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# Whom Do Urban Agriculture Parks Provide Landscape Services to and How? A Case Study of Beijing, China

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**Abstract:** An urban agriculture park (UAP) is a mixture of various kinds of urban agriculture and has a group of administrators to plan and manage its landscapes. Thus, the relationships between users and the ability of the UAPs to provide services are crucial. This study investigated the user profiles of three kinds of UAPs in Beijing, China. Investigation of 345 interviewees suggested that most of the users have an upper-middle level income and are well educated. Social connections vary across different types of UAPs. An assessment matrix of landscape services was introduced for a pioneer of UAP, Little Donkey Farm, based on questionnaires, a field survey, and indicators of landscape patterns. Pearson correlations between service demands and users' characters showed age, companions, and education level were significantly correlated to the needs of scenery and education services. The landscape with the highest supply value was the vegetable plots planted by members. The scenery service was not adequately supplied, and 31.5% of the areas did not meet the demand. Based on the budgets of supply and demand, six types of landscape should be optimized. This study provides an approach to understand the path of landscape service provision in UAP and supports basic knowledge on how to better involve urban agriculture in sustainable development.

**Keywords:** urban agriculture; landscape service; questionnaires; ecosystem services; assessment matrix

## 1. Introduction

Due to their multiple benefits to cities, urban agriculture (UA) and periurban agriculture meet the goals of the UN's 2030 agenda for Sustainable Development (SDGs): no poverty; zero hunger; sustainable cities and communities, and life on land in Goals [1–3], and especially urban sustainability [4]. UA appears when agricultural land is divided and surrounded by urban areas in the process of urban expansion. UA has evolved into various forms, including urban agricultural sightseeing parks, allotment gardens, controlled environmental agriculture garden, community gardens, home gardens, and so on [5]. One typical type of UA is an urban agriculture park (UAP). UAP is a mixture of several types of UA elements, like allotment gardens, picking-up gardens, and scenic view parks [6]. The function of UA has developed from simple food production to include multiple functions [5]. In practice, urban agricultural areas have faced the threat of rapid urbanization, and some cities ignored them or converted them to real estate [3]. Constructing the edible city and promoting involvement in nature-based solutions (NBS) can raise the awareness of UA. UA, in an edible city framework, contributes to food security, poverty alleviation, and other societal challenges [2,7,8]. Some researchers



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have developed an assessment framework for NBS [5]. However, further assessment on different kinds of UA are needed to provide evidence for practice.

Analysis of ecosystem services (ES) can better clarify the benefits of UA to residents [9]. ES includes the benefits human beings get from natural ecosystems. Based on studies from the USA, the UK, Austria, New Zealand, Germany, and Canada, etc., UA can provide ecosystem services, such as pollination, pest control, temperature regulation, soil health, water storage, and carbon storage [10,11]. UA also helps cities mitigate and adapt to climate change by reducing greenhouse gas emissions [12,13]. Additionally, UA improves biodiversity: the richness and diversity of bird communities is greater in UAPs than in either urban parks or rural agricultural areas [14]. Environmental concerns are emphasized by educated residents, while access to food is more important for low-income and unemployed urban gardeners [15]. Besides these environmental regulation services, UA also provides important cultural services [5,9]. Among 274 articles that analyzed the supply of ES by UA, 111 focused on cultural services, which thus received the greatest attention among 10 study fields [5]. Educational functions focus on environmental and social–ecological learning [16]. Local communities get actively involved at agricultural sites, which improves social cohesion [17]. Most studies focused on ES provision, such as on the different kinds of ecosystem provided by different types of UA [9], or on comparing UA to other green spaces [14]. Incorporating UA into cities in urban planning and design requires more scientific evidence concerning benefits and supply [17]. Studies have shown that the benefits of UA rely on the users' characteristics and different types of UA [9,15].

Compared to other types of UA, a UAP has a more complicated landscape structure. It has a group of administrators to manage the landscapes: it provides both agricultural production and sociocultural services for residents. A UAP is different to an urban park, because urban parks lack agricultural activity. It is also less intensive of food production than an agricultural area, whether urban or nonurban. The sustainability of a UAP is more sensitive to the relationship between supply and demand of ES. Spatial patterns and relationships can be better captured by a specification of ES and landscape services. Landscape services are provided by the landscape, which flow from the ecosystem to society [18]. These are closely associated with the landscape pattern [19]. UAP is a semi-natural system, which is modified by humans, and its functions rely on the landscape or the infrastructures. According to the seminatural characters of UA, landscape services are more suitable than ES for UPA research [20].

There are several assessment methods for landscape services. The participatory mapping of landscape services is more relevant to local actors [19,21]. The public participation method has been used to evaluate the spiritual value, educational value, aesthetic value, and social cohesion of landscape services; researchers conducted an expert or stakeholder scoring matrix, and mapped the spatial characteristics of landscape services using a Geographic Information System [22]. Burkhard introduced the supply–demand matrix method to show the relationship between services supply and demand for each land cover patch, describing 26 kinds of ES corresponding to the 44 kinds of different land cover types [23]. This research method in supply and demand analysis can better involve stakeholders, and is applicable to small study sites.

To make UAPs sustainably developed, treating a UAP as a point in the UA network is not enough, the analysis about landscape structure and relationship between supply and demand inside an UAP is necessary. Beijing, China was chosen as a case study, where the urban agricultural areas are mainly UAPs. Despite the importance of agriculture for the nation, as well as for global agriculture, few articles on Chinese UA have yet been published in English [24–26]. After solving the hunger issues, agriculture in urban areas or periurban areas has become more important in resilient cities, and for large numbers of urban residents [27]. This study aimed to clarify the relationship of demand and supply in UAPs using a supply–demand matrix of landscape services analysis, and provides suggestions for landscape planning inside them. We combined a field survey and questionnaires to describe the characteristics of 33 UAPs in Beijing and probed into the relationship between users' demand and their preferences in a case study area of UAP.

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## 2. Methods

The user profiles of UAPs in Beijing were investigated by questionnaires in three representatives of 33 UAPs (Figure 1). The relationship between users' characteristics and their demands were analyzed based on landscape service demand and questionnaires. One typical UAP was selected after a user profiles analysis. The spatial variations of landscape service demand–supply were showed by landscape structure mapping based on questionnaires for users, landscape metrics, and questionnaires for managers.

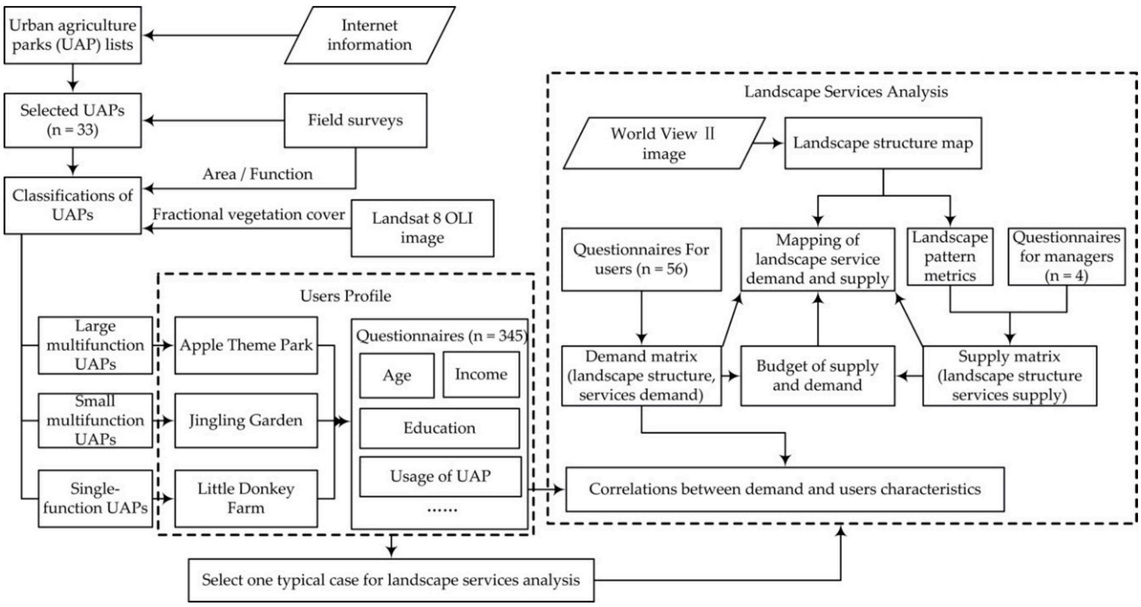


**Figure 1.** Flowchart of the methodology for sampling, user profiles, and landscape services analysis.

### 2.1. Study Area and Sampling

Beijing is the capital of the People's Republic of China. It is the nation's political, economic, cultural, educational, and international communications center. Beijing is located in northern China near the Yan Mountains, with a total area of 16,410.54 square kilometers. Beijing had a resident population of 21.542 million at the end of 2018 [28]. The topography of Beijing is high in the northwest and low in the southeast [29]. Beijing has a semihumid climate with clear-cut seasons. Winter and summer are long, while spring and autumn are short. The average temperature in Beijing from 1981 to 2010 was 11.5 degrees Celsius, and the extreme temperatures were 37.2 degrees Celsius and −16.9 degrees Celsius. The annual average rainfall was close to 511.1 mm [30].

