



# Utilization of urban agriculture to enhance urban sustainability: investigating people's heterogeneous preferences for proximity to urban agriculture through a choice experiment

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## Abstract

The purpose of this study is to investigate people's preferences for the geographical distance between residential locales and two types of urban agricultural land, namely, traditional agricultural land and a more complex and intensive agricultural landscape called “*satoyama*” and to evaluate the heterogeneity in people's preferences. The enhancement of urban sustainability is a crucial issue in sustainable development that can be potentially improved by urban agriculture. However, urban residents' perceptions and preferences regarding the distance between urban agricultural land and their locales remain unclear, and concrete measures to maintain and expand urban agriculture are still vague. Therefore, an online survey and choice experiment was conducted, with respondents from Ishikawa Prefecture in Japan, who are assumed to be familiar with the agricultural context. Mixed logit and latent class logit models were employed to evaluate urban residents' heterogeneous perceptions and preferences. The results reveal that: (1) urban residents generally prefer urban agricultural land in areas away from their residence; (2) preferences are diverse, and those who are relatively young, with higher income, and more environmentally conscious favor dwelling near urban agricultural land; (3) there is a quadratic relationship between the distance connecting people's locales and urban agricultural land, and thus, the most desirable distance exists; and (4) there is a difference in the proximity that people prefer between traditional agricultural land and *satoyama*. Based on the results, policy implications for urban planners and policymakers include implementing urban agriculture in peri-urban areas and handling a tradeoff between residential opposition and the intensity of urban agriculture.

**Keywords** Urban agriculture · Geographical distance · Choice experiment · Mixed logit model · Latent class model · *Satoyama* landscape

## Introduction

### Background

There is a growing global awareness among governments and the public that reducing the negative environmental impact of cities is critical for improving urban sustainability and ensuring that people and their descendants continue to reside in cities in the future (Mori and Christodoulou 2012;

Kabisch et al. 2016; Galli et al. 2020). The sustainable development goals (SDGs) consider sustainable cities and communities as one of its goals (Goal 11), of which target 11.6 requires the environmental impact of cities to be reduced. The negative environmental impacts of cities, such as environmental degradation, pollution emission, living stress of residents, and threats to biodiversity (Liu et al. 2011; Mori and Christodoulou 2012; Botzat et al. 2016), are not just limited locally, but also spread both spatially and temporally (Seto et al. 2012), directly affecting the environment of neighboring and geographically related areas. For example, the fine particulate matter and nitrogen dioxide emissions of a city not only cause local air pollution (Le et al. 2020; Berman and Ebisu 2020), but also indirectly affect the environment of economically related locales, even beyond the city's boundaries. A large amount of energy consumption in urban areas generates an environmental burden outside

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the city, which deteriorates because of urban living, even if the environment surrounding urban areas is not degraded. Furthermore, global environmental issues such as climate change get aggravated (Glaeser and Kahn 2010).

Urban agriculture plays a critical role in mitigating the adverse environmental impacts on cities and in enhancing urban sustainability (Clinton et al. 2018; Ayambire et al. 2019; Azunre et al. 2019; Viana et al. 2022). Urban agriculture is defined as food cultivation in urban and peri-urban areas that include various agricultural activities (Pearson et al. 2010; Tornaghi 2014; Azunre et al. 2019). Urban agriculture practices are broad and can be classified according to various perspectives (Ferreira et al. 2018; Bretzel et al. 2018). For example, household gardens, allotment gardens, community gardens, and school gardens are defined by how they are managed. Rooftop and balcony gardens are typologies by their location of the practice.

