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Residents' Perception of Informal Green Space—A Case Study of Ichikawa City, Japan

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Abstract: Urban green space (UGS) has been proven to be essential for improving the health of residents. Local governments thus need to provide attractive UGS to enhance residents' wellbeing. However, cities face spatial and finanical limitations in creating and managing UGS. As a result, greening plans often fail or are postponed indefinitely. To evaluate whether informal urban green space (IGS) can supplement existing UGS, we conducted a questionnaire survey of 567 residents in Ichikawa (Japan), a city currently providing only 3.43 m^2 green space per capita. In particular, we analyzed how residents' existing green space activities affect IGS perception, as it may be difficult to recognize IGS as greenery because it is not an officially recognized space for recreation. Results show that residents took a favorable stance towards IGS, but perception differs depending on their green environment exposure. Residents who are frequently exposed to green environments in their daily lives highly recognized the environmental improvement aspects of IGS and significantly perceived spatial accessibility as an advantage of IGS. Willingness to participate in conservation activities of UGS was linked with a likelihood of recognizing IGS as UGS. Our results encourage understanding IGS as supplementary green space taking into account the attitude of residents to UGS, and contribute to introducing the IGS discourse into green space planning.

Keywords: vacant land; street verges; spontaneous vegetation; postal questionnaire; Asia; Japan; recreation

1. Introduction

Urbanization throughout the world has led an increasing proportion of the population living in cities. The United Nations expects that 68% of the world's population will live in urban areas by 2050 [1]. As urbanization progresses and the urban proportion of the population increases, residents living in areas with paved environments often experience limited nature contact and increased exposure to noise and air pollution [2]. Therefore, many studies have focused their attention on urban green spaces (UGS), such as urban parks, forests, gardens, etc., to improve urban dwellers' quality of life and the urban environment. UGS plays a role in providing nature contact directly or indirectly in urban areas, supporting people's physical health and well-being. This support positively affects human mental health, including stress reduction [3–5]. In addition, UGS can also enhance social cohesion and attachment to a place, as well as encourage outdoor activities [6,7]. Therefore, the perception that UGS is an essential element in determining the quality of life of residents is well established. Local or national governments have thus created UGS as part of urban planning strategies to improve or support urban residents' wellbeing and urban environment [8–10]. However, building and managing new parks in the urban area places a financial burden on budgets [11]. This cost associated with public projects, such as creating an urban park, is particularly noticeable in countries, like Japan, where

economic growth has reached its peak and cities have begun to shrink [12,13]. The national budget of Japan for promoting public infrastructures, which includes the creation and maintenance of UGS, has been steadily declining since it peaked in 1997 [14].

Urban or green space planning mostly focuses on the formal and generally acknowledged UGS, including parks, forests, public gardens, and cemeteries. These UGS are highly managed using officially collected data, which provide the basis for extensive research [15]. However, urban spaces go through cycles of planning and (re)development repeatedly and regularly, which can generate spatial by-products, such as vacant lands, wastelands, brownfields, and arable, which could be recognized as leftover spaces [16]. These are generated not as a result of degradation and destruction, but as a result of differences in time as spatial byproducts of policy action [17]. Such spaces range from vacant lots in marginal areas to tiny cracks in between paved lanes. Previous studies have challenged the orthodox ideas of planing through discourses, such as 'place-making' in the contemporary city, in the context of these informal spaces [16,18]. Physically, these spaces are mainly covered with spontaneous vegetation of native or exotic species, mixed with construction rubble or subsoil, with little maintenance [19].

Recent research has drawn attention to reconsidering the possibility of formalizing these spaces to contribute to urban sustainability as green infrastructure [20–24], and provides evidence that these spaces can be valuable as green space and can meet the conditions necessary for recreational use [12,25–27]. Rupprecht and Byrne [25,28] call these spaces informal urban green space (IGS) and define IGS as a space with a history of strong artificial disturbance and spontaneous vegetation occupying some or all of the space. They classified IGS into nine types: Street verges, lots, gap, railway, brownfields, waterside, structural, microsite, and powerline. Furthermore, Rupprecht [12] proposed a participatory IGS management approach based on a survey of residents' perceptions in four representative shrinking cities in Japan. IGS is valued by residents similar to UGS, particularly in regard to the opportunity to access nature in urban areas [26]. However, a recent review found that the biodiversity literature is critically biased in its focus on urban forests or parks and its neglect of IGS [27]. Despite studies' efforts to enrich the discourse about green spaces, like IGS, that are not included in the formal classification and to work towards empirical management systems, it is still not recognized by stakeholders in urban planning. In the evolving discourse on IGS, of course, proposed solutions that distinguish green spaces in binaries, such as informal and formal, and focus solely on scientific-ecological arguments may not sufficiently capture the dynamics between humans and nature in urban areas [28,29]. Further research is thus needed on how residents perceive IGS, and what influences their perception.

In this study, we explore the potential of IGS as a supplementary urban green space in contributing to well-being in the urban environment given the spatial and financial constraints of Asian cities with a high population density, as represented by the case of Ichikawa City, Japan. To consider and evaluate IGS as supplementary green space in cities, we focus here on its perception by residents. Moreover, since IGS is not an officially recognized space as a formal classification category for either conservation or recreation, it may be difficult for residents to perceive IGS as a UGS. We hypothesize that their attitude towards green space is not based on formal education, but rather formed through experience and influences in real life. Therefore, to explore the issues, this paper seeks to contemplate the understanding of IGS against the background of residents' perception of existing green spaces, such as urban parks.

We focused on the following research questions: (1) What are the merits of IGS that residents perceive and why are they reluctant to use IGS; (2) how does IGS perception differ depending on UGS experience; (3) how do residents perceive IGS depending on their residential environment; and (4) what is the difference and relation between residents' attitudes toward urban nature, including UGS, and IGS perception?

2. Materials and Methods

2.1. Study Site

Our study site was Ichikawa (57.10 km^2 with 482,544 inhabitants), located in the Chiba Prefecture, Japan (Figure 1). This city has been formed while being strongly influenced by outer Tokyo. There have been three waves of rapid population inflows without prior establishment of urban infrastructure due to its location close to the capital of Japan. Land readjustment projects and railway construction projects have created high density urban districts. Currently, Ichikawa consists of more than 70% urbanized areas, including residential, commerce, and industrial districts, and about 30% (29.24%) of urbanization control area intended to constrain periurban sprawl.