As a pioneer in the development of UA in China, Beijing has developed various kinds of urban agricultural and periurban agriculture [31]: sightseeing urban agricultural parks; civic gardens; controlled environmental agriculture gardens; community gardens, and so on. To examine the user characteristics and landscape services, we chose the most popular UAPs from internet information using "flower garden .app" [32]. The closed UAPs and those with bad conditions were deleted from our investigation list. Thirty-three selected UAPs were located in the urban or periurban areas of Beijing (Figure 2a).

To investigate the profile of users of different UAPs, we used stratified random sampling and purposive sampling based on classification of 33 UAPs (Figures 1 and 2b). This ensured that samples covered different types of UAPs. We investigated the main function of each UAP by a network information query and by a field survey of 33 agricultural parks. These were categorized as picking; single rental; multifunctional rental; sightseeing and popular science; catering accommodation; and other. Fractional vegetation cover (FVC) and area were selected as indicators of heterogeneity in UAPs' landscape characteristics and functions. FVC was estimated using the dimidiate pixel model,

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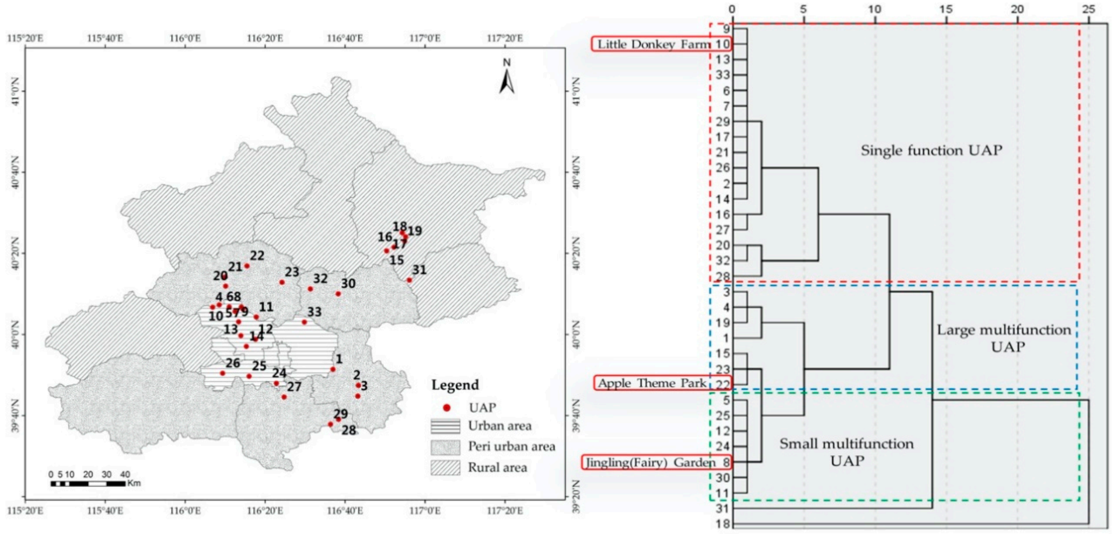
based on Landsat 8 OLI imagery data in 2017 [33]. The area was determined based on Worldview II remote sensing images (captured on 2 June, 2016). UAPs were then categorized using hierarchical cluster analysis, based on main function, vegetation coverage, and areas.




**(a) : The location of 33 urban agriculture parks**

**(b) : Classification of 33 urban agriculture parks**

**Figure 2.** Thirty-three investigated urban agriculture parks in Beijing, China. (**a**) Description of the location of 33 urban agriculture parks in Beijing. Urban areas, periurban areas, and rural areas were distinguished by the zoning in the overall planning of Beijing. (**b**) Classification of 33 urban agriculture parks. Three representative UAPs were used for user profile analysis: Jingling (Fairy) Garden (No. 8, located in an urban area); Little Donkey Farm (No. 10, located in an urban area); Apple Theme Park (No. 22, located in a periurban area).

Functional differences distinguished two UAP types—multifunction and single function. Two UAPs (Anlilong Heights and Chestnut Orchard) were ignored in classification because they were a great distance away from the other areas. The multi-functional UAPs then were classified into two types by area and FVC. Hierarchical cluster analysis classified thirty-three UAPs into these three main types: large multifunction UAPs, small multifunction UAPs, and single-function UAPs (Figure 2b). To investigate the users' characteristics in different types of UAPs, we chose Apple Theme Park from the large multifunction UAPs, Jingling (Fairy) Garden from the small multifunction UAPs, and Little Donkey Farm from the single-function UAPs (Figure 2b).

## *2.2. User Profiles*

We obtained the basic characteristics of users using questionnaires and a detailed face-to-face interview. The questionnaires focused on creating a portrait of the users, including their age, income, and education. The interviewees were also asked what kind of transportation they took and with whom they came. These questions helped us understand their purpose in visiting an UAP. The questionnaires were conducted face-to-face during the spring and summer of 2017 by three master's students. In Apple Theme Park, all users were tourists; in Little Donkey Farm, all users were gardeners, there to plant vegetables; in Jingling Garden, there were both tourists and gardeners. Therefore, four groups of people completed the questionnaires (n = 345): tourists in large multifunction UAPs, tourists and gardeners in small multifunction UAPs, and gardeners in single-function UAPs.

## *2.3. User Demand of Landscape Services and Preference Analysis*

Due to the differences between distinguished types of UAPs, in order to avoid uncertainty, we chose one type to carry out the match analysis of supply and demand of landscape services.

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Little Donkey Farm was chosen as the case study. It was constructed in April 2008 and is located at the foot of Fenghuangling, a famous natural scenic spot in the west of Haidian District of Beijing, next to the Beijing–Miyun diversion channel (Figure 2a). It was the first community-supported agriculture (CSA) farm in China, and it was a pioneer of UA in Beijing. Since its construction, Little Donkey Farm has adhered to the concept of an ecological and organic farm, on account of its good soil and water quality. Little Donkey Farm covers about 22 ha, of which about 36% is cultivated, mainly to produce "green, organic, healthy" vegetables. There are several vegetable plots rented by users who plant their own vegetables [34]. The vegetable field is 30 square meters for each member, and the members pay about 1500 CNY per year (approximately 214 US dollars/year) to the administrator.

#### 2.3.1. Unit of Landscape Services Assessment

Landscape patches were taken as the units for landscape service assessment and mapping [35]. The landscape of Little Donkey Farm was classified by the combination of land-use type, vegetation cover, and function (Table A1 in the Appendix A). The land cover classification was performed using Worldview II remote sensing images (captured on 2 June, 2016), which have a spatial resolution of 0.4 m. Information about vegetation cover and function was collected in the field study and was used in the landscape classification system. Though the main function of Little Donkey Farm is vegetable planting, land is also used in other ways, such as for basic infrastructure and scenery.

#### 2.3.2. Landscape Services Demand Assessment

According to the literature, education, exercise, natural experience, social cohesion, recreation, countryside life, and scenery services were identified as landscape services provided by UAPs [5] (Table 1).

**Table 1.** Landscape services and definitions in urban agriculture parks.

| Landscape Services | Definition |
|---|---|
| Education | Enables people to consciously increase their knowledge about agricultural culture through popular science information boards and close contact with agriculture landscape. |
| Exercise | Improves health and physical strength through agricultural activities. |
| Natural experience | Provides a place that makes people feel connected to nature. |
| Social cohesion | Enables people to enhance their relationship with companions through cooperation in agricultural cultivation. |
| Recreation | Creates a suitable atmosphere through landscaping to regulate and relax people's bodies and minds. |
| Countryside life | Provides a place away from the hustle and bustle of the city for a while, and allows self-sufficiency. |
| Scenery services | The landscape created is natural and beautiful. |

At Little Donkey Farm, the demands were assessed by a demand matrix based on questionnaires. The demand matrix shows the value of the landscape services provided by different landscape types from the perspective of users [23]. Each interviewee was asked to score their demand for certain landscape functions from 0 to 5 (0: don't need this function; 5: we need this function the most). We designed short and concise questions to describe the different functions of each landscape type (Appendix B). Pictures of each landscape type were provided to eliminate misunderstanding of landscape names. The questionnaires were conducted during spring and summer from 2017 to 2018 by five master's students. The five interviewers were specialized in landscape ecology and ecosystem services and were trained before administering the questionnaires. Fifty-six valid questionnaires on Little Donkey Farm were collected, accounting for 28% of the rental members.

The results were summarized in a demand assessment matrix. The rows of the assessment matrix correspond to each landscape type, and the columns correspond to types of landscape services [23].

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Where the rows and columns intersect, each cell includes the value of a certain service for each landscape type, calculated as the average score over 56 questionnaires. Where the value is higher, there was more demand for that service from the landscape type.

#### 2.3.3. Preference Analysis

To clarify differences in demand between distinct groups of people, basic personal information and reasons for choosing the farm were also collected during the interview. The questions included personal characteristics (age, income, education), numbers of visit per week, length of stay, transportation types, and visit companions. These indicators are preferences factors, which may influence demand for landscape services. Pearson correlation analysis was used to quantitively analyze the relationship between the demand and preferences factors.