Agricultural activities in urban areas are expected to improve urban sustainability, such as climate change mitigation and adaptation (Demuzere et al. 2014; Artmann and Sartison 2018); environmental burden accumulation (Clinton et al. 2018); urban resilience enhancement (Langemeyer et al. 2021); waste reduction (Orsini et al. 2013); air quality improvement (Orsini et al. 2013); and reduction of energy consumption (Ackerman et al. 2014). In addition, urban agriculture provides a variety of ecosystem services such as agricultural products (Ackerman et al. 2014; La Rosa et al. 2014; d'Amour et al. 2017; Hara et al. 2018); recreational opportunities (Zasada 2011; Brinkley 2012); landscapes (Zasada 2011; Brinkley 2012); contribution to the local economy (Orsini et al. 2013; Ackerman et al. 2014); and improvement to residents' life (Madureira et al. 2015). Although urban agriculture has made significant contributions to human well-being, agricultural land in cities is highly vulnerable to demand and economic activity, both within and outside cities (La Rosa et al. 2014; d'Amour et al. 2017; Azunre et al. 2019; Langemeyer et al. 2021). Depending on various economic imperatives, urban agricultural land can be easily converted to non-agricultural land that produce goods and services with higher market values (e.g., commercial and industrial). This change results in increased environmental impact and a degraded or reduced supply of agricultural goods and services. Therefore, urban planners and policymakers should efficiently manage and arrange agricultural land use in urban areas to achieve sustainability.

It is essential to investigate people's perceptions and preferences regarding agricultural land use in urban areas so that urban planners and policymakers maintain, manage, and further expand urban agriculture efficiently under pressure to change those land use (Dramstad and Fjellstad 2011; Ackerman et al. 2014; Langemeyer et al. 2021; Kyoj 2021). Since urban planners implement urban arrangements according to the preferences of urban residents, it is politically

challenging to execute land use strategies that are not supported by residents, as it will not only cause citizens to distrust the government but may also cause population exodus in the future. Furthermore, assessing citizens' preferences for agricultural land in urban areas will provide practical policy implications and evidence for urban planners for decision-making (Dramstad and Fjellstad 2011; Brown and Glanz 2018; Ayambire et al. 2019). If citizens value urban agriculture positively, urban planners can maintain and manage agricultural land use in urban areas with public support. In contrast, if citizens evaluate it negatively, additional environmental policies will be required, for example, an acceptable spatial arrangement of urban agriculture and settlements, an evaluation of the compensation requirements for citizens, and the provision of information on the importance of the role of urban agriculture (Brown and Glanz 2018; Ayambire et al. 2019).

## Research gap

Previous studies have attempted to evaluate people's perceptions and preferences for urban agriculture using multiple methods and have detected a variety of them. The stated preference approach evaluates the monetary value of urban agricultural amenities or activities by assessing the value of ecosystem services provided by urban agriculture (Yang et al. 2016; Jin et al. 2018; Albaladejo-García et al. 2021; Arata et al. 2021; Mariel and Arata 2022). For example, Martínez-Paz et al. (2021) evaluated the creation of a new type of agricultural activity in urban areas in Murcia (Spain). They revealed that the provisioning service of urban agriculture is highly valued by the inhabitants. They also suggested the local pattern of people's evaluations, which highlights the importance of spatial factors in terms of decision-making for urban agriculture. Yang et al. (2016) revealed that residents in Wuhan (China) are willing to pay for ecosystem services provided by the urban agricultural implementation. Brinkley (2012) reviewed studies that evaluated the value of agricultural land amenities and suggested that studies employing stated preference methods have generally evaluated the positive willingness-to-pay (WTP) value of urban people for agricultural land conservation programs. Additionally, the revealed preference method, such as the hedonic method, has revealed that hedonic values range from negative to positive, implying that living near agricultural land does not always affect rent and land prices positively (Brinkley 2012). Furthermore, some studies have employed interview-based approaches to detect people's perceptions and opinions on urban agriculture. For instance, Sanyé-Mengual et al. (2018) showed that people in Bologna (Italy) widely accepted urban agriculture, especially in agricultural production; however, they did not prefer an intensified agricultural system. In addition, Specht et al. (2016) revealed

that intensive urban agriculture was not highly acceptable for urban inhabitants in Berlin (Germany). Therefore, this implies that multifunctional urban agriculture with commercial, ecological, and social goals is most acceptable.

