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# Access and Use of Green Areas during the COVID-19 Pandemic: Green Infrastructure Management in the “New Normal”

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**Abstract:** This study aims to identify the influence of the socioeconomic attributes and environmental contexts of citizens’ residential areas on the access and use of green areas during the COVID-19 pandemic. The results can aid policymaking and facilitate the safe and unrestricted use of green areas during the pandemic. The access and use of green areas were analyzed using a survey conducted after the official COVID-19 emergency in Japan (16 April to 14 May, 2020). Visits to green areas during the pandemic have gained salience globally from multiple perspectives: health, planning, social justice, and equity. The results of this study demonstrated that socioeconomic factors influenced the frequency of visiting green areas. The factors further influenced the use of the three categories of green areas (parks, agricultural lands, and gardens). Environmental contexts, including the land use patterns in residential areas, also influenced the use of specific types of green areas. Thus, policies need to further facilitate visits to green areas by reflecting the socioeconomic attributes of residents and their households, including income, number of children, gender, and age, incorporating those who have less access and considering the spread of COVID-19 locally. Furthermore, policies for the use of specific green areas, including parks, agricultural lands, and gardens, need to take cognizance of the residents’ environmental contexts. Management of specific green areas, like agricultural lands, is required, and residents should be provided with opportunities to use these areas with measures to avoid infection.

**Keywords:** green area; accessibility; COVID-19; green infrastructure; Japan

## 1. Introduction

Green areas, including parks, gardens, agricultural lands, and forest lands, provide various ecosystem services—provisional, regulatory, and cultural [1–3]. Agricultural areas and forest lands, including urban spaces, provide us with services, such as food and water. As for the regulatory services, they regulate water and thus help in controlling floods in urban and rural areas. Green areas, including parks, serve residents culturally, as they inspire visitors and provide recreational opportunities. As for the betterment of the ecosystem, appropriate management of green areas and their networks can contribute to urban and rural biodiversity conservation if local governments seek national and international collaborations [4–6]. Despite these fundamental characteristics, citizens who access such services tend to be relatively limited to only certain socioeconomic statuses and environmental contexts [7–10]. Those on a higher income level easily access green areas, while those on low income levels face difficulties due to lack of transportation (including car ownership), time constraints, and entrance or membership fees for such areas [11]. Thus, the socioeconomic status can have an impact on accessibility for certain low-income citizens, as can education level. Furthermore, the environmental

context also influences accessibility and use of green areas. For example, properly allocated urban agricultural lands can facilitate agricultural activities [12]. In most areas, even if locals wish to access green areas, it is difficult to do so without proper environmental management and green infrastructure [13]. As fundamental environmental elements that can provide ecosystem services, management of green areas is necessary to enhance the quality of life, for environmental conservation, and to reduce disaster risk in urban and rural areas [14–18].

Basic social attributes such as age, gender, and number of children in households also influence the accessibility of green areas [19,20]. These attributes reflect the regional culture and structure of families and society at large. For instance, in a society with an active aging population [21], the ratio of elderly citizens who use green areas tends to be higher compared with other profiles. As another example, the ratio of females who use green areas might correlate with the number of children in a household in a society with a relatively high ratio of housewives. These societal and cultural contexts need to be considered when developing and implementing green area management. As an infrastructural element of society, green areas need to be supported by the residents. To enhance their ownership and facilitate the citizens' participation in the management, understanding these contexts is essential to establish appropriate policies and actions.

In the ongoing COVID-19 pandemic, trends of access and use of green areas have changed globally [22–24]. National governments have requested that citizens adopt the so-called “new normal” lifestyle to facilitate the changes, including measures such as home offices to avoid crowds in traffic and workplaces. Owing to the lockdown of municipalities to control the spread of infection, access and use of green areas have been restricted. Residents tend to avoid public spaces, and social distancing is required in green areas, especially public parks. The severity of lockdowns differs in various contexts, and Japan was relatively relaxed compared to Europe, China, or India in terms of the strictness of countermeasures and by requesting voluntary cooperation. However, precautionary measures were taken in Japanese parks, including playgrounds, by limiting the facilities. There were social disputes and confusion regarding the extent and perceptions of lockdowns, and some residents made police reports that parks were crowded (the municipalities later asked citizens not to report such incidents, as they were neither urgent nor relevant police tasks).