### *2.4. Match Between Supply and Demand*

#### 2.4.1. Supply Assessment

The questionnaires administered to managers show their willingness to provide particular services to users. We interviewed four farm managers (out of six) to rate the seven types of services for various landscape types. As in the demand questionnaires, ratings were from 0 to 5 (0: no supply of the landscape service; 5: the supply of the landscape service is sufficient). The values from the questionnaires were used to calculate the average value for the four managers. The questionnaire used pictures to represent each type of landscape to eliminate the inconsistent understandings of landscape names.

To reduce the influence of subjectivity in the managers' questionnaires, we combined landscape metrics and questionnaires in assessing the supply of landscape services (Table 2). The landscape metrics reflect landscape patterns, which include composition and spatial configuration of different landscape types. This influences people's aesthetic feelings, the convenience of leisure activities, the diversity of their experiences, and the degree of ES [36]. Following relevant literature, landscape shape index (LSI), class area (CA), largest patch index (LPI), mean shape index (MSI), and similarity index (SIMI) were selected and were calculated by Fragstates software [37]. SIMI describes the resemblance of different patches in the field [38]. The higher the SIMI, the more monotonous the landscapes will be. SIMI relates to some services that require landscape diversity and heterogeneity: it was used to assess scenery services and nature experience (Table 2). Where the patch similarity is higher, so is enjoyment of the scenery and nature experience. The LSI reflects the complexity of the patch shape. The more regular the shape is, the more human participation [39]. This index reflects the value of natural experience, enjoyment of the scenery, and pursuit of the countryside life, all of which are related to nature. CA measures the composition of different landscape types [39]. Generally, the larger the patch type is, the more related landscape services there are. Indicators of area-related landscape services include physical exercise and nature experience, with emphasis on the intensity of the experience within the same type of landscape. LPI measures the dominance of a certain type of patch [37]. Generally, the greater the dominance, the greater the value of scenery services from this kind of patch will be. MSI determines whether patch shapes of a certain type of landscape are closer to a square or a circle. The more circular the patches are, the better they will communicate with each other [40]. Therefore, social cohesion value is related to MSI index. The five metrics were calculated at class level in Fragstats [37]. With the maximum and minimum values as the critical values, each landscape metric was divided into five equal grades, and a corresponding score (1–5 points) was assigned to each grade. For the service supply value, with more than two landscape metrics, the final score was calculated as the average.

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**Table 2.** Indicators of landscape service.

| Indicators | Education | Exercises | Natural Experience | Social Cohesion | Recreation | Countryside Life | Scenery |
|---|---|---|---|---|---|---|---|
| SIMI | | | √ | | | | √ |
| LSI | | | √ | | | √ | √ |
| CA | | √ | √ | | | | |
| LPI | | | | | | | √ |
| MSI | | | | √ | | | |
| Questionnaires | √ | √ | √ | √ | √ | √ | √ |

Based on the rating scales of landscape metrics and the values from questionnaires, the final supply assessment matrix was calculated using the following formula (Equation (1)).

$$G_{ij} = \frac{1}{2}\left(L_{ij} + D_{ij}\right) \quad (1)$$

where $G_{ij}$ is the value of landscape type $i$ corresponding to each service type $j$; $L_{ij}$ is the rating score of landscape metrics for each landscape type, corresponding to each service; $D_{ij}$ is the score from the UPA managers for each landscape type corresponding to each service. Due to the fact that $L_{ij}$ and $G_{ij}$ are all ranks and standardized values, we gave them as the same weights. Although the values of $G_{ij}$ are of no practical significance, a comparison of landscape services from different landscape types can indicate which landscape type has better service provision.

#### 2.4.2. Budgets of Supply and Demand

The supply–demand budgets determine whether the landscape services provided by each landscape patch meets the needs of users. The supply of each landscape service type was subtracted from the demand, and the calculation results were aggregated into a supply–demand budget matrix. Each service in the budget matrix corresponded to a certain landscape patch. The budget values for each landscape type were assigned to the corresponding landscape patches to obtain the landscape service mapping. According to Natural Breaks, the supply–demand budget was divided into five levels: values between 0–1 and −1–0 show a basic balance of supply and demand; values between 4–5 and −5–−4 show a serious imbalance of supply and demand [23].

The total supply and demand were calculated by summing the values of each service for all the landscape types. The summed variables of the different services do not represent the actual variable of total services. They are used to compare which landscape types can provide the most high-value landscape services. If one landscape type has many kinds of services with high values, the sum for the landscape services will be high. After summation, a four-quadrant chart was drawn using a middle-digit standardized ranking of services values.

## 3. Results

### *3.1. Users' Characteristics in Various Types of UAPs*

The average area of large multifunction UAPs was 91.40 ha, located in periurban areas at the edge of urban areas (Figure 2). These have diverse functions, such as picking up, sightseeing, and even, in some of the UAPs, accommodation. The average area of small multifunction UAPs was 10.99 ha, and most of them were located in periurban areas and rural areas (Figure 2). Single-function UAPs focused on just one main function, such as planting vegetables or picking up.

There were no significant differences in income, education, and age between the users in different types of UAPs. Thus, we analyzed these three variables together. Results showed that most of the users were middle class, with an upper-middle level income and a good education. Forty-two percent (n = 345) of the interviewees' incomes were between 12,000 and 18,000 CNY/month (1690–2634 dollars/month). Most of them were well educated, with 89% of the interviewees holding bachelor's, master's, or doctoral degrees. The users were mostly middle-aged, between 31 and 50 years old (Table 3).

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**Table 3.** Users' characteristics (income, education, and age).

| Types of Prosperities | Categories | Total (%), *n* = 345 |
|---|---|---|
| Income (CNY) | 0–6000 | 0.0 |
| | 6000–12,000 | 27.7 |
| | 12,000–18,000 | 42.6 |
| | 18,000–24,000 | 16.6 |
| | 24,000–30,000 | 12.5 |
| | Above 30,000 | 0.7 |
| Education | Technical secondary school | 3.5 |
| | College degree | 7.0 |
| | Bachelor's degree | 57.0 |
| | Master's degree | 23.3 |
| | Doctor's degree | 9.3 |
| Age | 21–30 | 9.3 |
| | 31–40 | 31.4 |
| | 41–50 | 39.5 |
| | 51–60 | 14.0 |
| | >60 | 5.8 |

There were significant differences between three types of UAPs in companion structure, i.e., in whom the interviewees came to the UAPs with (Figure 3). The companion structures help us to understand the purposes of visits to UAPs. Families prefer single-function UAPs and small multifunction UAPs. People prefer to participate in planting activities with their spouse. In single-function UAPs, the main functions were renting a plot, planting vegetables, picking up vegetables, and taking them home. For the gardeners in multifunction UAPs, the main function was planting activities. In these two groups, the largest portion of interviewees visited with a spouse (Figure 3). In contrast, most of the interviewees at large, multifunction UAPs (67.4%) said they came to the UAPs with their friends.

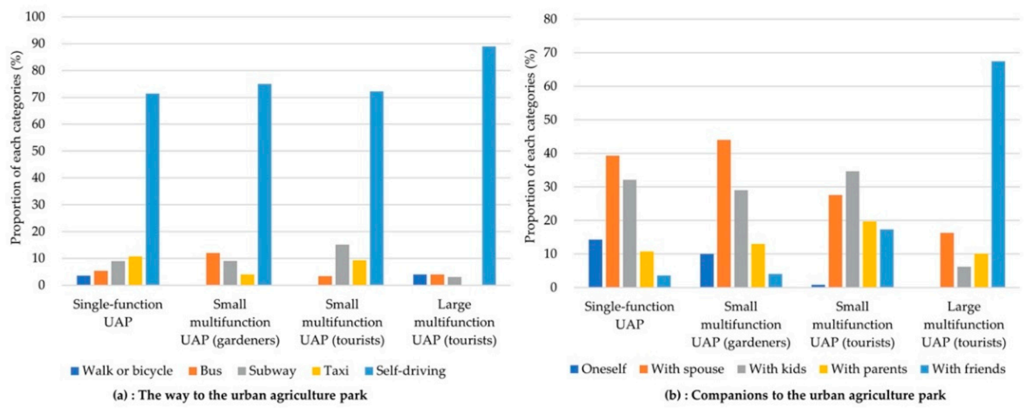


**Figure 3.** Users' ways of traveling to urban agriculture parks, and with whom they visited (total interviewees: 345). Pearson $\chi^2$ test showed that companions are significantly different between four groups of users at the 0.001 level.

## 3.2. *Services Demand and Preference Analysis in Little Donkey Farm*

### 3.2.1. Landscape Structure

A landscape structure map is the essential way of mapping landscape services. The main area of Little Donkey Farm is the vegetable plots, including vegetable plots planted by members, a vegetable greenhouse, and a vegetable plot planted by the managers (Figure 4). There were 14 patches of vegetable plots planted by members, accounting for 17.6% of the total areas. Every member has a 30 $m^2$ plot, where they can plant their favorite vegetables. There are also plots designed to provide infrastructure for vegetable cultivation, such as a storage room, tool house, and compost heap. Some

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built-up lands are used for member services, such as a rest area, parking plot, service center, and dining room, which occupy only 1.8% of the total areas. The zoo, landscape lake, and wetland provide a greater range of functions in a single-function garden. These services are only for members who rent a plot. Some posters hang on the sides of the field roads to provide knowledge of vegetables. The other fields supply fruit picking up, vegetable picking up, activities and sight viewing for members.