However, people's perceptions of and preferences for the spatial distance between urban agriculture and their residential locations remain unclear (Bergstrom and Ready 2009). Bertram and Rehdanz (2015) revealed that the spatial distance between residents in Berlin and green spaces in urban areas correlates with human well-being. In particular, they found significant and inverse quadratic impacts of distance to urban green spaces on stated life satisfaction. Nevertheless, the effects of urban agricultural activities, such as allergic reactions and unpleasant smells, negatively affect neighboring residents' lives (Lyytimäki and Sipilä 2009; Escobedo et al. 2011; Von Döhren and Haase 2015). Thus, people variously prefer these activities depending on the proximity of their locale to urban agricultural practices (Brinkley 2012; Sanyé-Mengual et al. 2018; Kyoi 2021). Additionally, the impact of urban agriculture intensity should be investigated. Urban agriculture encompasses various agricultural activities, and agricultural intensity varies depending on agricultural practices. Hence, people's preferences are associated with specific agricultural intensification (Specht et al. 2016; Sanyé-Mengual et al. 2018). Moreover, evaluating people's heterogeneous preference for neighboring agricultural land provides engaging and valuable information for urban planners and policymakers. Heterogeneous preferences among people potentially trigger conflicts among different land uses (Pearson et al. 2010; Specht et al. 2016). Understanding the extent of heterogeneity suggests the structure of conflict

and practical policy implications for urban planners and policymakers.

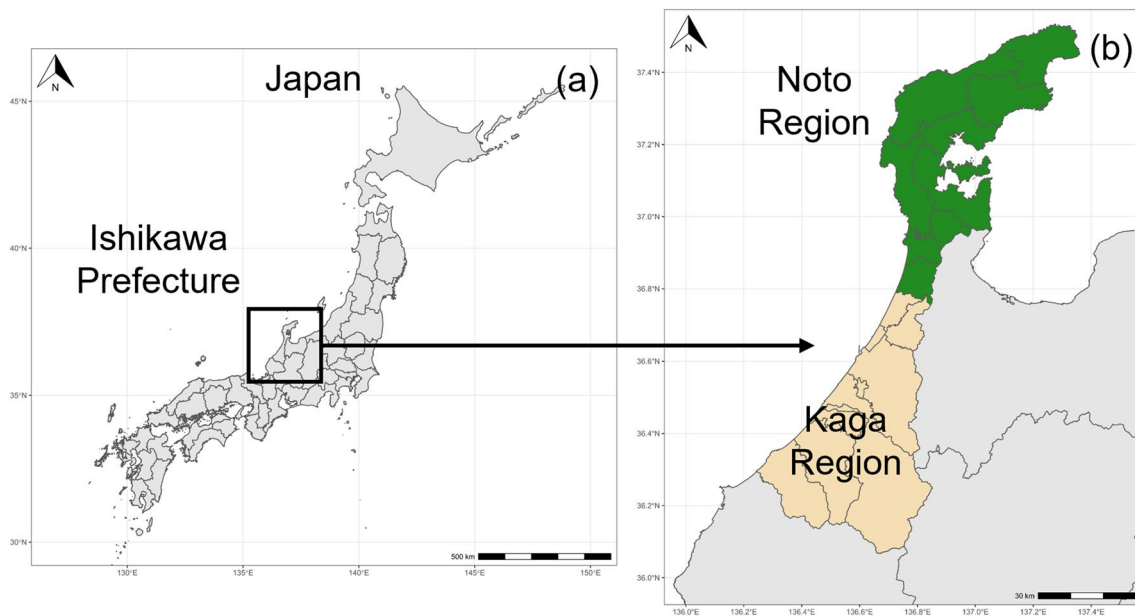
## Outline

The primary purposes of this study are: (1) to assess people's perceptions and preferences for the distance between their residential location and urban agricultural land, including traditional land and satoyama, and (2) to investigate the heterogeneity in people's preferences. Therefore, an online survey and choice experiment was conducted. Additionally, a mixed logit model was employed to evaluate the extent of heterogeneity, and a latent class model to classify people into groups, based on their preferences and determine the source of this heterogeneity. The remainder of this paper is organized as follows: the following section introduces the materials and methods employed in this study, including the study site, survey design, choice experiment, and estimation strategies. "Results" provides both survey and choice model results, and the subsequent section discusses an overview of these results. The final section concludes this paper.

