the economic value of an iconic urban heritage tree. *Urban. For. Urban. Green.* **2022**, *71*, 127551. [CrossRef]
60. Levantesi, S.; Piscopo, G. The Importance of Economic Variables on London Real Estate Market: A Random Forest Approach. *Risks* **2020**, *8*, 112. [CrossRef]
61. Rhodes, J.S.; Cutler, A.; Moon, K.R. Geometry- and Accuracy-Preserving Random Forest Proximities. *IEEE Trans. Pattern Anal. Mach. Intell.* **2023**, *45*, 10947–10959. [CrossRef] [PubMed]
62. Nachouki, M.; Mohamed, E.A.; Mehdi, R.; Abou Naaj, M. Student course grade prediction using the random forest algorithm: Analysis of predictors' importance. *Trends Neurosci. Educ.* **2023**, *33*, 100214. [CrossRef] [PubMed]
63. Wang, B. Study on Cultural Value of the Ancient and Famous Tree in China. Master's Thesis, Nanjing Agricultural University, Nanjing, China, 2009; p. 94. (In Chinese)
64. Wang, Q.; Zhou, X.; Huo, Z.; Shi, L.; Zhang, Y. Building an Up-and-Coming City-An overview of the Geological Data Sharing Service Platform of the Xiongan New Area. *China Geol.* **2019**, *3*, 566–568. [CrossRef]
65. Lu, H. Characteristics of the ancient and famous tree resources in Hebei Province and conservation strategies. *Hebei For.* **2012**, *7*, 20–21. (In Chinese)
66. Jianhua, X.; Cheng, L.; Congcong, L.; Ying, T.; Danmiao, Z. Study on the Resource Characteristics and Spatial Distribution of Ancient and Famous Trees: Taking the Tonglu County of Zhejiang Province as an Example. *Nat. Prot. Areas* **2022**, *2*, 110–118. (In Chinese)

67. Bourne, K.S.; Conway, T.M. The influence of land use type and municipal context on urban tree species diversity. *Urban. Ecosyst.* **2014**, *17*, 329–348. [CrossRef]
68. Huang, L.; Jin, C.; Pan, Y.; Zhou, L.; Hu, S.; Guo, Y.; Meng, Y.; Song, K.; Pang, M.; Li, H.; et al. Human activities and species biological traits drive the long-term persistence of old trees in human-dominated landscapes. *Nat. Plants* **2023**, *9*, 898–907. [CrossRef] [PubMed]
69. Jim, C.Y.; Zhang, H. Species diversity and spatial differentiation of old-valuable trees in urban Hong Kong. *Urban. For. Urban. Green.* **2013**, *12*, 171–182. [CrossRef]
70. Xu, F.; Wang, Y.; Xiang, N.; Tian, J.; Chen, L. Uncovering the willingness-to-pay for urban green space conservation: A survey of the capital area in China. *Resour. Conserv. Recycl.* **2020**, *162*, 105053. [CrossRef]
71. Houkai, W.; Peng, Y.; Shukun, W. *China Rural Revitalization Survey (2021)*; China Social Sciences Press: Beijing, China, 2022.
72. Hartel, T.; Nita, A.; Rozylowicz, L. Understanding human-nature connections through value networks: The case of ancient wood-pastures of Central Romania. *Sustain. Sci.* **2020**, *15*, 1357–1367. [CrossRef]
73. Majumdar, S.; Deng, J.; Zhang, Y.; Pierskalla, C. Using contingent valuation to estimate the willingness of tourists to pay for urban forests: A study in Savannah, Georgia. *Urban For. Urban. Green.* **2011**, *10*, 275–280. [CrossRef]
74. Yu, Y.; Minghua, T.; Guowei, Q.; Zhenyu, Z.; Chunhui, L. Monetization evaluation on the comprehensive value of old and valuable trees in cities—A case study of "Marguis of Shade" in Beijing. *J. Arid. Land. Resour. Environ.* **2019**, *33*, 185–191. (In Chinese)
75. *DB11/T 767-2010*; Specification for Routine Maintenance and Management of Ancient & Famous Woody Plants. Quality and Technical Supervision Bureau: Beijing, China, 2011.
76. Li, S.; Chen, Z.; Guo, L.; Hu, F.; Huang, Y.; Wu, D.; Wu, Z.; Hong, X. How Do Spatial Forms Influence Psychophysical Drivers in a Campus City Community Life Circle? *Sustainability* **2023**, *15*, 10014. [CrossRef]
77. The National Bureau of Development and Reform; the National Bureau of Statistics. *Standard for the Gross Ecological Product Value Accounting*; People's Publishing House: Beijing, China, 2022.
78. Hong, X.; Cheng, S.; Liu, J.; Guo, L.; Dang, E.; Wang, J.; Cheng, Y. How Should Soundscape Optimization from Perceived Soundscape Elements in Urban Forests by the Riverside Be Performed? *Land* **2023**, *12*, 1929. [CrossRef]