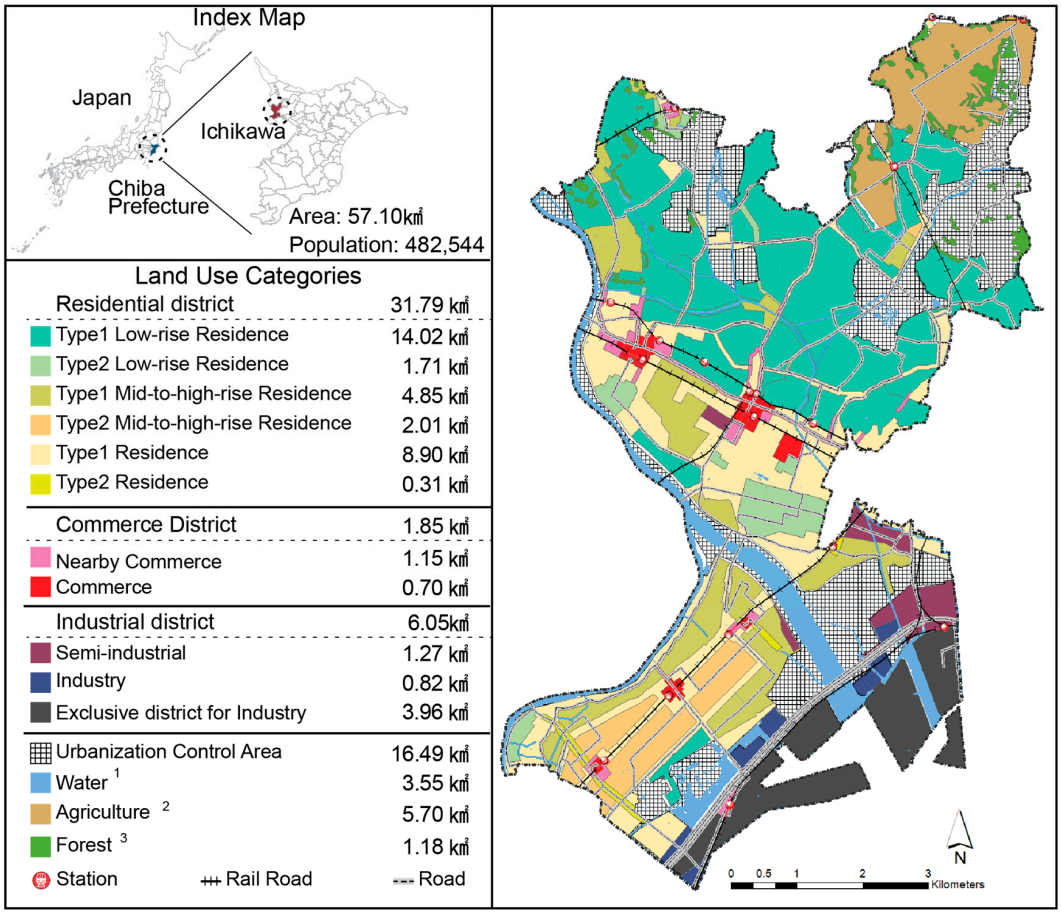

Figure 1. Location of and land use categories in Ichikawa, Japan. [1] Some of the total water areas overlap with urbanization control areas. [2] The agricultural district is included in the controlled urbanization district. [3] Forest area exists not only in agricultural districts, but also residence districts and controlled urbanization districts.

Acquisition of public land by the city is not easy because districts have formed dense urban areas of narrow roads and their land price has risen [30]. Since most citizens migrated from outside the city, the general sense of community attachment is low. This phenomenon influenced the city government to attempt addressing it through urban plans and creating green spaces. Ichikawa government has implemented several town plans for improving residents' quality of life since the year, 2000 [30,31]. According to the Green Master Plan of Ichikawa, the government aimed to improve green space from 2003 to 2025 in three steps, using green space per capita (m^2/person) as an indicator. The indicator at the time they declared the plan was 2.70 m^2, and the next goal was set at 3.85 m^2 for 2015 before the

final goal of 4.73 m^2 per capita by 2020 [32]. However, the city only had 3.43 m^2 per capita as of 2016, and it seems unlikely that it is possible to provide residents with equal opportunity to use green space according to the Urban Park Act of Japan, which recommends 10.0 m^2 per capita.

2.2. Data Collection, IGS Typology, and Data Analysis

We conducted a survey targeting residents using a mail-back questionnaire distributed around the sample sites (Figure 2a) of an existing grid that was set up for a previous field survey of IGS distribution. Sampling kits were allocated at 20 per sample site, and a total of 3700 kits were distributed, except in the non-resident areas. If there were not enough residences in the sample site, we extended the distribution scope using a buffer as 50 m or 100 m focusing on the sites. The number of replies per site was from 1 to 8, with an average of 3.29 responses (Figure 2b).

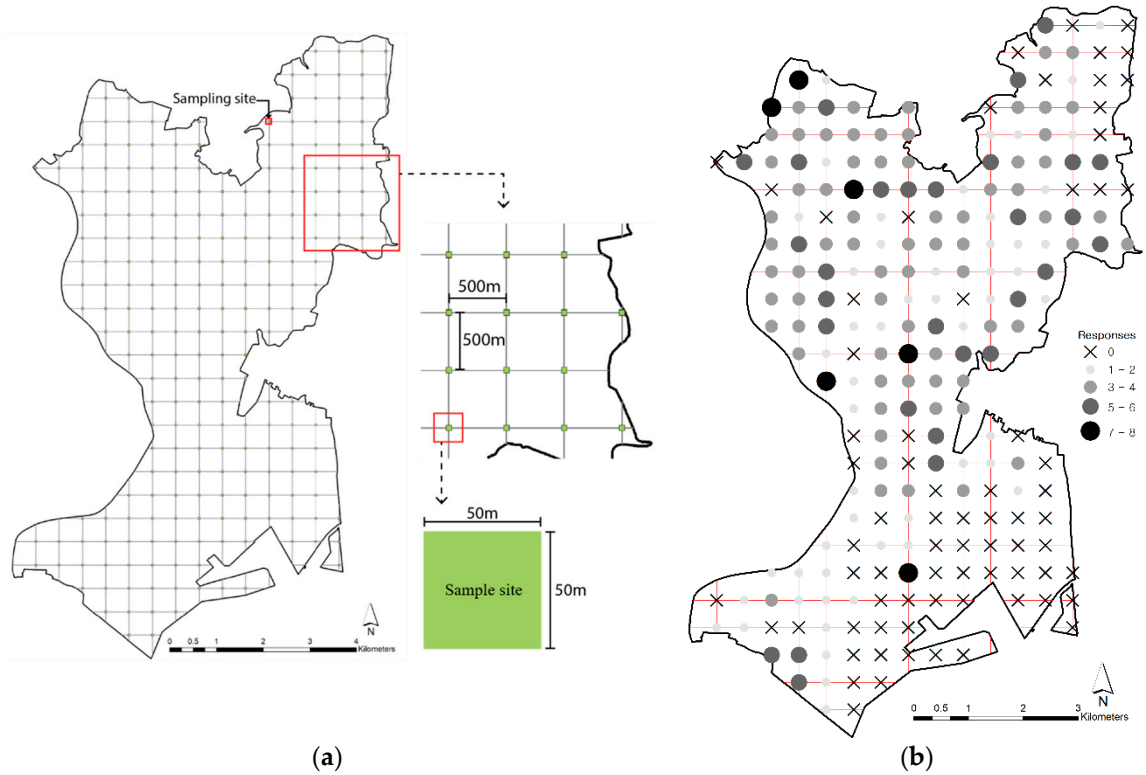

Figure 2. Sampling strategy and number of responses: (**a**) Distribution of survey sites across Ichikawa; (**b**) number of responses per sample site.

Before creating the survey instrument, we conducted a pilot workshop on IGS with 70 undergraduate students of agricultural science and landscape architecture. We discussed the merits IGS is considered to have and reasons why one may be reluctant to use it. Results were used to create the questionnaire. The questionnaire contains questions on general characteristics of the respondents, the merit of IGS, potential reasons for their reluctance to use IGS, and on respondents' attitudes toward urban green space. To ensure the contents of the questionnaire were easy to understand and answer for residents without a relevant professional or academic background, grammar and wording were revised by seven native non-specialist Japanese speakers. To capture the full variety of IGS in Ichikawa, we extended the IGS typology by adding 'parking lot verges' and 'unimproved land' to the typology used in previous work [28] (Table 1). Additionally, we provided photos of the revised IGS types in our questionnaire sheet to allow residents to visually identify what IGS looks like (Figure 3). We lowered the color saturation of the non-IGS area in the photos to make it easier for residents to notice IGS in the images provided.

Table 1. Description of the nine types of informal urban green space (IGS).