## Materials and methods

### Study sites

The study site was the Ishikawa Prefecture of Japan, located in the mid-north of Japan's main island (Fig. 1a). Ishikawa Prefecture is divided into two regions having different characteristics, Kaga and Noto (Fig. 1b). The Kaga region is



**Fig. 1** a Location of Ishikawa Prefecture, Japan. b Two regions in Ishikawa Prefecture, Kaga and Noto regions

urbanized, including the prefectural capital city (Kanazawa city), and most people in Ishikawa Prefecture reside in this region. In 2015, Ishikawa Prefecture had approximately 1.1 million inhabitants, with more than 900,000 people inhabiting the Kaga region (Ishikawa Prefecture 2018). By contrast, the Noto region has richer agricultural landscapes, consisting of many hills, low mountains, and a few flat lands that are unsuitable for agricultural practices. However, these disadvantages have created distinctive agricultural landscapes called "satoyama" (Hashimoto et al. 2015, 2019).

Satoyama landscapes refer to a Japanese traditional, complex, and intensified agricultural landscape, including various agricultural and non-agricultural lands, such as cropland, woodland, grassland, farms, ponds, and brooks (Kobori and Primack 2003; Kadoya and Washitani 2011). Satoyama landscapes have contributed to biodiversity conservation, climate change mitigation, and human well-being (Kobori and Primack 2003; Kadoya and Washitani 2011). For instance, the satoyama landscape in the Noto region is a popular destination for migratory birds and a habitat for endangered species. Many of the endangered species in the satoyama landscape depend on agricultural land managed by humans, which suggests that satoyama is a form of land in which humans and nature coexist.

In addition to a biological contribution, satoyama landscapes also have sociological implications. Satoyama landscapes have a history of being maintained through intervention by local residents, which has facilitated the cohesion of local communities (e.g., collaborative work and rituals). Japanese citizens recognize satoyama landscapes as landscapes covered with forests and where paddy field agriculture is practiced (Iwata et al. 2011). In Japan, since the 1990s, policies have been implemented to increase interest in satoyama landscapes and promote conservation (Fukamachi 2017). These policies for conservation of satoyama landscapes have raised public interest in satoyama landscapes and promoted activities at the citizen level.

The main reason for selecting Ishikawa Prefecture is that there are rich agricultural resources, and therefore, people are assumed to be familiar with the agricultural context. In particular, the Noto region has valuable agricultural land. This region has been recognized as a "Globally Important Agricultural Heritage System" by the Food and Agriculture Organization in 2011 because of its traditional agricultural landscapes and culture comprising of rituals and practices (FAO 2011). As a result, it is assumed that residents in Ishikawa Prefecture can recall an agricultural land and satoyama landscape and distinguish them. In addition, Ishikawa Prefecture could be a representative site for other locations that need to assess the preferences of local residents for managing urban. This is because Ishikawa Prefecture is surrounded by (peri-) urban agriculture and has a land use pattern similar to other cities where traditional agriculture is practiced

(e.g., Murcia). This is another reason why Ishikawa Prefecture was chosen as the study site.

## Survey design and choice experiment

The online survey was carried out on a representative sample of 1,648 people in Ishikawa Prefecture, Japan, from January 27 to 28 and February 17 to 18, 2020, using a web survey monitor of a private survey company, *MACROMILL Inc.* (<https://group.macromill.com/>). The first-period survey was initially performed as a pilot survey, and as a result, it was found that the survey was found to be conducted without problems. Therefore, an identical survey was conducted in the second period. Note that online research implicitly excludes some residents who do not use the internet, which potentially brings about the biased result. This is discussed in the limitation part ("[Limitations and future works](#)").