However, the situations during the COVID-19 pandemic did not necessarily result in negative impacts on residents. For instance, citizens can visit green areas to reduce their COVID-19-related stress issues [25,26]. The circumstances created by COVID-19 can propel the understanding, reexploring, and rediscovering of the meaning and value of green areas. Although green area management in the “new normal” is still in the developing phase, residents' awareness can be enhanced by visiting such areas during this crisis period.

The existing studies tend to analyze the overall number of visitors, but have less data for the visitors' attributes. There need to be more detailed analyses as to “who are the actual visitors?”. Given the negative and positive impacts of COVID-19 on green areas, management of such spaces in the “new normal” needs to reflect the socioeconomic attributes and environmental contexts of the residents using them. The influences of these attributes and contexts on the access of green areas during and before the pandemic remain rather unexplored. The purpose of this study is to identify the influence of the socioeconomic attributes of citizens and environmental contexts of their residential areas on the access and use of green spaces. The results can serve as evidence for policymaking to facilitate the safe and equal use of green areas during the pandemic. As for the survey and analysis, the status of access and use of green areas during the time of the COVID-19 crisis is examined using the results of a questionnaire survey. The following sections describe the analysis of the relationships between the access and use of green areas with the socioeconomic attributes of residents and their environmental contexts.

## 2. Materials and Methods

The results of an online questionnaire survey were used. The survey was conducted after the emergency period (16 April–14 May 2020) of COVID-19 in Japan. During this period, residents were discouraged from going out of their houses and visiting places beyond prefectural borders, although the restrictions in the emergency declaration were not as stringent as lockdowns in other countries. The target site of the survey was Aichi Prefecture and its capital, Nagoya City, which includes one of the largest metropolitan areas and can be a representative case of an urban and rural interface connected with green area networks. The total number of respondents was 1244, with 47.6% females and 52.4% males; the ratio of elderly respondents over 60 years was 36.6%, and other five-year age groups had relatively similar ratios (7–11%), except the age group of 20–24 years (2.9%), which was the youngest age group. The online survey period was from 31 July–1 August 2020.

In the questionnaire, respondents were asked for the following information:

- Socioeconomic attributes: Gender, age, annual household income, number of children in the household;
- Environmental contexts: Zip code area (to compute the ratios of land use categories in individual zip code areas), and whether respondents resided in Nagoya City (Answer: Yes/No);
- Status of access and use of green areas: Whether respondents visited green areas (parks, agricultural lands, common or private gardens, and other green areas) during the emergency period (Answer: Yes/No);
- Change in frequency of access and use of green areas: Whether the frequency of visits was higher compared with the same period in the previous year (Answer: Yes/No).

To compute the ratios of land use categories in zip code areas to analyze the environmental contexts of respondents, Japan Aerospace Exploration Agency (JAXA) High-Resolution Land Use Data (2014–2016) ([https://www.eorc.jaxa.jp/ALOS/en/lulc/lulc\\_index.htm](https://www.eorc.jaxa.jp/ALOS/en/lulc/lulc_index.htm)) were used. The resolution of data was a 30 m square grid, and it had 10 land use categories. Because the zip code areas were relatively small, especially in city centers, high-resolution data were used (Figure 1). To understand the ratios of land use categories, the ratios of urban areas, agricultural lands, and forest lands were computed. Nagoya City is a very dense urbanized area, and its environmental context is largely different from those of other municipalities. Considering these characteristics, the place of residence (whether in Nagoya City or not) was included in the environmental context data.

In the data analysis, the Chi-square and *t*-test were performed. The former test was applied to nominal data, and the latter test was applied to continuous data. The status and the change in frequency of access and use of green areas were nominal variables, and the Chi-square test was applied to the analysis of data on socioeconomic attributes, except for age and environmental contexts. Average values of age and ratios of individual land use categories were analyzed using a *t*-test.