IGS		Description (Non-Exclusive Criteria)
Vacant lots	Profile	Space left unused after its previous use ends. The site may be empty, or the infrastructure of the building's frame or debris from the building remain. Former use was primarily housing, but it is now unused and neglected.
	Vegetation	The type of vegetation differs depending on the status of the management of the space and the period left from the time when the original usage ends. The pattern of vegetation ranges from well-trimmed grass to small-scale bushes where succession has progressed to some extent.
	Maintenance and Access	Management is carried out irregularly with minimum maintenance, such as mowing the lawn. However, there are many places where management is not done for a long time. Access is restricted by fences or signs to protect private property, but some are open space.
Street verges	Profile	Mainly located on the perimeter of a driveway or pedestrian road.
	Vegetation	The pattern of vegetation consists mainly of herbaceous plants, which are dominated by spontaneous vegetation. Vegetation begins to spread linearly among heterogeneous pavement materials.
	Maintenance and Access	It is usually managed irregularly by the government and contractors rather than individuals, and plant cutting activities are often carried out in response to residents' complaints. There are no elements, such as fences or signs, to restrict access, and the accessibility depends on where they are located.
Water verges	Profile	Formed by vegetation within 10 m from the water body. The type of the area includes all sections where water flows, such as river, canal, stream, waterway, and watersheds.
	Vegetation	Vegetation communities can be directly tied to water bodies, or they grow on land within 10 m of the water bodies. Unlike intended planting patterns for a recreational purpose, such as a waterside park, these are spontaneous vegetation communities.
	Maintenance and Access	Government agencies usually conduct management. For the non-waterfront parks, the management activities focus on monitoring for disaster prevention or the quality of water. Most of them are difficult to access to the water center due to fencing or signs.
Gaps	Profile	Vegetated space formed between structures. The spaces of structures include between walls, between fences, and between remaining building structures.
	Vegetation	Most of the space in the gap is covered with herbaceous plants.
	Maintenance and Access	Space management is carried out on an irregular basis, if at all. Most of the management activities are cutting overgrown plants and disposing of garbage.
Brownfields	Profile	Space where the existing infrastructure has remained as all or a part after the end of the previous use and not used at present. The previous uses of space are mainly by the light industry or commerce, not housing.
	Vegetation	Vegetation is spontaneously scattered in an atypical shape influenced by existing planting space, cracks, and heaps of dirt.
	Maintenance and Access	Largely neglected space whose original use has been terminated and the access of the public is controlled. Vegetation and spaces are rarely managed.
Unimproved lands	Profile	Empty land without infrastructure, such as electricity and sewage facilities; has the potential for development at any point in time. It is located in periurban areas rather than the central portion of the city, such as the 'Urban Control District'.
	Vegetation	Most of the vegetation is composed of spontaneous herbaceous plants, but, in some cases, a small number of trees have been planted intentionally by a landowner.
	Maintenance and Access	Since the site is not currently being used for any other purpose, systematic and regular management does not occur. In the case of some places that are located away from the center of the city, vegetation succession has progressed and forms a meadow because management has not been carried out for a long time.
Parking lot verges	Profile	Site representing a secondary use of a 'vacant lot' rather than a planned place for parking. The site features minimal land maintenance and separation of parking spaces. Distinct from an automated parking lot operated by a professional enterprise.
	Vegetation	Vegetation is clustered linearly around the edge of the parking lot and is dominated by spontaneous herbaceous plants, and not by intentional plantings.
	Maintenance and Access	Minimal maintenance is performed regularly for the function of the parking lot. Vegetation communities formed on the edges are often removed due to parking lot users' complaints.
Railroad verges	Profile	Space with vegetation adjacent within 10 m of railway tracks.
	Vegetation	Vegetation forms linearly along the track or forms communities around a station.
	Maintenance and Access	For reasons of safety, direct public access is strictly controlled. Removal of plants or use of herbicides is carried out irregularly.
Overgrown structures	Profile	Space where plant communities cover artificial structures and often grow vertically.
	Vegetation	These spaces are predominantly dominated by vines. In the case of public buildings or structures with no safety concerns, there are sometimes intentional plant patterns to improve the thermal environment.
	Maintenance and Access	There may be differences in public accessibility depending on the type and location of the structure. If structural safety is to be maintained, plants are regularly removed, and public access is blocked.

Figure 3. Nine types of IGS in Ichikawa.

We compared the differences and characteristics of the perceptions of IGS from the two perspectives of IGS eight merits (ME) and eight reasons for reluctance to use IGS (RE): (ME.1) IGS makes urban landscape beautiful; (ME.2) IGS can make me feel nature in an urban area; (ME.3) IGS is easy to access because it is close to where I live; (ME.4) it is possible to use IGS freely in many ways; (ME.5) IGS can be a place where children can play; (ME.6) IGS can be a habitat for living things; (ME.7) IGS has the effect of suppressing dust; (ME.8) IGS can be useful for air purification; (RE.1) I'm concerned about the conflict with the landowner of the site; (RE.2) signs or fences make it difficult to get into the site; (RE.3) risk of injury; (RE.4) there is a lot of trash inside; (RE.5) it seems to be polluted; (RE.6) it is not managed for use; (RE.7) it is too small or narrow to use; and (RE.8) it may be either developed or disappear someday. We therefore used 'ME' and 'RE' as dependent variables and used as independent variables the general attributes of respondents, experience with UGS, the relationship between surrounding greenery and residence environment, and attitude towards UGS. We organized the attitude of residents toward urban green space (AT) into ten categories based on the pilot workshop: (AT.1) I cherish the urban nature with plants and animals; (AT.2) UGS makes my everyday life environment healthy; (AT.3) it is important to coexist with plants, animals, and humans in an urban environment; (AT.4) I'm willing to participate as a volunteer to conserve nature; (AT.5) I'm willing to arrange a time for conserving nature; (AT.6) I'm willing to pay some money to conserve nature; (AT.7) I've known plants, animals, and insects that are often observed in or near my area; (AT.8) I can feel the community attachment from plants, animals, and insects that are often observed in or near my area; (AT.9) the neighborhood green space should be managed; and (AT.10) the neighborhood green space should be convenient. For the variables for each section, the values for asymmetry and kurtosis were considered acceptable between −2 and +2 to prove normal univariate distribution [33–35], but we found that some variables did not meet normality. Therefore, we used

the Mann-Whitney U test as a nonparametric test method to compare differences in IGS perception, and the Chi-Square test (X^2 test) to analyze observations for statistically significant results. We also conducted a factor analysis to reduce and interpret the 10 attitudes toward the urban nature including UGS into useful factors. The reliability of the variables by factor analysis was tested using the Cronbach Alpha test of Kaiser-Meyer-Olkin measure of sampling adequacy (KMO). Logistic regression analysis was used to measure which factors can be classified into IGS perception using the forward conditional method after identifying the correlation between the IGS perceptions and attitudes. We verified the fitness of the logit model by the Hosmer-Lemeshow test (Figure 4). To statistically analyze and chart the questionnaire, we used Excel 2016 and IBM SPSS (version 25) software.