The primary purpose of the survey was to quantitatively examine people's perceptions and preferences regarding the proximity of their dwellings to neighboring agricultural land. Therefore, a choice experiment was conducted in this study. The survey consisted of 28 questions, including respondents' interest in agriculture and the environment (e.g., "Have you ever heard about biodiversity?"); information about the residential locale of participants (e.g., proximity to the nearest traditional agricultural land and satoyama landscapes and monthly rent), choice experiment, and socioeconomic characteristics (see Table 8 in the Appendix for the list of questions). Additionally, each respondent was required to identify their residential location on a map that measured 1 km squared.

Respondents are asked to state the two geographical distances between their locales to agricultural land and satoyama in the Likert scale: *subjective distance* and *preferred distance* (see question 19–22 in Table 8 in the Appendix). In this study, *subjective proximity* refers to the geographic distance, as perceived by respondents, between their place of residence and the nearest specific landscape (i.e., agricultural land and satoyama). In other words, it refers to respondents' subjective perception of the geographic distance to the most neighboring agricultural land and satoyama. In contrast, *preferred distance* refers to the geographic distance between the locale of respondents' residences and the landscape around one's place of residence that each respondent considers to be favorable. In other words, it is the distance to the most neighboring landscape that each respondent finds preferable. Note that we removed the respondents who do not state their *preferred distance* (8 respondents, 0.4% of all sample).

A choice experiment is a form of conjoint analysis that elicits respondents' preferences for multiple attributes of hypothetical goods and services (Louviere et al. 2000). This approach evaluates respondents' preferences in monetary

terms for various attributes by employing monetary attributes, such as price and tax, to represent the object assessed. In the choice experiment, respondents are asked to select their most preferred alternative from the options provided, indicating goods and services that are described as a combination of some attributes. These choices are repeated in a series of choice tasks.

In this study, the choice experiment investigated the participants' preferences for the (1) proximity of their residence locale to traditional urban agricultural land, (2) proximity of their residence location to satoyama, and (3) richness of biodiversity, represented by the number of species of dragonflies, resulting from urban agricultural activities surrounding their residence. Therefore, the choice experiment employed four attributes to describe hypothetical residences: proximity to a piece of traditional agricultural land and a satoyama area, number of observable dragonfly species around the residence, and monthly rent (in JPY). The attributes and levels are listed in Table 1.

Four levels were employed for the attribute of proximity to traditional agricultural land: 0, 200, 500, and 1000 m. The reason why these four levels were used is that people may not care about the environment that is far from their residences. Additionally, observable agricultural land use can influence people's preferences (Walls et al. 2015; Kyoji 2021).

Moreover, four levels were employed for the attribute of proximity to satoyama: 0, 200, 500, and 1000 m. The main reason for utilizing satoyama for land use is that, as mentioned above, satoyama is a more intensive, complex, and valuable agricultural landscape than agricultural land. Thus, in comparison, people's preference for satoyama is expected to be more complicated. Both proximity attributes are used as continuous variables in the estimation.

Respondents' choice of "Do not choose among them" indicated that they preferred their current residence to the three hypothetical options given to them. Thus, respondents' actual residence levels for each attribute have to be assumed to examine their decisions. When respondents chose no choice options, the level of proximities to the traditional agricultural land and satoyama were replaced by respondents' perceived proximity to both land uses that were asked in the survey (see Table 8). In the estimation, we coded the

respondent's statement of "subjected distance is greater than 1000 m" as 2000 m and treated it as a continuous variable and proximity attribute of the experiment.