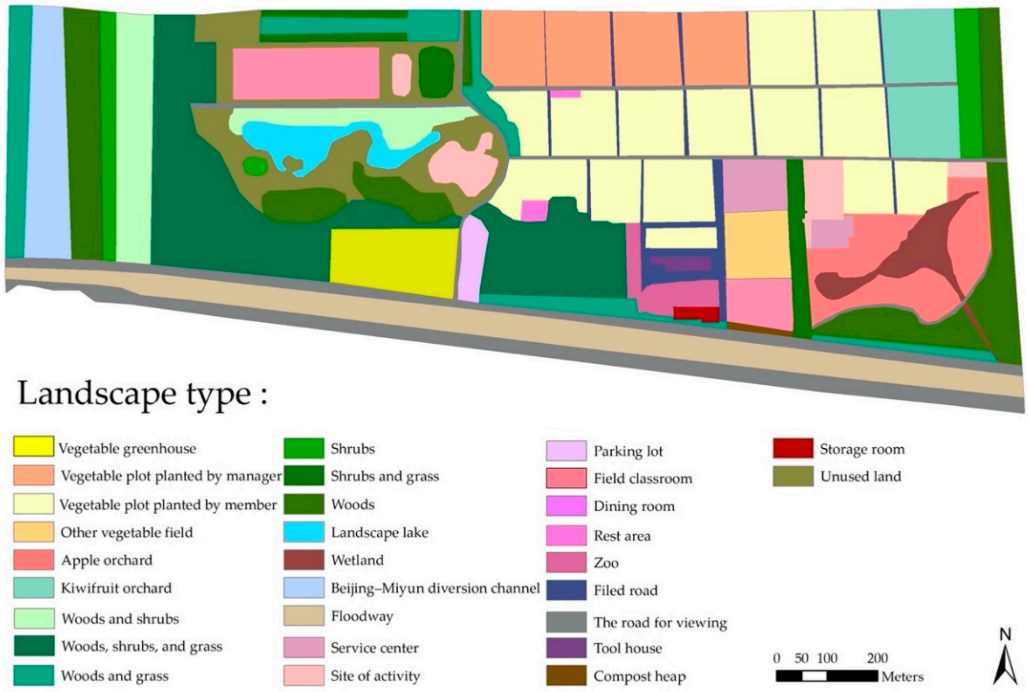


**Figure 4.** Landscape structure map of Little Donkey Farm.

### 3.2.2. Demand of Landscape Services

The vegetable plots planted by members were the landscape type with the highest demand from users in Little Donkey Farm (Table A2 in the Appendix A). The highest demand value for four out of seven services were found in the vegetable plots planted by members. The area with the greatest demand for recreation was not in the vegetable patch, but in the rest areas, where users preferred more recreation services. The dining room was the landscape where users required the most social cohesion services. The "woods and grass" responded to the highest demand of scenery service.

If service demand is associated with the areas of different landscape types, the value of the service will grow continuously with an increase in landscape areas. The demand values for the ten types of landscape were higher than the values provided by landscapes with smaller areas. The rest area was the smallest landscape, while users demanded the most recreation service from it (Table A2 in the Appendix A, Figure 5). Vegetable plots planted by members represented a landscape type where service demand was the greatest and occupied the largest area. Among landscape types whose size was between that of the rest areas and the vegetable plots planted by members, some were linked directly with agricultural activities and their area was proportional to demand (Figure 5: picking area; landscape lake; activity square; shrubs and grass; vegetable greenhouse; apple orchard; vegetable plot planted by manager; woods, shrubs, and grass). However, a few landscape types did not fit the growing trend (Figure 5), which exposed the mismatch between demand for services and landscape area. The three categories in which service declined significantly compared to the landscapes of similar sizes were the zoo, field classroom, and the woods (Figure 5).

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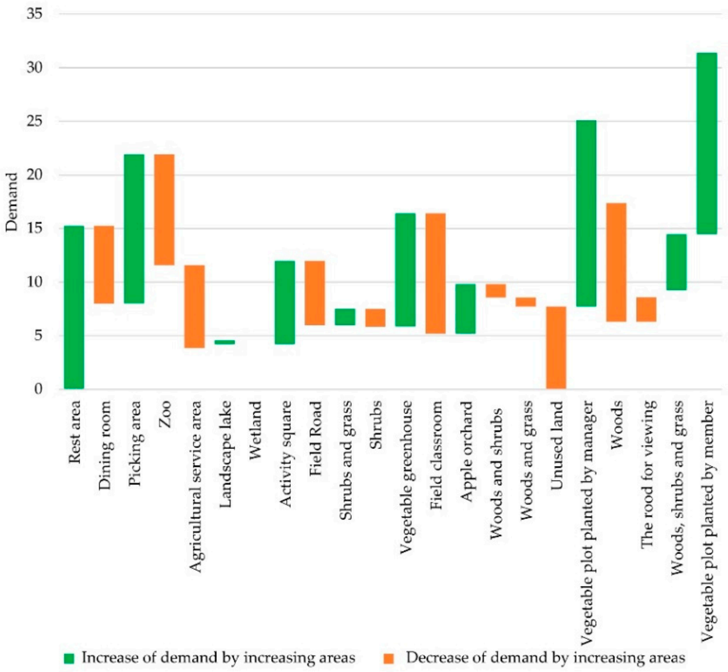


**Figure 5.** Waterfall chart of demand changes from small-area landscapes to large-area landscapes types (top to bottom). The length of bars represents the degree of service increase (or decreases) for this landscape type over the previous landscape type.

### 3.2.3. Relationship between Users' Characteristics and Service Demand

Correlation analysis between the basic situation of users and their demand for landscape services showed that there were different factors closely related to various landscape services (Table 4). The correlation between age and service demand showed that retired persons were sensitive to services of exercise, pursuit of countryside life, and scenery services. For older people, UAP requires more diverse landscapes and more convenient transportation. Parents and highly educated people demand more education services provided by information boards and popular science activities (Table 4). Beautiful views may attract people to visit UAPs more frequently and stay longer, as the correlation coefficient between scenery services and stay time was higher (Table 4). Duration of stay was significantly positively correlated with four types of landscape services (exercise, social cohesion, countryside life, scenery service), and was the factor most correlated with the services (Table 4).

**Table 4.** Correlations between preferences factors and landscape service demand.

| | **Age** | **Education** | **Frequency of Visiting per Week** | **The Duration of Stay** | **The Way to Visit the Garden** | **Companion** |
|---|---|---|---|---|---|---|
| Education | 0.003 | 0.385 ** | 0.038 | −0.094 | 0.057 | −0.047 |
| Exercise | 0.446 ** | 0.013 | −0.136 | 0.323 ** | −0.230 * | −0.216 * |
| Natural experience | 0.113 | 0.201 * | 0.057 | 0.071 | −0.180 | 0.042 |
| Social cohesion | 0.140 | 0.001 | −0.066 | 0.287 ** | −0.021 | −0.037 |
| Recreation | 0.290 ** | 0.097 | −0.026 | 0.169 | −0.003 | 0.002 |
| Countryside life | 0.341 ** | 0.112 | −0.071 | 0.297 ** | −0.183 * | −0.126 |
| Scenery service | 0.025 | 0.153 | 0.196 * | 0.285 ** | −0.121 | 0.041 |

Note: * correlation is significant at the 0.05 level; ** correlation is significant at the 0.01 level.

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## 3.3. Budget of Supply and Demand

### 3.3.1. Supply of Landscape Services

Overall, the greatest supply of landscape services was from the vegetable plots planted by members (Table A3 in the Appendix A). The greatest supply of education, exercise, natural experience, recreation, and enjoyment of countryside life was from the vegetable plots planted by members. The natural experience and enjoyment of countryside life in the picking area were tied for the highest score with the vegetable plots planted by members. The social cohesion service in the picking area was the highest among all landscape types. The most valuable type of landscape for scenery services was the woods.

### 3.3.2. Match Between Supply and Demand

The supply of landscape services for exercise and enjoyment of countryside life met the demand in various landscapes, but the supply of education, recreation, and scenery services did not meet the demand in some landscapes (Figure 6). Overall, 31.5% of the area did not meet the demand for scenery services—this mainly included the field road, the woods, and the landscape lake. The supply of education services was not enough to meet the demand in 11% of the study area—mainly including the zoo, the agricultural service center, the vegetable plots planted by managers, and the vegetable greenhouse. The landscapes where recreation services did not meet the demand included the zoo, the rest areas, activity square, and apple orchards, accounting for 6.9% of the total area of the study area.