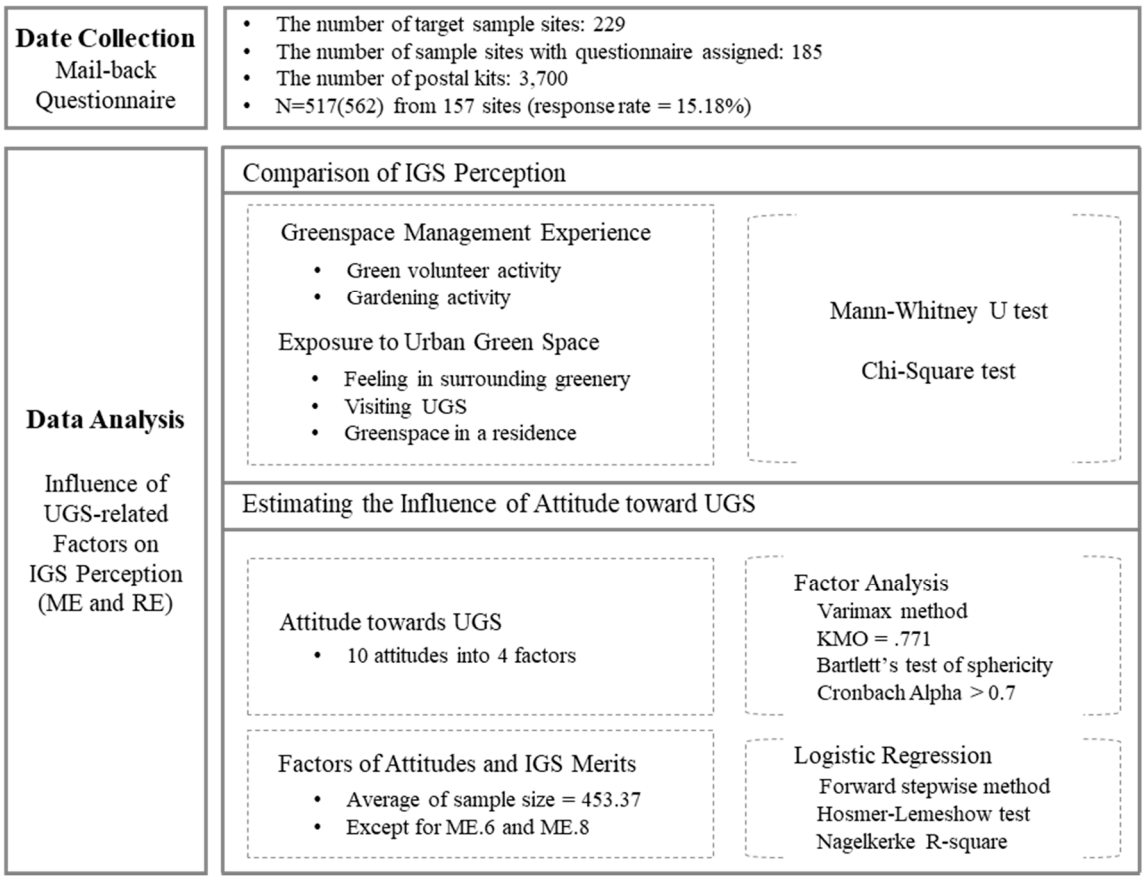

Figure 4. Research workflow.

3. Results

3.1. Demographic Composition and Sample Characteristics

Of the 229 planned distribution sites, 44 sites were excluded because they contained either no-residence or were inaccessible. We thus distributed the survey kits to 185 sites (total 3700 kits) and received 562 responses from 157 sites in about two months (response rate = 15.18%). Some enthusiastic respondents sent comments on IGS and its survey contents using memos and letters. Respondents were 59.6% female and 41.4% male, and respondents over 50 years accounted for 60% of respondents (Table 2). To understand residents' stance toward IGS perception in the context of greenery in their everyday life, we asked questions about three topics: UGS-related experience, greenery contact, and attitude towards urban nature. Respondents had little experience, such as being a green volunteer in public spaces (urban parks, protected forests etc.), but more than 60% of all respondents had experience with private spaces, such as home gardens, verandas, or allotments. Those who had never visited

surrounding green space were 10% higher than those who went there every day. For contact with greenery within the residential environment, about 80% of respondents could access green space within their residential range in the form of a home garden or shared green space. Moreover, residents who thought that there was plenty of green space around their living environment were about 10% higher than those who felt green space lacking.

Table 2. Respondents composition (n = 517).

Respondents Composition		Total	(%)
Gender	Male	214	41.4
	Female	303	58.6
Age	20–29	27	5.2
	30–39	56	10.8
	40–49	105	20.3
	50–59	98	19.0
	60–69	108	20.9
	Over 70	123	23.8
Children in family	No	374	72.3
	Yes	143	27.7
Employment status	Unemployed or retired	218	42.2
	Employed	299	57.8
Public experience [1]	No	422	81.6
	Yes	95	18.4
	Mean participation frequency: 23.12 (minimum value = 1, maximum value = 1000, SD = 109.077, n = 86)		
Individual experience [2]	Never	93	18.0
	Sometimes	88	17.0
	Ongoing	336	65.0
Frequency of visiting green space	Never	155	30.0
	1~3 times a year	93	18.0
	1~3 times a month	94	18.2
	1~3 times a week	70	13.5
	everyday	105	20.3
Housing type	Detached house with green space	300	58.0
	Detached house without green space	60	11.6
	Apartment with shared green space	105	20.3
	Apartment without shared green space	52	10.1
Recognition of the quantity of surrounding greenery	Strongly lacking	27	5.2
	Lacking	133	25.7
	Moderate	136	26.3
	Considerable	171	33.1
	Plenty	50	9.7

[1] Public experience here refers to green space conservation activity like volunteering for improving the public environment in parks, forests, and rivers. The main activities are tree planting, weeding, cleaning, agricultural experience, observing fauna and flora, and monitoring introduced species. [2] Individual experience here refers to gardening activity to grow and manage plants in the home garden or veranda. This activity focuses more on individual satisfaction than on the improvement of the public environment.

3.2. Merits of IGS and Reasons for Reluctance to Use IGS

Before exploring how IGS perception was influenced by residents' green space contact in daily life, we asked about the overall merits (ME) of IGS that residents were aware of and why they were reluctant (RE) to use it. When comparing perceived merits and reluctance, most of the residents more strongly felt the benefits of IGS than a reluctance to use it (Figures 5 and 6). Residents valued IGS aesthetically (ME.1 and ME.2) and its environmental functions (ME.6 to ME.8) higher than its recreational aspects (ME.3 to ME.5). There was no difference in perception of IGS merits according to respondents' general characteristics, such as gender, having children in the family, and employment status. However, age

was related to ME.3. As the age range of the respondents increased, they recognized that having IGS close to where they reside as an advantage (X^2 = 52.141, sig(p) = 0.000).

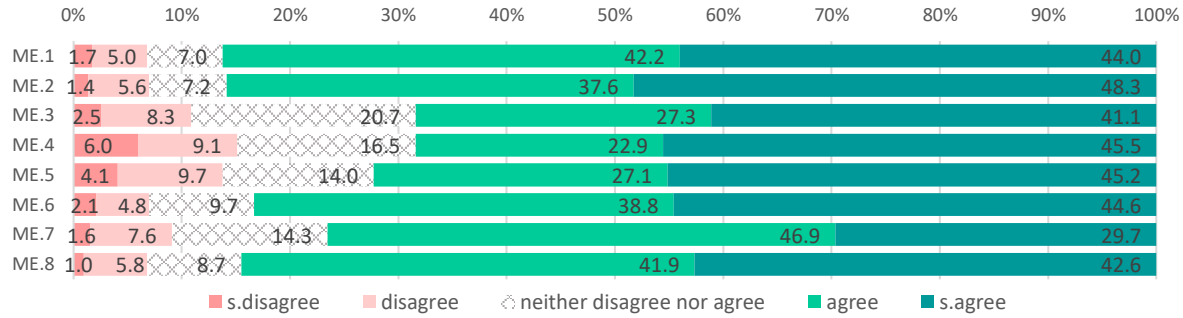

Figure 5. The merit of IGS. (ME.1) IGS makes urban landscape beautiful; (ME.2) IGS can make me feel nature in an urban area; (ME.3) IGS is easy to access because it is close to where I live; (ME.4) it is possible to use IGS freely in many ways; (ME.5) IGS can be a place where children can play; (ME.6) IGS can be a habitat for living things; (ME.7) IGS has the effect of suppressing dust; and (ME.8) IGS can be useful for air purification.