Four levels were employed for the attribute of the number of observable dragonfly species around respondents' residences: 0, 2, 4, and 8 species. This attribute indicates the degree of biodiversity around the residences. According to previous studies, the number of dragonfly species determines the degree of biodiversity (Sahlén and Ekstubbé 2001; Kadoya and Washitani 2011; Goertzen and Suhling 2013). People tend to perceive biodiversity positively (Nijkamp et al. 2008; Bakhtiari et al. 2014). However, previous studies considered biodiversity in areas where nature was present in abundance, and they did not evaluate biodiversity close to people's daily activities, including people's residences. It is expected that people will show a different preference for biodiversity around their residence compared to other areas.

When respondents choose no choice option, the level of number of dragonfly species observable around the residence was estimated using the respondent's parcel and its Satoyama Index (Kadoya and Washitani 2011). Following Kadoya and Washitani (2011), the number corresponding to the richness of dragonfly species in a parcel was calculated using the following formula:

$$y_i = \exp(0.429x_i + 0.735), \quad (1)$$

where  $y_i$  is the number corresponding to the richness of the dragonfly species in parcel  $i$ , and  $x_i$  is the Satoyama Index in parcel  $i$ .

The monthly rent attribute in the choice experiment differed among respondents to emulate a realistic residence choice. Before conducting the choice experiment, the respondents were asked about the monthly rent respondents actually pay (called current monthly rent, hereinafter). Note that there were three types of questions regarding current monthly rent depending on the respondent's demographics: (1) respondents living in rented apartments were asked about their monthly rent; (2) those dwelling in owned residences were asked about their monthly house mortgage payments; and (3) the ones residing in owned houses and who had already finished paying the house mortgage were asked about their monthly real property tax, which was treated as

**Table 1** The attributes and levels in the choice experiment, and the coding for our estimation

Attributes	Levels	Codes
Proximity to agricultural land	0, 200, 500, and 1000 m	<i>ProxAgri</i> (100 m)
Proximity to satoyama	0, 200, 500, and 1000 m	<i>ProxSato</i> (100 m)
Number of dragonfly species observable around the residence	0, 2, 4, and 8 species	<i>Biodiv</i>
Monthly rent	80, 90, 100, 110, and 120% of current monthly rent	<i>Mrent</i> (1000 JPY)

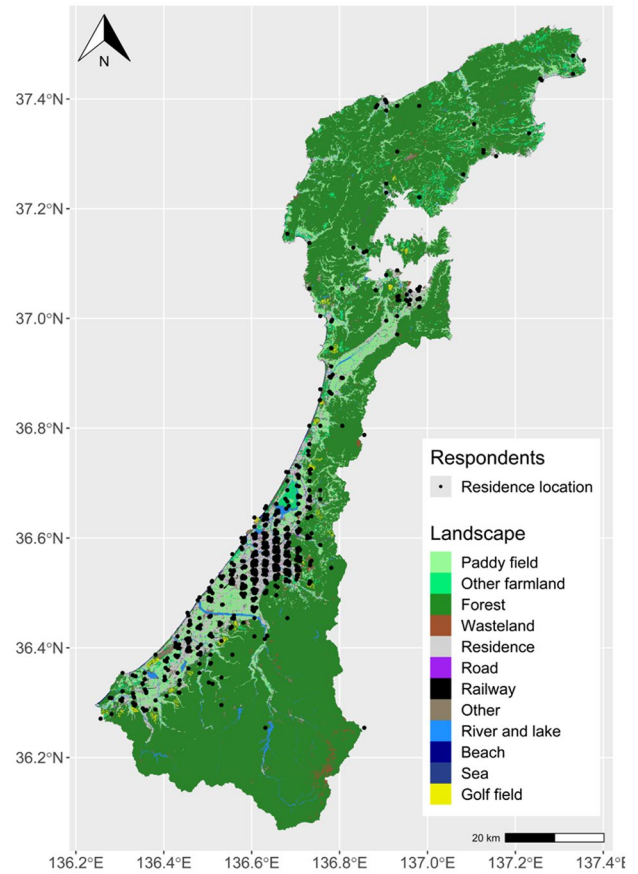
their monthly rent. Using the respondent’s current monthly rent, five different levels were employed in the choice experiment: 80, 90, 100, 110, and 120% of current monthly rent (see Table 9). For example, "80% of current monthly rent" is a hypothetical monthly rent, calculated by multiplying the respondent's current monthly rent by 0.8. For no choice option, the monthly rent level was replaced with the current monthly rent. Note that we removed the respondents who answered that their current monthly rent was zero (24 respondents, 1.4% of all sample).