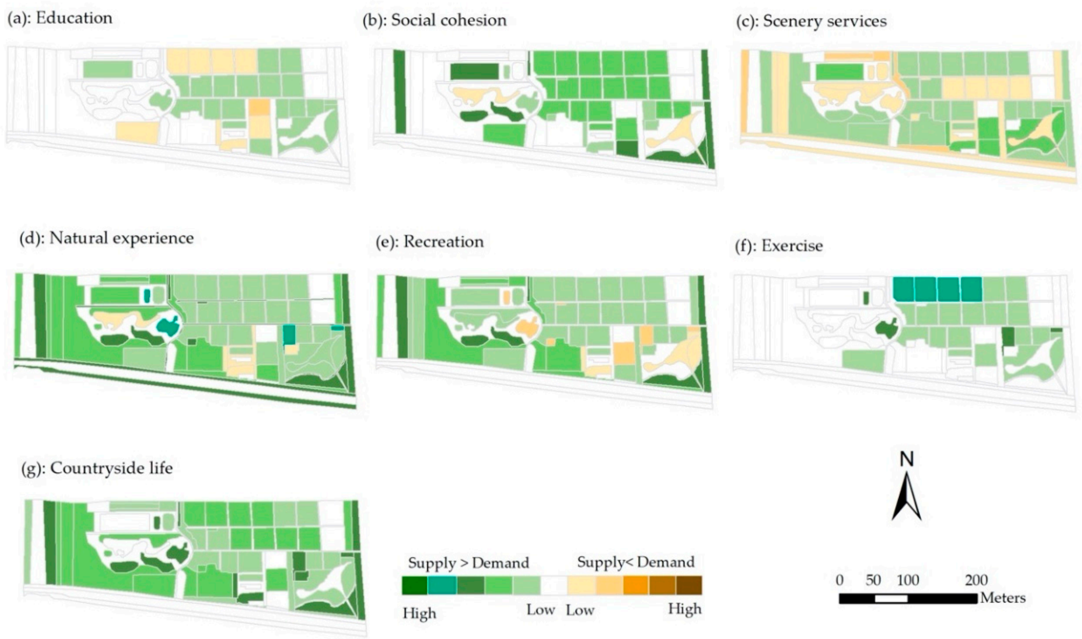


**Figure 6.** Budget map of supply and demand for seven types of landscape services (**a**) education, (**b**) social cohesion, (**c**) scenery services, (**d**) natural experience, (**e**)recreation, (**f**) exercise, and (**g**) countryside life in Little Donkey Farm.

By comparing total supply and total demand, landscapes can be divided into three types: high supply–high demand, high supply–low demand, and low supply–low demand (Figure 7). There was no landscape with high demand–low supply in the study area. The main parts of the study area, vegetable plots planted by members and picking areas, had high supply and demand levels. Vegetable plots planted by managers, the activity square, and the vegetable greenhouse had high supply–low demand (Figure 7). The remaining landscape types were mostly located in the low supply–low demand quadrant (Figure 7). Except for the wetland, the landscape lake, and the agriculture center, demand

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for landscape services in the low demand–low supply quadrant was lower than supply (Figure 7). The supply for the wetland, landscape lake, and service center did not meet the overall demand.

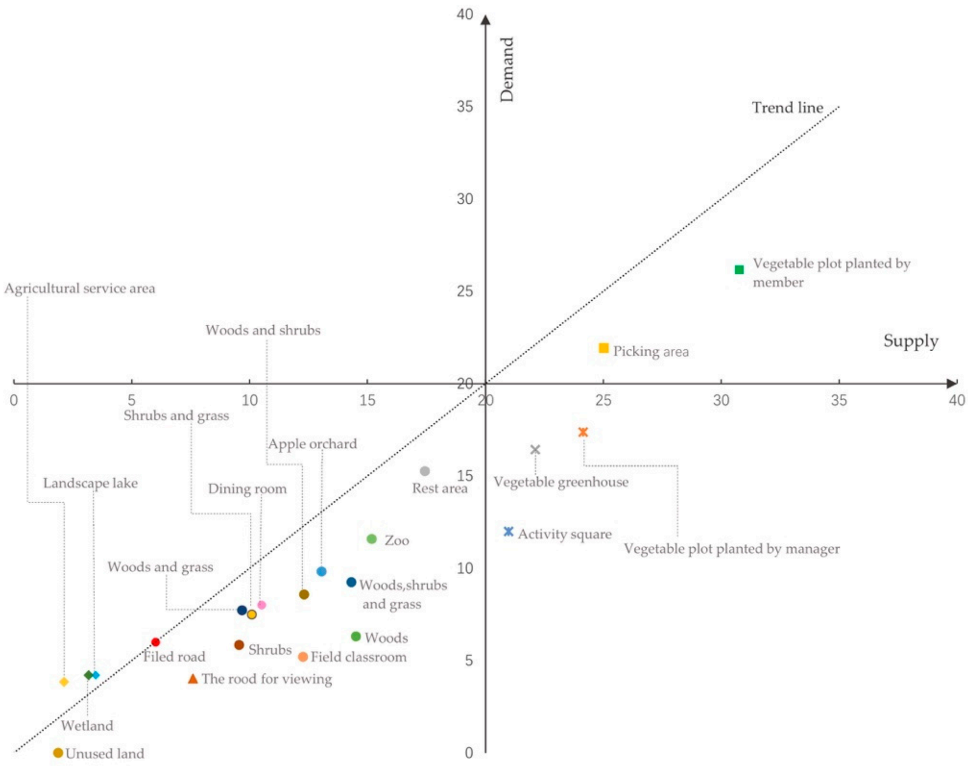


**Figure 7.** Four-quadrant chart of total supply and demand for landscape services in Little Donkey Farm.

## 4. Discussion

This study investigated the user profile of UAPs in Beijing and provided an approach to understand the relationship between users' characteristics and UA from a landscape service perspective. It employed a supply and demand matrix using landscape indicators and questionnaires.

### *4.1. Differences of User Profiles*

There is a significant difference between the characteristics of users of Chinese UAPs and users of UA in other countries. Among 345 interviewees in Beijing, there was a lower proportion of elderly people than in the studies from Spain and Australia, where 80% and 65% of the gardeners were over 50 [9,41]. Middle-aged people (41–50) were the highest proportion of users in Beijing's UAP (Table 3). Our surveys in Beijing showed that people who use UAPs have higher incomes than previous studies, which found users of UA generally had low incomes [2,9,42,43]. Most of the users had middle- to upper-level incomes and high education level (Table 3). The interviewees' incomes were much higher than the average monthly income of Beijing residents in 2019 (3435 CNY). The member fee costs may be the reason [44]. In Beijing, a 30 $m^2$ site rents for more than 1500 CNY (214 US dollars) per year. Some of the allotment gardens are close to residents in Europe and Latin America [9], while in Beijing, most of them are far away from residential areas. This is why 70% of the gardeners need to drive a car to the UAP (Figure 3).

One possible reason for the differences is the function of UAPs in Beijing. We compared the research results in Europe, South America, and Asia, with the corresponding functions of different types of UAPs in Beijing. The single-function UAPs are like allotment gardens in Europe and pick-your-own farms [45–47], and their main function is for planting vegetables and picking fruits. Multifunction UAPs are more like urban farms, institutional gardens, agriculture parks, tourism farms, and farming

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experience farms [45,47]. UAPs in Beijing have a broader range of functions. Food production is not the greatest need of users. Even the relatively single-function agriculture has evolved into multifunctional UA areas, providing more recreation and ES for urban residents [9,46,48]. Compared to the original aims of food provision, UA has begun to fulfill multiple functions for residents [5,45]. Among all the cultural services, recreation and physical exercise were what users valued most in our case study (Table A2 in the Appendix A). Social cohesion is a function that is heavily involved in both our research and previous research [46,49].

Another reason for the differences is the urbanization progress in China. The characteristics and development process of China's UA are closely linked with China's urbanization process, population migration, agricultural development, and land system. As a country that has historically faced doubt about whether it can feed its entire population through agriculture, China has made food security one of its most important state policies, and agricultural development is centered on ensuring food security. With the development of globalization and urbanization, China's agriculture has begun to show versatility. A statistical assessment indicated that 62.9% of the urban residents come from rural areas [50]. Although living in the city, these people and their descendants have a strong desire for rural life. Therefore, the edge of the city and surrounding areas have become popular spots of UA. This background is greatly different from the original purpose of allotment gardens: poverty alleviation in the 18th century [46]. However, they have much in common in terms of function and landscape structure. UAPs in Beijing mainly serve the middle class, who have larger incomes and more education (Table 3). Their desire for UA is mainly to exercise and enjoy the rural life.

### *4.2. Implications of Landscape Services Analysis of UAPs*

Analysis of user sources and preferences provides a basis for development for potential users of UAPs. The values of different services mainly depend on users' age and education. In the investigation, people wanted to get physical exercise by engaging in agricultural activities, especially older people (Table 4). This demand put higher requirements on the size of each members' allocated patch. In a relatively small garden, people tend to need less energy to complete vegetable planting. The users valued vegetable plots greatly, where they also required multiple services. The managers mostly sought a combination of elements, like parks, allotment gardens, and picking-up gardens, to gain more economic benefits. What was previously a win–win situation—farmers' financial gain and gardeners' recreational enjoyment—is now a problem. Research into mixed-use land and the right proportion of built-up and infrastructure will be key.