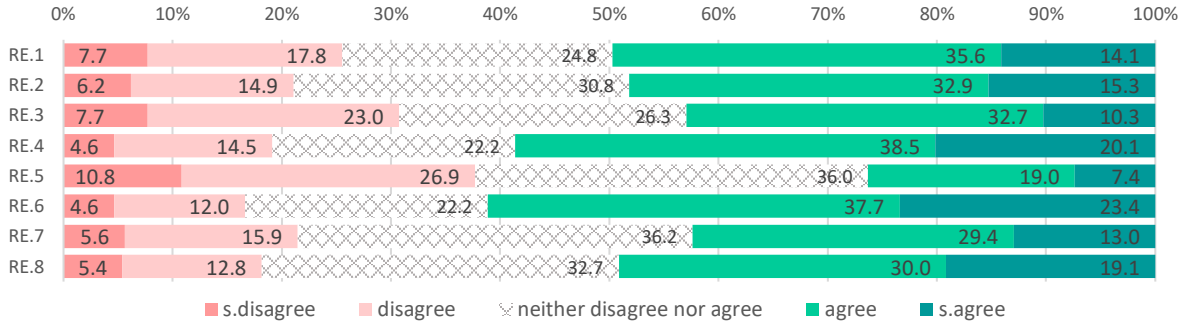

Figure 6. Reasons for reluctance to use IGS. (RE.1) I'm concerned about the conflict with the landowner of the site; (RE.2) signs or fences make it difficult to get into the site; (RE.3) risk of injury; (RE.4) there is a lot of trash inside; (RE.5) it seems to be polluted; (RE.6) it is not managed for use; (RE.7) it is too small or narrow to use; and (RE.8) it may be either developed or disappear someday.

When asked about reasons for their reluctance to use IGS, respondents were more sensitive to the current non-managed status (RE.4 and RE.6) than concerns that might arise when actually using it (RE.1 to RE.3). They perceived IGS as an unmanaged space, but they did not agree that it was dirty or contaminated (RE.5). Respondents' general characteristics, such as age and childcare, influenced responses to RE.6. Young and child-care respondents were more aware of IGS as an unmanaged space. Respondents from teens to those up to 49 years old more strongly agreed on 'RE.6' than respondents over 50 years of age; younger respondents agreed to RE.6, with an average of 71.6%, while the over 50 s agreed on it, with an average 55.2% (X^2 = 22.835, sig(p) = 0.029). In addition, respondents who were raising children strongly agreed on 'RE.6' with 69.9% compared to those who are not (X^2 = 7.142, sig(p) = 0.028).

3.3. Influence of UGS-Related Factors on IGS Perception

3.3.1. Greenspace Management Experience

We sorted the greenspace management experiences into two groups based on where the experiences took place. Green volunteer activity refers to conservation activity in public areas, such as parks, forests, and rivers, etc. This activity involves tree planting, weeding, cleaning, observing fauna

and flora, and monitoring introduced species. The effect of these activities may encourage participants to be considerate of the public environment. In contrast, gardening activity refers to horticultural activities for self-satisfaction and improvement of personal living environments. This activity takes place in private spaces, such as private home gardens, verandas, and allotments. The gardening performers seek individual aesthetic and therapeutic effects for mental health and/or consumption of food [36]. We used the Mann-Whitney U test to compare how having or not having experience in either the public or private space affected the perception of IGS merits and reasons for reluctance to use IGS. We reclassified the existing three items of the frequency of gardening activity into two items: 'No' and 'yes'. Mean rank of the Mann-Whitney U test indicated that people who have experienced UGS management had a more favorable position toward IGS merits. Besides, the result of the experiment demonstrated that people who had experienced gardening activities were less reluctant to use IGS, as shown by the significant difference in responses between the variables for four MEs and two REs (Table 3). Volunteer experience was associated with differences between the variables in the response about environmentally functional aspects of IGS, but no significant difference was found regarding a reluctance to use IGS.

Table 3. Mann-Whitney U test result of the urban green space (UGS) experience (n = 517).

Green Volunteer Activity		**ME.6**	**ME.7**	**ME.8**
Mean Rank	No (n = 422)	254.08	253.89	253.14
	Yes (n = 95)	256.94	281.68	285.05
Mann-Whitney U		17,967.000	17,890.000	17,570.000
Z		−2.428 *	−2.215 *	−2.993 **

Gardening Activity		**ME.3**	**ME.6**	**ME.7**	**ME.8**	**RE.4**	**RE.6**
Mean Rank	No (n = 93)	219.44	235.29	227.58	229.48	288.06	291.84
	Yes (n = 424)	267.68	264.20	265.89	265.47	252.63	251.80
Mann-Whitney U		16,036.500	17,511.000	16,794.000	16,971.000	17,013.000	16,661.500
Z		−3.442 **	−2.598 **	−3.028 **	3.347 **	−2.348 *	−2.693 **

* $p < 0.05$, ** $p < 0.01$ (ME.3) IGS is easy to access because it is close to where I live; (ME.6) IGS can be a habitat for living things; (ME.7) IGS has the effect of suppressing dust; (ME.8) IGS can be useful for air purification; (RE.4) there is a lot of trash inside; and (RE.6) it is not managed for use.

Based on the differences in variables identified above, we visualized Chi-Square (X^2-test) test results to compare the observed counts (Figure 7). Gardening activity in the X^2-test was compared with the existing three items based on the frequency of gardening experiences as 'Never', 'Sometimes', and 'Ongoing'. Since about 81% of all respondents had no public green-related volunteer experience, the 'No (no experience)' proportion was relatively high in responses to all ME. In this pattern of responses, however, we found a change in the proportion on each answer from 'disagree', 'neither', and 'agree' from ME. Although there are no statistically significant differences on ME.6 and ME.7 in the X^2-test, the proportion of respondents agreeing on the air purification merits of IGS (ME.8) was higher in those with volunteer experience. Since 65% of all respondents are doing gardening every day as well, the proportion of experienced respondents is high. Those who do every day horticultural activities account for a higher rate of positive ME perceptions, while those who have never or rarely done horticultural activity had a more negative stance. The proportion of people who do gardening activity daily was 50.8% on average in those with a negative stance towards IGS merits and 69.8% in those with a positive view. The difference of opinion according to whether respondents engaged in garden activity was largest in ME.7. People who had never or rarely experienced gardening activity were more skeptical of IGS merits and agreed more strongly with reasons to be reluctant to use IGS. The responses to 'RE.4 and 'RE.6' showed statistically significant differences.

Figure 7. X^2-test between greenspace management experience and ME&RE; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (ME.3) IGS is easy to access because it is close to where I live; (ME.6) IGS can be a habitat for living things; (ME.7) IGS has the effect of suppressing dust; (ME.8) IGS can be useful for air purification; (RE.4) there is a lot of trash inside; and (RE.6) it is not managed for use.

3.3.2. Exposure to Urban Green Space

We categorized environmental contact with green spaces into three types: First, how much green space do residents perceive in their living surroundings? Second, what kind of green space is connected to residents in their residential environment? Third, how often do residents use UGS? Asked how much green spaces residents perceive in their surrounding environment, 221 respondents (42.8%) responded that green spaces are abundant, while 160 (31.2%) answered that green spaces are lacking. Four hundred and five respondents were living in housing with green space, of which 72.07% of them could access green space by a home garden from the house, and 25.93% shared green space within an apartment housing. The proportion of people who do not use UGS at all was about 2% higher than the proportion of people visiting UGS every day. We divided the responses regarding environment toward surrounding greenery into two groups: Low and high green space exposure. In these groups, we excluded neutral responses and compared the perception of 'ME and RE' of IGS. Table 4 shows significant values for differences in IGS perception for each independent variable. The group with high amounts of green space exposure had a more positive stance toward IGS merits. Moreover, residents who could access green space from their home garden in the residential environment showed a higher position on 'ME.7' than people who could access green space as a shared form. The group with low green space exposure agreed more strongly with reasons for being reluctant to use IGS.