Ngene software generated 36 choice sets without duplication, considering D-efficiency (ChoiceMetrics 2018), which is one of the guidelines for obtaining an efficient choice design. The D-efficient profile design minimizes the variance of the estimated parameters and the inverse determinant of the Fisher information matrix (Huber and Zwerina 1996). We divided the 32 choice sets into four versions equally, and randomly assigned the participants to one of the four versions. The choice task was repeated eight times for each participant, using different choice sets. In each choice task, we asked respondents to select a favorable option from the four alternatives provided: three hypothetical residences and refusal to choose (i.e., do not choose among them). Before each respondent answered, we repeatedly emphasized the following notification, "Please answer our questions, keeping in mind that the amount of money you have at your disposal will be reduced by the amount of the product you have chosen." as a cheap talk script (Carlsson et al. 2005; Silva et al. 2011). Table 2 presents an example of the choice tasks.

Finally, some respondents were removed from the valid sample, who chose "Do not choose among them" as an option for all eight tasks (139 respondents, 8.4% of all sample), because we assumed that they would refuse to answer the choice experiment.

**Data geocoding**

We obtained GIS data on land use of Ishikawa Prefecture in 2016, using the National Land Numerical Information (Ministry of Land, Infrastructure, Transport and Tourism 2021). The data includes land use details for all 1 km grid squares in Ishikawa Prefecture (see Fig. 2). The data identified 12 land use types: paddy fields, other farmlands, forests,



**Fig. 2** The land use pattern of Ishikawa Prefecture in 2016 and our valid respondents’ locations. Note: the black dots illustrate the centroid points of the residence grid based on respondents’ reports. Since some respondents revealed the same residence grid, the residential locations exhibited by the latitude and longitude were adjusted with a uniform random value [−0.005, 0.005]

wastelands, residential land use, and so on. Note that the land use data differentiates between paddy fields and other farmlands, although in this study, we merged both and termed it as agricultural fields.

This land use data is identically structured to the survey data, with both having a 1 km grid square structure. Therefore, we obtained the geocoded survey data by combining the survey and land use data. However, several respondents declined to provide grids or offered inaccurate grids (i.e.,

**Table 2** An example of a choice task

Attribute	Option 1	Option 2	Option 3	Option 4
Proximity to agricultural land	200 m	500 m	0 m	Do not
Proximity to satoyama	1000 m	0 m	1000 m	choose
Number of dragonfly species observable around the residence	0 species	8 species	0 species	among
Monthly rent	110%	90%	100%	them
Choose the most preferred option	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

non-existent or grids referring to the outside of Ishikawa Prefecture), making it impossible to spatially combine the two datasets. Hence, we removed such respondents (702 respondents, 42.5% of all sample) from the valid sample.

## Estimation methods

This study employs mixed logit and latent class logit models to evaluate participants' preferences by explicitly considering preference heterogeneity. The mixed logit model provides a flexible and practical evaluation that assumes preference heterogeneity among respondents, which is more realistic (McFadden and Train 2000; Train 2009). In the estimation model, we employed a random utility model to express respondents' choice behavior. We define the utility  $U_{njt}$ , that the respondent receives based on their choices in the choice experiment, as follows:

$$U_{njt} = V_{njt} + \varepsilon_{njt} = \beta' x_{njt} + \varepsilon_{njt}, \quad (2)$$

where  $V_{njt}$  is the observable utility;  $n \in (1, \dots, N)$ ,  $j \in (1, \dots, J)$ , and  $t \in (1, \dots, T)$  are the indexes of the respondents, alternatives, and choice tasks in the choice experiment, respectively;  $\beta'_n$  is the taste parameters of respondent  $n$ ;  $x_{njt}$  is the bundle of the attributes; and  $\varepsilon_{njt}$  is the random draw from a type I extreme value distribution. The choice probability  $P_{ni}$ , of the series of choices  $y_n$ , of respondent  $n$  is expressed as a conditional logit model as follows:

$$P_{ni} = \prod_{t=1}^T \frac{\exp(\beta' x_{nit})}{\sum_j \exp(\beta' x_{njt})}. \quad (3)$$