Our research used demand and supply assessment of landscape services based on questionnaires, and can inform design of UAPs fully considering the intentions of users and administrators [27]. Among the supply and demand of landscape services, the supply and demand for countryside life, exercise, and social cohesion were balanced (Figure 6). The areas with the greatest value for promoting social cohesions are picking areas, vegetable plots planted by members, rest areas, and dining room (Table A2 in the Appendix A). The construction of the rest area in Little Donkey Farm is distinctive: the rest area was built around the vegetable plots and is connected to the surrounding landscape. This design has promoted communication between people and meets the need for social cohesion.

There are some gaps between supply and demand, especially in the education and scenery services in Little Donkey Farm (Figure 6). The space utilization of the farm is not perfect: a lot of places have disorderly compost, affecting the beauty, so the users' needs cannot be met. In the field interviews, many users expressed hope that the farm could improve its management and strengthen the constructions. The concept of autonomy can also be introduced, to allow members to participate in the overall planning and construction of agricultural parks to achieve more sustainable development [46,51]. In Little Donkey Farm, woods, shrubs, and grass are the landscape types that offer significant scenery services (Table A2 in the Appendix A). As these landscapes are separated from people's main activity areas, people's satisfaction in the pursuit of scenery services is affected. Administrators in single-function

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UAPs can optimize landscape types by connecting vegetable plots to some relatively natural fields, such as woods, shrubs, and grass.

From the perspective of overall landscape services from different landscape types, landscapes needed to be optimized to include two types: types that users valued highly, and types that do not currently supply sufficient services (Figure 7). According to the statistics of total service value, the most important landscape types are the picking area and the vegetable plot, which should be the focus of the planning and design of the whole agricultural park. The areas with supply deficits included the landscape lake, the wetland, and the agriculture service center, most of which provide scenery services. To better meet users' needs, UAP should be built with small but sophisticated scenic spots and beautiful environments, rather than neglecting these because of the lack of direct economic benefits. Some landscape patches occupy larger areas but demand less services, such as zoo, field classrooms, and woods, which also need to be optimized (Figure 5).

### *4.3. Limitation and Future Research*

The approach we used requires a lot of field surveys and interviews; these take a lot of time, which makes it hard to conduct questionnaires for each UAP. In this study, UAPs in Beijing were classified and sampled before the questionnaire to increase the universality of the research results. However, it is uncertain whether the user characteristics may be different from the results of larger-range surveys. Little Donkey Farm, selected in the study, was a pioneer of single-function (rental) farming, which was imitated by many subsequent UAPs. Therefore, the results of the landscape services analysis represent the general situation of single-function UAPs. Beijing's agricultural parks have been developing rapidly, with the ES value of UA growing from 48.206 billion USD in 2012 to 52.625 billion USD in 2018 [31]. Although the numbers of UAPs cannot be counted precisely, it must have been increasing, and the 33 agricultural parks selected in this study are not representative of all agricultural parks.

International studies have shown that UA as an approach to NBS is an important trend in sustainable development [5,18]. Although we studied some site of urban agricultural parks in Beijing, our potential contribution is to provide basic research data for future consideration of UA as an approach to NBS. From the perspective of a city as a whole, the inclusion of UA into the NBS framework requires a careful consideration of local management policies, climate change conditions, and resource utilization characteristics, and a balance between ecosystem services and ecosystem disservices [27]. The model should be multilevel, and it is necessary to analyze the ecological, cultural, and social values that may be generated by different types of UA [51]. Different types of UA have various functions, with focuses including cultural value, food production, and environmental regulation. Thus, a suitable "niche" can be found to replace some functions of green space, while land-use policy and owner's equity can be guaranteed.

At present, the management of agricultural parks in Beijing is bottom-up and relatively isolated, and there are no well-established projects, as in Europe [49,52]. Our interviewees were people who have used urban agricultural landscape services, even for many years. From a planning perspective on how to develop UA, information on people who do not use UAPs is particularly important, as their demands may differ from existing users. Current planning and design may not meet their demands. They may be unable or unwilling to use UAPs due to factors like distance and cost. In the process of implementing NBS and edible urbanism 5.0, current agricultural parks in China cannot support the food security of low-income people and their demand should be explored in future studies [53]. To provide social cohesion and food security to more low-income groups in the city, one possible approach is to switch low-efficiency, neglected community green space to community gardens, and study how to provide broader and more equitable ES through more intensive and easily accessible ways [17,46]. Meanwhile, policymakers should pay close attention to whether UA will cause water consumption problems in the process of climate change.

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## 5. Conclusions

We have applied a landscape services assessment to UA, based on questionnaires and an analysis of landscape structure. Users' characteristics and preferences were also investigated. The results indicated the main users of UAPs in Beijing are middle-income class, and most of them are well educated, which is different from UA users in other countries. Preferences analysis showed that user characteristics greatly influence the services demand. Comparing with a previous study [15], the values of different services mainly depend on users' income, age, and education.

The case study in Little Donkey Farms showed that the match between supply and demand has spatial variation inside a UAP. The supply of landscape services for exercise and enjoyment of countryside life met demand in various landscapes, while the supply of education, recreation, and scenery services for some landscape types did not meet the demand. Overall, 31.5% of the areas did not meet the demand for scenery services. Both landscape services analysis and preferences analysis confirmed the lack of scenery services. The fields with supply deficits are landscapes where people expected scenery services, which need more design and administration. The landscapes with agriculture activities, such as vegetable plots planted by members and picking areas, are the high demand–high supply sites, which satisfy users' needs well. Landscapes that can provide scenery services, such as woods and grass, need to be better configured. Some infrastructure with popular science propaganda and recreation can be improved to provide more education and recreation services.

This study applied an approach to landscape services assessment in UA areas, and also created potential for landscape planning within the agriculture parks to balance demand and supply. Our research focused on a pioneer of single-function (rental) farming; future application to other kinds of UAPs may clarify the supply–demand relationship in UAs.

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

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## Appendix A

**Table A1.** The description of landscape classifications in Little Donkey Farm.

| Landscape Classification | Land Cover | Function |
|---|---|---|
| Vegetable plot planted by member | Farmland | Land where members grow their own vegetables |
| Vegetable plot planted by manager | Farmland | Administrators plant fresh vegetables for members |
| Vegetable greenhouse | Farmland | A land for growing vegetables in a greenhouse |
| Apple orchard | Garden | A garden for planting apple trees |
| Woods | Forest land | A land that only grows trees |
| Woods and grass | Forest land | A land that grows trees and is covered with flowers and herbal plants |
| Shrubs | Forest land | A land that grows only shrubs |
| Shrubs and grass | Forest land | A land that grows only shrubs and is covered with flowers and herbal plants. |
| Woods and shrubs | Forest land | Land covered by trees and shrubs |
| Woods, shrubs, and grass | Forest land | A land planted with trees and shrubs and covered with flowers and plants |
| Dining room | Commercial land | The land for providing catering services to visitors |
| Site of activity | Administration and public services | Land used for activities organized by agricultural administrators or members |
| Field classroom | Administration and public services | Land used by agricultural administrators for teaching of agricultural knowledge |
| Rest area | Administration and public services | A small patch to take a break from agriculture activities |
| Service center | Administration and public services | Land used by agricultural managers for instruction, self-promotion, etc. |
| Tool house | Land for warehouses | For reserve tools and materials |
| Zoo | Administration and public services | Land used for raising various animals and for visitors' viewing (the donkey where Little Donkey Farm's name comes from lives there) |
| Filed road | Land for roads and transport facilities | Roads for cultivation and rest |
| The road for viewing | Land for roads and transport facilities | Roads for visitors' viewing |
| Landscape lake | Water and water facilities' land | The lake formed by artificial excavation to provide beautiful waterscape |
| Unused land | Other sites | Has not been used |
| Wetland | Other sites | A natural or artificial marsh near the lake |
| Beijing–Miyun diversion channel | Water and water facilities' land | A channel used to transport water from reservoir to city |
| Kiwifruit orchard | Garden | A garden for planting kiwifruit trees |
| Other vegetable field | Farmland | Providing vegetables for sales or the dining room |
| Floodway | Water and water facilities' land | A channel used to help increase the flood-fighting capacity by helping the main channel to disperse flood pressure |
| Compost heap | Land for warehouses | The land used for stacking cow dung and dead branches and leaves |
| Parking lot | Land for roads and transport facilities | Land for parking |
| Storage room | Land for warehouses | For reserve materials |

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**Table A2.** Landscape services demand for each landscape class.