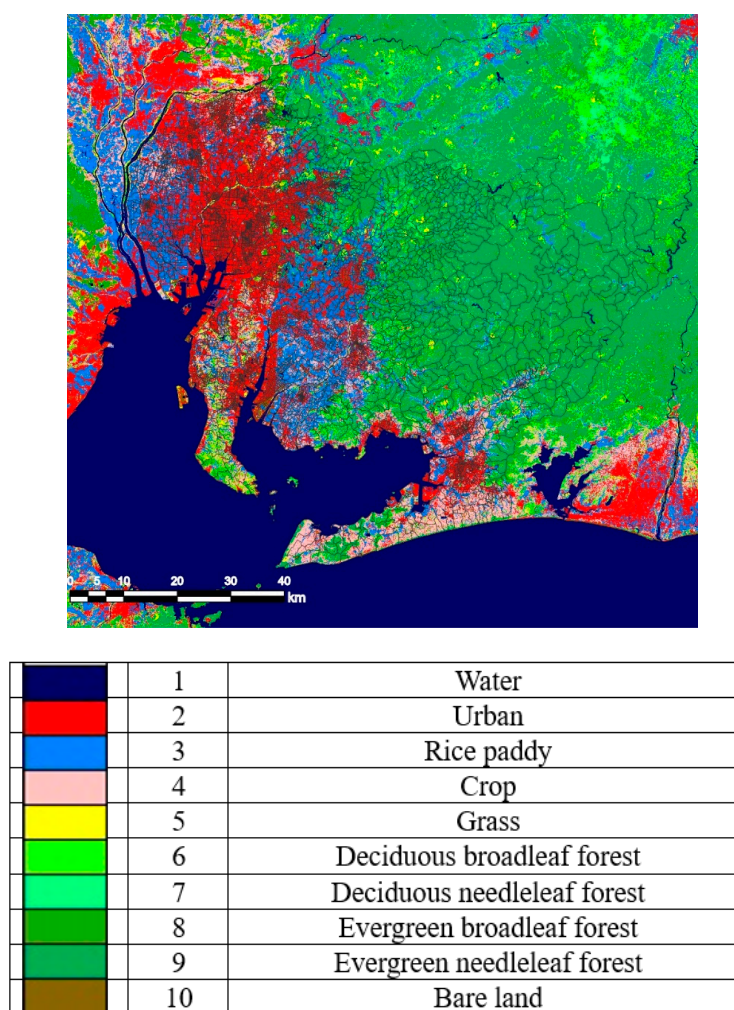


Figure 1. Research site (Aichi Prefecture).

### 3. Results

#### 3.1. Influence of Personal Attributes and Environmental Contexts on Access and Use of Green Areas

This section describes the results of the analysis of relationships between personal attributes and environmental factors and the access and use of green areas. The results of the cross-tabulation of the number of respondents who visited or did not visit green areas and the data of socioeconomic attributes and environmental contexts are found on the left side of Table 1. Statistical analysis was applied to the respondents who reported annual household income ( $n = 953$ ). The Chi-square and  $t$ -test indicate that the number of children in the household and household income variables had statistically significant correlations. As shown in Table 1, the respondents whose households had one or more children tended to visit green areas more compared with the respondents without any children. Furthermore, the respondents whose household income was relatively high (more than 400 million JPY, which is 38 thousand USD (10 November 2020)) tended to visit green areas more compared with those from relatively low-income households.

The  $t$ -test was applied to the average values shown on the right side of Table 1, and there was no statistically significant difference between the respondents who did and did not visit green areas during the emergency period.

According to the results, whether respondents visited visit green areas or not was influenced by their socioeconomic attributes, including the number of children and level of household income.

Conversely, environmental context was not a major factor influencing the motivation or action to visit green areas.

### 3.2. Influence of Personal Attributes and Environmental Contexts on Use of Individual Types of Green Areas

This section explains the results of the analysis of the influence of socioeconomic attributes and environmental contexts on the use of individual green areas. The number of respondents to visit parks, agricultural land, and gardens was analyzed, whereas other green areas, including mountains, did not have enough respondents to apply statistical analysis. The Chi-square and *t*-test were applied to the groups of respondents who visited at least one type of green area during the emergency period ( $n = 542$ ).

The results indicated that socioeconomic attributes and environmental contexts that influenced the use of green areas varied among parks, agricultural lands, and gardens (Table 2). Gender, location of residence, age, and ratios of land use categories had a certain influence on park visits. For example, female respondents and residents of Nagoya City tended to visit parks (Table 2). The respondents who visited parks were relatively young compared with those who did not visit. The average values of zip code areas were statistically and significantly varied between the respondents who visited and did not visit parks. Because the zip code areas tended to be larger in rural areas and smaller in urban areas, the results implied that the respondents who visited parks lived in urban areas. This implication was supported by the results of the *t*-test applied for the average values of the ratios of urban areas, agricultural lands, and forest lands. The ratios of those land use categories in zip code areas that are the residential places of respondents who visited parks indicated that the respondents lived in urban areas.