Table 4. Mann-Whitney U test results of exposure to urban green space.

Feeling in Surrounding Greenery		**ME.3**	**ME.6**	**RE.1**	**RE.5**	**RE.7**	**RE.8**
Mean Rank	Lacking (n = 160)	150.50	180.15	204.18	208.01	215.87	203.43
	Abundant (n = 221)	220.32	198.86	181.46	178.68	173.00	182.00
Mann-Whitney U		11,200.000	15,944.000	15,572.000	14,958.000	13,701.500	15,691.500
Z		−7.427 ***	−2.602 **	−2.154 *	−2.732 **	−4.028 ***	−2.047 *
Visiting UGS		**ME.3**	**ME.4**	**ME.6**	**RE.4**	**RE.5**	**RE.6**
Mean Rank	Never (n = 155)	144.43	148.03	152.92	176.04	175.94	176.25
	Frequently (n = 175)	184.16	180.97	176.64	156.17	156.26	155.98
Mann-Whitney U		10,296.500	10,855.000	11,612.500	11,929.500	11,945.000	11,896.000
Z		−4.753 ***	−3.799 ***	−3.381 **	−2.115 *	−1.994 *	−2.200 *
Green Space in a Residence		**ME.3**	**ME.7**	**Green Space in a Residence**			**ME.7**
Mean Rank	Nothing (n = 112)	222.27	238.44	Mean Rank	Home garden (n = 300)		211.74
	Contacting (n = 405)	269.16	264.69		Shared Green Space (n = 105)		178.03
Mann-Whitney U		18,566.000	20,377.000	Mann-Whitney U			13,128.500
Z		−3.588 ***	−2.225 *	Z			−3.547 ***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (ME.3) IGS is easy to access because it is close to where I live; (ME.4) it is possible to use IGS freely in many ways; (ME.6) IGS can be a habitat for living things; (ME.7) IGS has the effect of suppressing dust; (RE.1) I'm concerned about the conflict with the landowner of the site; (RE.4) there is a lot of trash inside; (RE.5) it seems to be polluted; (RE.6) it is not managed for use; (RE.7) it is too small or narrow to use; and (RE.8) it may be either developed or disappear someday.

All independent variables had significant influence on 'ME.3'. We have visualized a summary of the respondents' groups' cases regarding contact with the green environment for 'ME.3' among the IGS perception variables (Figure 8). In the case of the respondents who had relatively less access to the green environment in their residential area than home garden owners, the perception of 'ME.3' significantly increased with more UGS visits. In other words, residents who did not exclusively use green space within their dwellings had a notably higher perception of IGS proximity according to the frequency of UGS visits (Figure 8a). For the respondents who had no green space attached to their dwellings, agreement with 'ME.3' increased with the greenery they perceived around their residential area. There was a significant difference in the perception of 'ME.3' between those perceived to lack green space and those perceived as moderate (Figure 8b).

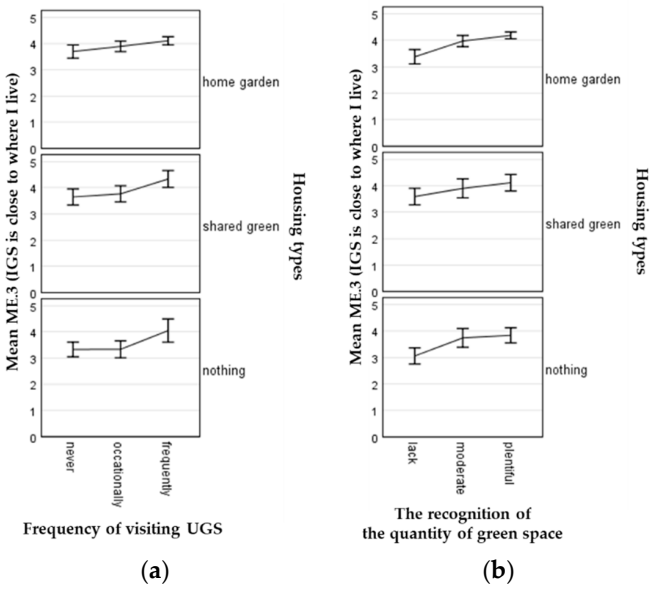

Figure 8. Exploring independent variable effects on 'ME.3' (Error bars: 95% CI). (**a**) Frequency of visiting UGS for different housing types; (**b**) perceived quantity of green space for different housing types.

3.3.3. Attitude towards Urban Green Space

Although IGS is not an officially recognized green space, such as an urban park, we hypothesize that to meet recreational or aesthetic needs of users, even in liminal spaces, naturally occurring vegetation may provide the potential to supplement UGS. Therefore, we tested how perception of IGS was affected by respondents' general attitude toward UGS and the urban environment. We asked residents ten questions about their attitude (AT) towards not only UGS, but also the urban environment, and identified factors with a factor analysis to investigate variable relationships for mixed concepts using varimax rotation (Figure 9).

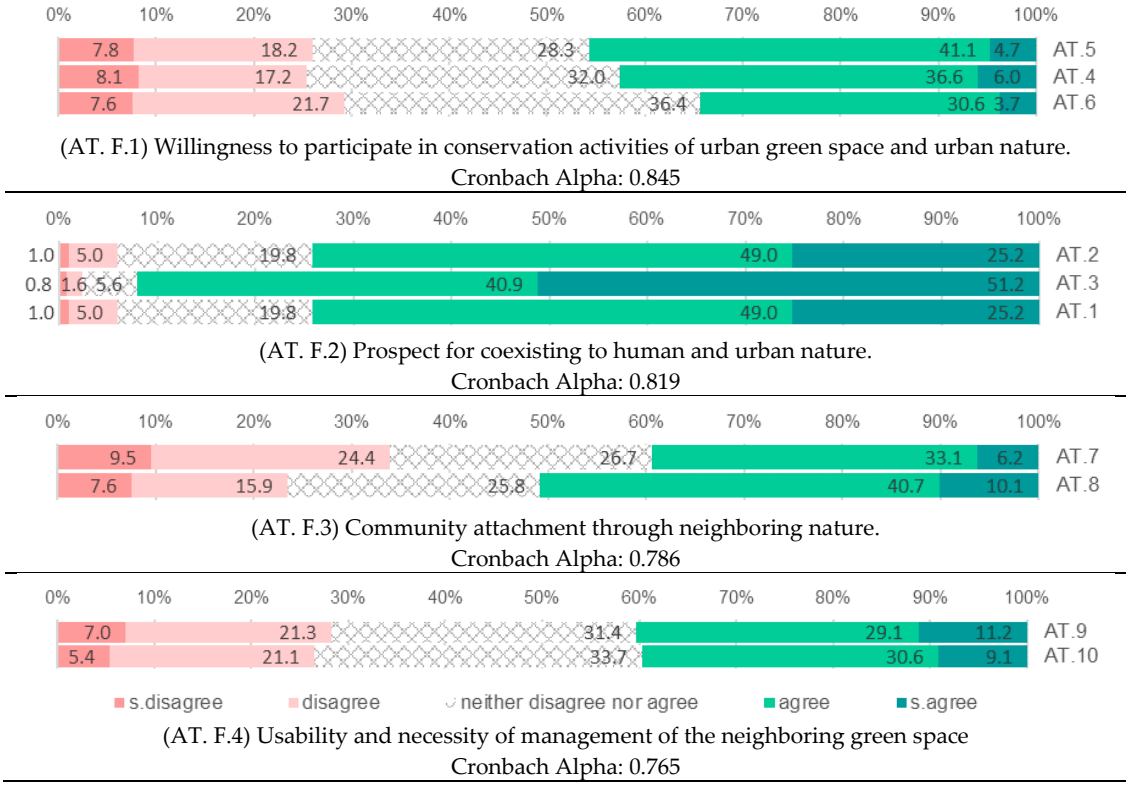

Figure 9. Residents' attitude to UGS and urban nature. (AT.1) I cherish the urban nature with plants and animals; (AT.2) UGS makes my everyday life environment healthy; (AT.3) it is important to coexist with plants, animals, and humans in an urban environment; (AT.4) I'm willing to participate as a volunteer to conserve nature (AT.5) I'm willing to arrange a time for conserving nature; (AT.6) I'm willing to pay some money to conserve nature; (AT.7) I've known plants, animals, and insects that are often observed in or near my area; (AT.8) I can feel the community attachment from plants, animals, and insects that are often observed in or near my area; (AT.9) the neighborhood green space should be managed; and (AT.10) the neighborhood green space should be convenient.