| Landscape Structure | Education | Exercise | Natural Experience | Social Cohesion | Recreation | Countryside Life | Scenery Services |
|---|---|---|---|---|---|---|---|
| Vegetable plot planted by member | **3.21** | **4.43** | **4.29** | 3.36 | 4.20 | **4.29** | 2.39 |
| Vegetable plot planted by manager | 2.57 | 1.12 | 3.54 | 2.55 | 2.12 | 3.24 | 2.23 |
| Vegetable greenhouse | 2.23 | 2.87 | 2.89 | 2.64 | 1.39 | 2.87 | 1.54 |
| Picking area | 2.97 | 3.13 | 3.76 | 3.65 | 4.02 | 2.77 | 1.63 |
| Kiwifruit orchard | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Apple orchard | 0.43 | 1.22 | 2.26 | 0.00 | 1.97 | 1.83 | 2.11 |
| Woods | 0.00 | 0.00 | 1.29 | 0.00 | 1.12 | 0.34 | 3.56 |
| Woods and grass | 0.00 | 0.00 | 1.53 | 0.00 | 1.41 | 0.75 | **4.03** |
| Shrubs | 0.00 | 0.00 | 1.31 | 0.00 | 1.15 | 0.43 | 2.96 |
| Shrubs and grass | 0.00 | 0.00 | 1.63 | 0.00 | 1.52 | 0.92 | 3.43 |
| Woods and shrubs | 0.00 | 0.00 | 1.87 | 0.00 | 1.71 | 1.24 | 3.76 |
| Woods, shrubs, and grass | 0.00 | 0.00 | 1.93 | 0.00 | 2.02 | 1.48 | 3.82 |
| Dining room | 0.00 | 0.00 | 0.96 | **4.38** | 1.42 | 1.25 | 0.00 |
| Warehouse | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Compost place | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Activity square | 0.83 | 0.92 | 0.15 | 3.53 | 4.31 | 0.00 | 2.25 |
| Field classroom | 0.79 | 0.00 | 1.74 | 0.93 | 1.03 | 0.00 | 0.71 |
| Rest area | 0.00 | 0.00 | 0.00 | 4.02 | **4.79** | 3.12 | 3.33 |
| Agricultural service area | 3.85 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Tool room | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Zoo | 2.41 | 0.00 | 3.18 | 2.42 | 2.30 | 1.16 | 0.12 |
| Field Road | 0.00 | 0.00 | 3.13 | 0.00 | 0.00 | 0.00 | 2.86 |
| The rood for viewing | 0.00 | 0.00 | 1.89 | 0.00 | 0.00 | 0.00 | 2.14 |
| Parking lot | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Landscape lake | 0.00 | 0.00 | 2.63 | 0.53 | 0.84 | 0.00 | 0.21 |
| Headrace channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Flood discharge channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unused land | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wetland | 0.00 | 0.00 | 2.63 | 0.53 | 0.84 | 0.00 | 0.21 |

Note: The highest value is in bold for each service. The value of 0 means users don't need this service; the value of 5 means the need of this certain service is greatest.

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**Table A3.** Landscape services supply for each landscape class.

| Landscape Structure | Education | Exercise | Natural Experience | Social Cohesion | Recreation | Countryside Life | Scenery Services |
|---|---|---|---|---|---|---|---|
| Vegetable plot planted by member | **4.38** | **5.00** | **4.50** | 4.75 | **4.38** | **4.50** | 3.25 |
| Vegetable plot planted by manager | 2.50 | 4.13 | 4.13 | 4.00 | 3.00 | 3.38 | 3.00 |
| Vegetable greenhouse | 1.88 | 3.25 | 3.84 | 3.88 | 2.38 | 4.38 | 2.50 |
| Picking area | 2.00 | 3.50 | **4.50** | **5.00** | 2.38 | **4.50** | 3.13 |
| Kiwifruit orchard | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Apple orchard | 0.50 | 2.50 | 3.21 | 0.00 | 1.00 | 2.63 | 3.21 |
| Woods | 0.00 | 0.00 | 3.63 | 0.00 | 4.00 | 2.75 | 4.13 |
| Woods and grass | 0.00 | 0.00 | 2.92 | 0.00 | 2.63 | 1.38 | 2.75 |
| Shrubs | 0.00 | 0.00 | 2.79 | 0.00 | 1.63 | 2.25 | 2.88 |
| Shrubs and grass | 0.00 | 0.00 | 2.42 | 0.00 | 2.00 | 2.38 | 3.29 |
| Woods and shrubs | 0.00 | 0.00 | 3.09 | 0.00 | 2.63 | 2.88 | 3.71 |
| Woods, shrubs and grass | 0.00 | 0.00 | 3.38 | 0.00 | 3.88 | 2.88 | **4.17** |
| Dining room | 0.00 | 0.00 | 0.00 | 4.88 | 2.13 | 3.50 | 0.00 |
| Warehouse | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Compost place | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Activity square | 2.00 | 3.88 | 3.63 | 4.50 | 2.75 | 2.38 | 1.84 |
| Field classroom | 1.38 | 0.00 | 3.04 | 3.38 | 2.00 | 0.00 | 2.46 |
| Rest area | 0.00 | 0.00 | 2.92 | 4.38 | 3.00 | 4.13 | 3.00 |
| Agricultural service area | 2.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Tool room | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Zoo | 2.38 | 0.00 | 2.96 | 2.50 | 2.00 | 3.38 | 1.96 |
| Field Road | 0.00 | 0.00 | 3.88 | 0.00 | 0.00 | 0.00 | 2.13 |
| The rood for viewing | 0.00 | 0.00 | 3.88 | 0.00 | 0.00 | 0.00 | 3.71 |
| Parking lot | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Landscape lake | 0.00 | 0.00 | 2.34 | 0.00 | 1.13 | 0.00 | 0.00 |
| Headrace channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Flood discharge channel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Unused land | 0.00 | 0.00 | 1.88 | 0.00 | 0.00 | 0.00 | 0.00 |
| Wetland | 0.00 | 0.00 | 2.67 | 0.00 | 0.50 | 0.00 | 0.00 |

Note: The highest value is in bold for each service. The value of 0 means this landscape does not provide the service; the value of 5 means the provision of the certain service is greatest.

## Appendix B

Please score your demands of landscape type *name* by 0–5 (0, I don't need this function; 5, I need this function greatest)

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A. Obtain knowledge about agriculture (education service). Score:
B. Do some physical exercises (exercise service). Score:
C. Natural experience (natural experience service). Score:
D. Enhance the connection to friends and families (social cohesion). Score:
E. Relax and recreation (recreation service). Score:
F. Seeking a countryside life (countryside life service). Score:
G. Enjoy the beautiful views (scenery service). Score:

## References


1. United Nations (UN). Transforming Our World: The 2030 Agenda for Sustainable Development. 2015. Available online: https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed on 10 January 2020).
2. Khumalo, N.Z.; Sibanda, M. Does urban and peri-urban agriculture contribute to household food security? An assessment of the food security status of households in tongaat, eThekwini municipality. *Sustainability* **2019**, *11*, 1082. [CrossRef]
3. Ayambire, R.A.; Amponsah, O.; Peprah, C.; Takyi, S.A. A review of practices for sustaining urban and peri-urban agriculture: Implications for land use planning in rapidly urbanising Ghanaian cities. *Land Use Policy* **2019**, *84*, 260–277. [CrossRef]
4. Gradinaru, S.R.; Triboi, R.; Ioja, C.I.; Artmann, M. Contribution of agricultural activities to urban sustainability: Insights from pastoral practices in Bucharest and its peri-urban area. *Habitat Int.* **2018**, *82*, 62–71. [CrossRef]
5. Artmann, M.; Sartison, K. The role of urban agriculture as a nature-based solution: A review for developing a systemic assessment framework. *Sustainability* **2018**, *10*, 1937. [CrossRef]
6. Li, Y.; Zhu, S. Discussion on planning of overall urban agriculture park. *Agric. Sci. Technol.* **2013**, *14*, 1521–1525.
7. De Bon, H.; Parrot, L.; Moustier, P. Sustainable urban agriculture in developing countries. A review. *Agron. Sustain. Dev.* **2010**, *30*, 21–32. [CrossRef]
8. Barthel, S.; Isendahl, C. Urban gardens, agriculture, and water management: Sources of resilience for long-term food security in cities. *Ecol. Econ.* **2013**, *86*, 224–234. [CrossRef]
9. Langemeyer, J.; Camps-Calvet, M.; Calvet-Mir, L.; Barthel, S.; Gomez-Baggethun, E. Stewardship of urban ecosystem services: Understanding the value(s) of urban gardens in Barcelona. *Landsc. Urban Plan.* **2018**, *170*, 79–89. [CrossRef]
10. Lin, B.B.; Philpott, S.M.; Jha, S. The future of urban agriculture and biodiversity-ecosystem services: Challenges and next steps. *Basic Appl. Ecol.* **2015**, *16*, 189–201. [CrossRef]
11. Doherty, K. Urban Agriculture and Ecosystem Services: A Typology and Toolkit for Planners. Master's Thesis, University of Massachusetts Amherst, Amherst, MA, USA, 2015.
12. Lee, G.-G.; Lee, H.-W.; Lee, J.-H. Greenhouse gas emission reduction effect in the transportation sector by urban agriculture in Seoul, Korea. *Landsc. Urban Plan.* **2015**, 140. [CrossRef]
13. Waffle, A.D.; Corry, R.C.; Gillespie, T.J.; Brown, R.D. Urban heat islands as agricultural opportunities: An innovative approach. *Landsc. Urban Plan.* **2017**, *161*, 103–114. [CrossRef]
14. Sorace, A. Value to wildlife of urban-agricultural parks: A case study from Rome urban area. *Environ. Manag.* **2001**, *28*, 547–560. [CrossRef]
15. Da Silva, I.M.; Fernandes, C.O.; Castiglione, B.; Costa, L. Characteristics and motivations of potential users of urban allotment gardens: The case of Vila Nova de Gaia municipal network of urban allotment gardens. *Urban For. Urban Green.* **2016**, *20*, 56–64. [CrossRef]
16. Bendt, P.; Barthel, S.; Colding, J. Civic greening and environmental learning in public-access community gardens in Berlin. *Landsc. Urban Plan.* **2013**, *109*, 18–30. [CrossRef]
17. Fox-Kaemper, R.; Wesener, A.; Muenderlein, D.; Sondermann, M.; McWilliam, W.; Kirk, N. Urban community gardens: An evaluation of governance approaches and related enablers and barriers at different development stages. *Landsc. Urban Plan.* **2018**, *170*, 59–68. [CrossRef]
18. Willemen, L.; Verburg, P.H.; Hein, L.; van Mensvoort, M.E.F. Spatial characterization of landscape functions. *Landsc. Urban Plan.* **2008**, *88*, 34–43. [CrossRef]