The results revealed that visits to agricultural lands were significantly influenced by location of residence, age, and ratios of land use categories. As for agricultural lands, socioeconomic attributes, except age, were not major factors influencing the motivation and action to visit there. The respondents who visited agricultural lands were relatively old and lived mainly outside Nagoya City (Table 2). The zip code area sizes and the ratios of land use categories implied that they did not live in urban areas. Because of their environmental contexts, those who visited agricultural lands during the emergency period had easy access.

The results indicated that the number of children, location of residence, age, and ratios of land use categories had a certain influence on visiting gardens. As indicated in the Materials and Methods section, “garden” listed in the questionnaire referred to common and private gardens. Respondents who visited gardens tended to have one or more children. Respondents who visited gardens tended to reside outside Nagoya City (Table 2). The ratios of urban areas were relatively lower, and the ratios of agricultural lands were higher in areas of their zip code and residence. These results implied that the respondents who visited gardens tended to live in non-urbanized areas. The average age of the respondents who visited gardens was slightly older than those who did not visit.

As an overall trend, parks were visited by relatively younger respondents who lived in urban areas, and agricultural lands and gardens were visited by the older respondents who lived in rural areas or areas in between. Income level was not a major factor influencing motivation and action to visit the three individual types of green areas.

### 3.3. Change of Frequency of Using Green Areas

The results of the analysis of relationships between personal attributes and environmental contexts and change in frequency of visiting green areas indicated a similar trend to that in Section 3.1, which revealed the analysis results of these factors’ influence on access and the use of green areas. Environmental context was not a major factor that influenced the change in frequency of visiting green areas. Conversely, socioeconomic attributes were related to the change in the frequency (Table 3). Household income was the common major factor that influenced the analysis results provided in Section 3.1. The respondents’ gender was a factor that influenced the results of this section, and while the number of children was not a factor, it did influence the respondents visiting green areas, as shown in Section 3.1.

**Table 1.** Relationships between personal attributes and environmental factors and access and use of green areas.

	Number of Respondents						Average Value						
	Number of Children (>1)	Number of Children (0)	Household Income (≥400 Million JPY)	Household Income (<400 Million JPY)	Male	Female	Nagoya City	Other Municipality	Age	Zip Code Area (ha)	Urban Area (%)	Agricultural Land (%)	Forest Land (%)
Yes	439	159	421	177	343	255	190	408	51.3	165.6	66.0	23.3	5.0
No	215	140	229	126	208	147	111	244	52.3	149.4	67.2	22.8	4.2

(Green:  $p < 0.01$ , orange:  $p < 0.1$ ; 400 million JPY is equal to 38 thousand USD (10 November 2020); Yes: accessed and used, No: did not access and use).

**Table 2.** Relationships between personal attributes and environmental factors and access and use of the three types of green areas.

	Number of Respondents						Average Value						
	Number of Children (>1)	Number of Children (0)	Household Income (≥400 Million JPY)	Household Income (<400 Million JPY)	Male	Female	Nagoya City	Other Municipalities	Age	Zip Code Area (ha)	Urban Area (%)	Agricultural Land (%)	Forest Land (%)
Park (y)	142	51	139	54	103	90	71	122	47.0	121.3	71.7	19.3	3.2
Park (n)	261	88	242	107	213	136	101	248	54.7	184.4	63.2	25.2	6.0
Agricultural Land (y)	20	4	17	7	17	7	2	22	64.1	565.5	46.2	31.7	17.2
Agricultural Land (n)	383	135	364	154	299	219	170	348	51.4	143.2	67.2	22.7	4.5
Garden (y)	180	43	152	71	122	101	52	171	53.3	172.6	60.5	28.2	5.6
Garden (n)	223	96	229	90	194	125	120	199	51.0	154.5	70.3	19.6	4.6

(Green:  $p < 0.01$ , yellow:  $p < 0.05$ , orange:  $p < 0.1$ ; 400 million JPY is equal to 38 thousand USD (10 November 2020); (y): accessed and used, (n): did not access and use).

**Table 3.** Relationships between personal attributes and environmental factors and change in frequency of visiting green areas.

	Number of Respondents						Average Value						
	Number of Children (>1)	Number of Children (0)	Household Income (≥400 Million JPY)	Household Income (<400 Million JPY)	Male	Female	Nagoya City	Other Municipality	Age	Zip Code Area (ha)	Urban Area (%)	Agricultural Land (%)	Forest Land (%)
Frequency (Higher)	81	35	92	24	57	59	35	81	47.2	170.0	66.8	23.9	4.3
Frequency (Stable/Lower)	322	104	289	137	259	167	137	289	53.3	159.7	66.1	22.9	5.2

(Green:  $p < 0.01$ , yellow:  $p < 0.05$ ; 400 million JPY is equal to 38 thousand USD (10 November 2020)).