The conducted four valuable factors were derived with a Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value of 0.771 and Bartlett's Test of Sphericity (Approx. Chi-Square: 2241.887, df:45, Sig(p): 0.000), and the identified factors were tested by calculating their Cronbach Alpha. Even though respondents were not overly confident in their knowledge of UGS, harmony between non-human and human life in urban areas was considered important by respondents (AT.F.2). However, their attachment to close-by nature was weaker than their belief in the value of coexistence with nature (AT.F.3). Residents were generally in favor of participation in conservation activities of UGS or urban environment, but not in a very active way (AT.F.1). Regarding the usability and necessity of management of neighborhood green space, opinions were distributed relatively evenly (AT.F.4). Of the derived four factors, AT.F.1 and AT.F.2 were correlated with all items of ME. AT.F.3 was

correlated with all 'ME' items except ME.5, and AT.F.4 was related to the recreation potential of IGS, ME.4, and ME.5. Concerning RE, there was a correlation with a few variables, but none with most. AT.F.1 and AT.F.2 correlated with RE.5 and RE.6, which are related to the management status of IGS. AT.F.3, which referred to the local attachment, was correlated with RE.1, RE.6, and RE.7. Finally, AT.F.4 correlated with RE.3 and RE.5, which implies a negative perception of non-management.

We established the correlation with ME and RE as the dependent variables by conducting a logistic regression. We rearranged the group of the dependent variables into binary forms of 'agree' and 'disagree' for IGS's ME and RE and excluded the neutral opinion, 'undecided'. As a result, the size of the samples corresponding to each dependent variable was less than the overall sample of this study (n = 517). The sample size for each variable ranged between 409 to 481, with an average of 453.37. The correct percentage of classifying the attitude factors for ME variables was high, ranging from 81.8% to 92.7%. On the other hand, the correct classification of attitude factors for RE variables was 65.66% on average. In this study, the explanatory power Nagelkerke R Square for the regression model for the ME variables was 0.160 on average (Min: 0.103, Max: 0.273), and for the RE variables the average was 0.031. Thus, we performed the logistic regression on the ME variables, excluding the RE variables with low classification accuracy and explanatory power. Among the results of the logistic regression toward ME, we also excluded ME.6 and ME.8, where the fitness of the logit model by the Hosmer-Lemeshow test was not established (Table 5). We found that the factors for ME were all significant ($p < 0.05$). For the odds ratio (Exp(B)) value, which can identify the change of the probability of 'ME' recognition as each attitude factor variable increases, the AT.F.1 variable [Exp(B) = 3.330] corresponding to the ME.1 dependent variable was the highest. The willingness to participate in the conservation activities of an urban nature (AT.F.1) was included as an element increasing the probability of the perception in all ME dependent variables. AT.F.4, the usability and necessity of management of the neighboring green space, has been included as a recognition element of ME.4 and ME.4, the recreational aspect of IGS.

Table 5. The results of the logistic regression.

Dependent Variable	Independent Variables	B	S.E.	Wald	df	Sig.	Exp(B)
ME.1 (beauty) [1]	AT.F.1	1.203	0.199	36.603	1	0.000	3.330
	AT.F.2	0.529	0.166	10.206	1	0.001	1.697
	AT.F.3	0.432	0.177	5.980	1	0.014	1.540
	Constant	3.227	0.276	139.501	1	0.000	25.199
Classification percentage = 92.7%, Nagelkerke R^2 = 0.273, Hosmer and Lemeshow test Chi-square = 5.105 (df = 8, Sig(p) = 0.746)							
ME.2 (nature)	AT.F.1	0.793	0.167	22.576	1	0.000	2.210
	Constant	2.764	0.209	174.147	1	0.000	15.860
Classification percentage = 92.5%, Nagelkerke R^2 = 0.114, Hosmer and Lemeshow test Chi-square = 7.174 (df = 8, Sig(p) = 0.518)							
ME.3 (close)	AT.F.1	0.397	0.140	7.982	1	0.005	1.487
	AT.F.2	0.479	0.137	12.133	1	0.000	1.614
	AT.F.3	0.294	0.142	4.283	1	0.038	1.341
	Constant	1.936	0.157	151.227	1	0.000	6.930
Classification percentage = 86.3%, Nagelkerke R^2 = 0.103 Hosmer and Lemeshow test Chi-square = 9.008 (df = 8, Sig(p) = 0.342)							
ME.4 (activity)	AT.F.1	0.761	0.137	31.024	1	0.000	2.140
	AT.F.2	0.485	0.135	12.942	1	0.000	1.623
	AT.F.3	0.447	0.132	11.480	1	0.001	1.563
	AT.F.4	0.342	0.135	6.429	1	0.011	1.408
	Constant	1.747	0.151	134.029	1	0.000	5.738
Classification percentage = 81.9%, Nagelkerke R^2 = 0.222 Hosmer and Lemeshow test Chi-square = 3.670 (df = 8, Sig(p) = 0.886)							

Table 5. *Cont.*

Dependent Variable	Independent Variables	B	S.E.	Wald	df	Sig.	Exp(B)
ME.5 (children)	AT.F.1	0.510	0.136	14.000	1	0.000	1.666
	AT.F.2	0.414	0.124	11.078	1	0.001	1.153
	AT.F.4	0.374	.0132	7.986	1	0.005	1.453
	Constant	1.803	0.145	154.854	1	0.000	6.070
Classification percentage = 84.0%, Nagelkerke R^2 = 0.127 Hosmer and Lemeshow test Chi-square = 6.370 (df = 8, Sig(*p*) = 0.606)							
ME.7 (dust)	AT.F.1	0.537	0.154	12.093	1	0.001	1.711
	AT.F.2	0.415	0.142	8.565	1	0.003	1.151
	AT.F.3	0.619	0.157	15.468	1	0.000	1.857
	Constant	2.408	0.190	160.820	1	0.000	11.115
Classification percentage = 89.4%, Nagelkerke R^2 = 0.160 Hosmer and Lemeshow test Chi-square = 5.133 (df = 8, Sig(*p*) = 0.743)							

[1] The words in parentheses are keywords that can describe each dependent variable. (ME.1) IGS makes urban landscape beautiful; (ME.2) IGS can make me feel nature in urban area; (ME.3) IGS is easy to access because it is close to where I live; (ME.4) it is possible to use IGS freely in many ways; (ME.5) IGS can be a place where children can play; and (ME.7) IGS has the effect of suppressing dust.

4. Discussion

This study was conducted to consider IGS as a supplementary urban green space in response to the physical and financial constraints in green provisioning in contemporary urban areas. Overall, we suggest our findings support the view that IGS has potential to supplement UGS in Ichikawa. However, IGS is not officially designated or recognized by the government or landowner for a recreational or protective purpose [28]. Therefore, it may be difficult for residents to perceive IGS as a stance equivalent to existing UGS, such as urban parks. Understanding these issues, we investigated the perception of IGS from the point of existing UGS that is already familiar to residents. In this context, we examined residents' IGS perception as influenced by their experience, green space exposure, and attitude towards UGS. We discuss the implications of our findings in more detail in the following section.