المنارة للاستشارات
www.manaraa.com

19. Termorshuizen, J.W.; Opdam, P. Landscape services as a bridge between landscape ecology and sustainable development. *Landsc. Ecol.* **2009**, *24*, 1037–1052. [CrossRef]
20. Clinton, N.; Stuhlmacher, M.; Miles, A.; Aragon, N.U.; Wagner, M.; Georgescu, M.; Herwig, C.; Gong, P. A global geospatial ecosystem services estimate of urban agriculture. *Earth's Future* **2018**, *6*, 40–60. [CrossRef]
21. Fagerholm, N.; Kayhko, N.; Ndumbaro, F.; Khamis, M. Community stakeholders' knowledge in landscape assessments—Mapping indicators for landscape services. *Ecol. Indic.* **2012**, *18*, 421–433. [CrossRef]
22. Plieninger, T.; Dijks, S.; Oteros-Rozas, E.; Bieling, C. Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy* **2013**, *33*, 118–129. [CrossRef]
23. Burkhard, B.; Kroll, F.; Nedkov, S.; Müller, F. Mapping ecosystem service supply, demand and budgets. *Ecol. Indic.* **2012**, *21*, 17–29. [CrossRef]
24. Hamilton, A.J.; Burry, K.; Mok, H.-F.; Barker, S.F.; Grove, J.R.; Williamson, V.G. Give peas a chance? Urban agriculture in developing countries. A review. *Agron. Sustain. Dev.* **2014**, *34*, 45–73. [CrossRef]
25. Peng, J.; Liu, Z.; Liu, Y.; Hu, X.; Wang, A. Multifunctionality assessment of urban agriculture in Beijing City, China. *Sci. Total Environ.* **2015**, *537*, 343–351. [CrossRef] [PubMed]
26. Xiao, W.; Zhao, G. Agricultural land land and rural-urban migration in China: A new pattern. *Land Use Policy* **2018**, *74*, 142–150. [CrossRef]
27. Russo, A.; Cirella, G.T. Edible urbanism 5.0. *Palgrave Commun.* **2019**, *5*. [CrossRef]
28. Beijing Municipal Bureau of Statistics; Beijing Survey Team of National Bureau of Statistics. *Bulletin of National Economic and Social Development Statistics of Beijing in 2018*; Bulletin of Beijing Municipal People's Government: Beijing, China, 28 February 2019.
29. China Weather Network Beijing Station. Beijing Topography and Flood Season Characteristics. Available online: http://www.weather.com.cn/beijing/sygdt/06/1898262.shtml?f_ww=1,2013-06-13/2020-02-12 (accessed on 15 January 2020).
30. Feng, Z. Taking Stock of the Climate Characteristics of Beijing in 2019. Available online: http://bj.cma.gov.cn/xwzx/qxyw/202001/t20200115_1380086.html,2020-01-13/2020-02-12 (accessed on 15 February 2020).
31. Beijing Municipal Bureau of Statistics. Ecological Bulletin. Available online: http://tjj.beijing.gov.cn/tjsj_31433/tjgb_31445/stgb_31450/ (accessed on 28 February 2020).
32. Beijing Flower Technology Co., Ltd. Flower Garden. Available online: http://www.huaernc.com/ (accessed on 5 June 2018).
33. Jia, K.; Li, Y.; Liang, S.; Wei, X.; Yao, Y. Combining estimation of green vegetation fraction in an arid region from Landsat 7 ETM+ data. *Remote Sens.* **2017**, *9*, 1121. [CrossRef]
34. Li, J. It's only natural. *ChinAfrica* **2018**, *10*, 30–31.
35. Gulickx, M.M.C.; Verburg, P.H.; Stoorvogel, J.J.; Kok, K.; Veldkamp, A. Mapping landscape services: A case study in a multifunctional rural landscape in The Netherlands. *Ecol. Indic.* **2013**, *24*, 273–283. [CrossRef]
36. Grafius, D.R.; Corstanje, R.; Harris, J.A. Linking ecosystem services, urban form and green space configuration using multivariate landscape metric analysis. *Landsc. Ecol.* **2018**, *33*, 557–573. [CrossRef]
37. McGarigal, K.; Cushman, S.A.; Ene, E. FRAGSTATS: Spatial Pattern Analysis Program for Categorical Maps. 2012. Available online: http://www.umass.edu/landeco/research/fragstats/fragstats.html (accessed on 17 June 2017).
38. Sinha, R.K.; Sharma, A. Landscape level disturbance gradient analysis in Daltonganj south forest division. *J. Indian Soc. Remote Sens.* **2006**, *34*, 233–243. [CrossRef]
39. Mao, D.; Zhang, Y.C.; Kong, D.Z.; He, S.L.; Li, X.Y. Evaluation of urban multi-scale landscape ecological pattern based on open space classification: A case study in xinxiang, China. *Appl. Ecol. Environ. Res.* **2018**, *16*, 6787–6799. [CrossRef]
40. Kim, J.-H.; Li, W.; Newman, G.; Kil, S.-H.; Park, S.Y. The influence of urban landscape spatial patterns on single-family housing prices. *Environ. Plan. B Urban Anal. City Sci.* **2018**, *45*, 26–43. [CrossRef] [PubMed]
41. Kirkpatrick, J.B.; Davison, A. Home-grown: Gardens, practices and motivations in urban domestic vegetable production. *Landsc. Urban. Plan.* **2018**, *170*, 24–33. [CrossRef]
42. Orsini, F.; Kahane, R.; Nono-Womdim, R.; Gianquinto, G. Urban agriculture in the developing world: A review. *Agron. Sustain. Dev.* **2013**, *33*, 695–720. [CrossRef]
43. Saeumel, I.; Reddy, S.E.; Wachtel, T. Edible city solutions-one step further to foster social resilience through enhanced socio-cultural ecosystem services in cities. *Sustainability* **2019**, *11*, 972. [CrossRef]


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44. Krikser, T.; Zasada, I.; Piorr, A. Socio-economic viability of urban agriculturea comparative analysis of success factors in germany. *Sustainability* **2019**, *11*, 1999. [CrossRef]
45. La Rosa, D.; Barbarossa, L.; Privitera, R.; Martinico, F. Agriculture and the city: A method for sustainable planning of new forms of agriculture in urban contexts. *Land Use Policy* **2014**, *41*, 290–303. [CrossRef]
46. Scott, A.; Dean, A.; Barry, V.; Kotter, R. Places of urban disorder? Exposing the hidden nature and values of an English private urban allotment landscape. *Landsc. Urban Plan.* **2018**, *169*, 185–198. [CrossRef]
47. Yoshida, S.; Yagi, H.; Kiminami, A.; Garrod, G. Farm diversification and sustainability of multifunctional peri-urban agriculture: Entrepreneurial attributes of advanced diversification in Japan. *Sustainability* **2019**, *11*, 2887. [CrossRef]
48. Tappert, S.; Kloti, T.; Drilling, M. Contested urban green spaces in the compact city: The (re-)negotiation of urban gardening in Swiss cities. *Landsc. Urban Plan.* **2018**, *170*, 69–78. [CrossRef]
49. Prove, C.; Dessein, J.; de Krom, M. Taking context into account in urban agriculture governance: Case studies of Warsaw (Poland) and Ghent (Belgium). *Land Use Policy* **2016**, *56*, 16–26. [CrossRef]
50. The Research Group on Urbanization and Rural Migrant Workers in China. Cheng Zhen Hua Jin Cheng Zhong Nong Cun Lao Dong Li Zhuan Yi: Zhan Lue Jue Ze Yu Zheng Ce Si Lu. *Chin. Rural Econ.* **2011**, *6*, 4–14.
51. Contesse, M.; van Vliet, B.J.M.; Lenhart, J. Is urban agriculture urban green space? A comparison of policy arrangements for urban green space and urban agriculture in Santiago de Chile. *Land Use Policy* **2018**, *71*, 566–577. [CrossRef]
52. Peng, J.; Zhao, S.Q.; Tian, L.; Liu, Y.X.; Liu, Z.C. The dynamicas of mulit-functionality of urban agriculture, a case study of Beijing city. *Chin. J. Agric. Resour. Reg. Plan.* **2016**, *37*, 152–158.
53. UN Habitat. Planning Sustainable Cities—Global Report on Human Settlements 2009. Available online: https://mirror.unhabitat.org/content.asp?typeid=19&catid=555&cid=5607 (accessed on 15 January 2020).


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