In summary, the household income of the respondents whose frequency of visiting green areas tended to be higher than that of the respondents whose visits were stable or lower. Regarding gender, the frequency of female respondents visiting green areas tended to be higher than that of males. The average age of the respondents who frequently visited green areas was relatively higher (Table 3).

Household income was detected as a factor that influenced (i) the change in frequency of visiting green areas (Section 3.3) and (ii) whether the respondents visited green areas or not (Section 3.1). Furthermore, it should be noted that environmental contexts that influenced the use of the three types of green areas were not major factors regarding (i) the change in frequency and (ii) visiting green areas.

In the next section, the interpretation of the results provided in Section 3 and implications for policies and management of green areas will be discussed.

#### 4. Discussion and Conclusions

This study describes a major behavioral pattern seen during the COVID-19 crisis in Japan. We found that socioeconomic attributes influenced the changes in frequency of visiting green areas. The attributes further influenced whether the respondents did or did not visit green areas, categorized into three types. Alternatively, environmental contexts, including the residential location of the respondents, was a factor that had a certain influence only on the use of the three types of green areas. These results implied that motivation or actions of visiting green areas tended to be influenced by the socioeconomic attributes of the residents. Environmental contexts might have an influence on the motivation of visiting green areas by providing scenery and an opportunity to visit green areas near the citizens' residential spaces; however, the influence might not be relatively strong compared with that of socioeconomic attributes. The use of specific green areas such as parks, agricultural lands, and gardens tended to be influenced by socioeconomic attributes and environmental contexts. Future policies to promote visits to green areas or to enhance the frequency of visits need to focus on the socioeconomic attributes of residents, such as household income, number of children, gender, and age, rather than environmental ones. These factors influence whether residents will visit green areas or not.

Before the pandemic, a study focusing on a Japanese city suggested that household income and related socioeconomic attributes did not correlate with the use of green areas [27]. Although further research is needed to detect the specific impact of income level on the access and use of green areas, this study showed that income level might have become a factor that influences the use of green areas in Japan. In Europe, socioeconomic attributes, including income level and age, were detected as factors influencing the access of green areas even before the period [28]. As for research in North America, existing studies showed the correlation between high socioeconomic status and access of green areas [8,9]. In China, those attributes were not influential factors on the access of green areas [29], which is a similar trend to that shown in Rupperecht et al. [27]. As for the research published right after the beginning of the pandemic, it was reported that the frequency and access of green areas had changed, as the existing studies, such as Žlender and Thompson [30], analyzed accessibility and purpose of visit [22,24,31]. Some of the research focused on health issues rather than socioeconomic issues [26,32]. As Honey-Rosés et al. [23] suggested, inequities and exclusions can be included in research on access and use of green areas in the pandemic, and this research provided the empirical results that can contribute to these topics. Further empirical research is needed to verify the status and trends of the inequities and exclusions in the access and use of green areas in different regions and countries with different backgrounds, such as post-socialist countries [10].

The question remains as to how one promotes visits from those social stratifications that are not actively visiting the areas. Reflecting on the opinions from the citizens with different socioeconomic attributes, policies and actions are necessary to enhance the accessibility of green areas for residents whose socioeconomic status is relatively low. As for the gender and number of children, they seem not to correlate in the results, although both are factors that influence access and use of green areas. It can be assumed that certain numbers of female respondents visited green areas with their children, but that trend was not very clear in the results. In future research, the detailed influence of gender and

number of children on access to green areas needs to be identified, and specific policies that can be applied for children, parents, and other family members need to be discussed. The involvement of citizens with different backgrounds is needed in the process of policymaking and practices of green area management [7].

Having said this, the environmental contexts of residents are influential once the residents decide to visit the green areas. Therefore, policies regarding the use of specific green areas, including parks, agricultural lands, and gardens, need to be considered with the general policies facilitating visits to green areas. The results suggest that parks were mainly used by urban residents, and agricultural lands and gardens were used by rural residents. If there is a policy demand for facilitating the use of specific green areas, such as agricultural lands, both adequately preparing the green areas and providing opportunities for the use of such areas are required.

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