4.1. The More Favorable Towards UGS, The More Favorable Towards IGS

In general, familiar objects are recognized categorically, and perceptual similarities are closely related to perceived objects [37]. Respondents who have a close relationship with UGS in their daily lives tend to have a favorable perception toward IGS, even if IGS is not designated by the government or landowner for recreational use. Overall, respondents took a favorable stance to IGS, but there were differences in their positions according to the frequency of their exposure to UGS and their experience of greening-related activities. Respondents who actively engaged with the environment, such as green volunteering and gardening, tended to perceive IGS as a medium that may improve environmental issues in urban areas, for instance, air purification and dust suppression. They see the possibility to improve the surrounding environment due to the spontaneous vegetation within IGS. Respondents who use UGS more also recognized IGS more as a spatial element which people can use and act. In contrast, the respondents with little experience about UGS took a skeptical stance to using IGS. Respondents who have no active UGS experience, such as visiting and managing greenspace, recognized IGS as an unmanaged and neglected space (see Tables 3 and 4). The respondents who were not satisfied with the quantity of UGS in their surroundings felt more uncertain about using IGS and were concerned with the landowners (see Table 4). Therefore, considering that favorable perception toward IGS is linked to the degree of UGS experience, one cause for this may be the perceptual similarity between UGS and IGS. This relationship between green space experience and perception of IGS suggests that urban green space can be supplemented, but more so in areas where a certain level of UGS are already provided and for residents who already use UGS. In contrast, these findings

suggest that unlocking the potential of IGS for recreation for areas with very little UGS and residents unfamiliar with UGS may be challenging.

4.2. IGS: Located Close By and Easy to Access

Many studies show that green space is an essential component of urban space as an open space for improving the sustainability of the urban environment and the health of residents. In the context of these issues, contemporary researchers are concerned about accessibility to urban green spaces as access is linked to improvements in residents' health and social well-being [38–40]. In previous research on the recognition of green space with IGS [26,41], accessibility from home was perceived as an important reason why participants used IGS. Our survey results show that the accessibility aspects of IGS are highly influenced by UGS experience. Those with UGS experience perceived that IGS that is located near their residence as an advantage. In contrast, residents who lack access to green space in their housing and are less satisfied with their surrounding green environments had a lower perception of IGS proximity. This is important because accessibility and quantity of green space are linked to maintaining the well-being of residents of the neighborhood, particularly housewives, the elderly, and those who are socially vulnerable [42,43]. Improving accessibility to open space, including green space, has been shown to play an important role for the elderly in encouraging their physical activity and quality of life [44,45]. Moreover, living nearby a relatively comfortable and walkable green space was correlated with a lower mortality risk for older people [46]. In this context, IGS proximity is of particular interest when taking access to greenspace for aging residents into account. Most of the respondents in our study were of a high age. This demographic composition reflects the current situation in Japan, which has entered a super-aged society. In fact, the proportion of the aging population in Ichikawa was 23.8% by 2015. In our study, older adults took part more frequently in green activities and responded more to the surrounding green environment. The beneficial effects from green space are more pronounced in elderly and housewives who rely more on the local living environment [47]. According to a recent study, about 67% of adults over the age of 60 spent 8.5 h indoors on a sedentary basis [48]. Therefore, given the age groups surveyed and the IGS accessibility they perceive, IGS may serve as an element that not only encourages outside activity and promotes physical health, but also promotes social cohesion and a community for older adults, for whom social isolation has been linked with increased mortality [49,50].

4.3. IGS and Participatory Aspects

Green spaces managed by local residents enhance the local biodiversity and ecosystem services production and encourage user participation [51]. While the structural complexity and intensity of management influences the basis of participation, appropriate participatory management provides an opportunity to improve participants' health with physical activities through the management of the site [52,53]. In our study of the residents' attitudes toward UGS, they were significantly less willing to conserve urban nature than to agree that urban nature and human beings must coexist. Although the level of willingness to participate was overall rather low in this study, the results confirm findings of previous research on willingness to participate in IGS management [12]. However, the willingness to participate in urban environmental activities was identified as an influential element in perceiving IGS favorably. To structure the integrative UGS planning for compact and green cities, a landscape ecological approach, governance processes, and public participation is required to adopt the demands of residents [54]. This suggests efforts to increase overall participatory green space management may lead to more positive perceptions of IGS in the future. Our findings corroborate previously proposed principles for participatory IGS management [12] and highlight the importance of non-IGS related experience in facilitating willingness to participate.

4.4. Limitations

This study has some limitations. Older residents (over 60) accounted for almost half of all respondents (44.7%). Therefore, it is assumed that the perception of the elderly has been reflected more strongly. However, this can be interpreted to provide a glimpse into the future Ichikawa is heading towards due to the rapid aging process ongoing in Japan. In an aging society, encouraging equality of outdoor activities and green life for the elderly is thus of increasing importance.

Another limitation was the number of 'undecided' responses to the perceived IGS in our survey responses. However, similar results by Rupprecht [12], despite using a different data collection method, suggest this may be typical for the study topic. While the reason could be a lack of interest in IGS, we find it more likely that the unfamiliarity of the concept makes expressing strong opinions difficult for residents. In the future, we propose testing a six-level Likert scale rather than a five-level Likert scale when surveying unfamiliar concepts, providing respondents with more nuanced ways to indicate weak agreement or disagreement while ensuring all respondents' opinions are reflected in the final results.

5. Conclusions

This study examined the potential of IGS as supplementary greenspace to meet the wellbeing needs of residents in the context of spatial and financial limitations in Ichikawa, Japan. Based on our findings, we conclude that IGS in Ichikawa is not disparate from green spaces that are recognized by residents, and has potential as a supplement for UGS. IGS can play a role in relieving the spatial and financial burden of governments and help them meet the needs of residents' comfortable lives. However, planners must consider ways to compensate for the fact that it may be difficult for residents with little UGS and related experience to perceive the potential of IGS. Therefore, when discussing IGS to resolve the inequality of green space provision, proposals should consider the perceptions of residents disadvantaged in terms of green space access to address this environmental justice issue. Another issue for planners to consider is the distinct spatial form of IGS. IGS is smaller than large-scale urban parks, and the continuity of space may be uncertain. IGS, however, is a result of spatially appearing by-products of human activities, scattered around the area where human activities take place. As our findings show, accessibility is one of IGS's most significant features and potential advantages—something planners can seek to leverage. This suggests that even though it may be difficult to provide users with the full functions of green space, such as an urban park, it can provide a minimum level of functions that can contribute towards meeting residents' needs in some parts of everyday life.

We conclude with some directions for future research based on our findings and limitations of our study in the hope they will contribute to furthering our understanding of IGS. Since close to half of our respondents were over 60 years old, we believe older adults' perception of IGS and its potential for them merits further investigation. Although our study was limited to Japan, represented by a shrinking and aging city, we suggest additional research in other Asian cities that share the issue of aging as an aspect affecting the quality of residents' lives, but which still experience rapid urban growth (e.g., Seoul). While a study in rapidly growing Brisbane, Australia suggested that IGS exists even when development pressure is high, IGS availability in Asian megacities is a topic that merits further study. Such a follow-up study of the availability of IGS should also consider recognition by older people in response to the increasingly aging Asian societies. Furthermore, in this context, IGS could be investigated as a relief not only for the elderly, but also people in lower socioeconomic groups who often experience unequal availability of green space; however, more data is needed on this topic. In addition, even though research on IGS has been increasing, support from the government and stakeholders is still limited because IGS's recreational use is contested by continuous development and land speculation pressure. Future work should thus investigate the direction of IGS's empirical development through perceptions towards IGS by residents and what role the government and urban planners play in how IGS are integrated into policies.

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