The conditional logit model assumes that the estimated parameters are constant across all respondents. In other words, every individual has an identical preference, which is unrealistic. By contrast, the mixed logit model assumes that preferences differ across respondents, that is, preference heterogeneity. The mixed logit probabilities are obtained by integrating the conditional logit probabilities with the distribution of  $\beta$  because the individual taste parameter  $\beta_n$  is unknown. Hence, the mixed logit probability is expressed as follows:

$$P_{ni} = \int \prod_{t=1}^T \left[ \frac{\exp(\beta' x_{nit})}{\sum_j \exp(\beta' x_{njt})} \right] g(\beta|\theta) d\beta, \quad (4)$$

where  $g(\beta|\theta)$  is the probability density function of  $\beta$  with parameter  $\theta$ . In this study, we assumed that  $g(\beta|\theta)$  was a normal distribution with an estimated mean and standard deviation for *ProxAgri*, *ProxSato*, *Biodiv*, and *Mrent* variables.

The latent class logit model provides distinct classes of individuals according to their preferences and classifies people into an arbitrary number of classes according to their choices, so that preference heterogeneity can be investigated. Moreover, the model employs multiple variables (e.g., socioeconomic variables) to assess the sources of preference heterogeneity. In the estimation, the model assumes that there are  $C$  discrete values of  $\beta$ , labelled  $b_1, b_2, \dots, b_C$ , with the probability  $\pi_c$ , that  $\beta = b_c$ . The choice probability is expressed as follows:

$$P_{ni} = \sum_{c=1}^C \pi_{nc} \prod_{t=1}^T \frac{\exp(b_c x_{nit})}{\sum_j \exp(b_c x_{njt})}. \quad (5)$$

## Results

### Survey results

After validation, 775 valid samples (47% of all sample) were obtained (Fig. 2). The primary reason 53% of respondents were dropped from the analysis is that many of them did not correctly indicate their place of residence. Such respondents may have been reluctant to provide information about their place of residence. Our sample was mainly collected from Kaga region, the most urbanized area of Ishikawa Prefecture. Table 3 summarizes the key socioeconomic characteristics of our sample. As shown in Table 3, our sample did not differ significantly from the average characteristics of residents in Ishikawa Prefecture with regard to three socioeconomic factors (*Male*, *Age*, and *Income*). These results indicate that our respondents are a good representation of urban residents throughout Ishikawa Prefecture and are appropriate for this study's purpose.

Tables 4 and 5 describe the correspondence between subjective and preferred proximity to both, urban agricultural as well as satoyama land. We calculated Spearman's rank correlation coefficients for both land types and obtained 0.78 ( $p < 0.00$ ) for agricultural land and 0.66 ( $p < 0.00$ ) for satoyama. These results suggest that, for both land use types, the stated value of preferred proximity of respondents increases when that of subjective proximity increases.

### Choice model results

This section presents the estimation results of the mixed and latent class logit models. Mixed and latent class logit models were estimated using Stata 17 software and the command "*mixlogit*" and "*lcllogit*", respectively (Hole 2007; Pacifico and Yoo 2013). Table 6 presents the three estimations results of mixed logit model. Model 1 is the simplest, as it includes only the attribute variables used in the choice experiment.

**Table 3** Descriptive statistics of the valid sample ( $N=775$ )

Variable	Description	Mean	S.D.	Min	Max	Average of Ishikawa <sup>a</sup>
<i>Male</i>	= 1 if respondent is male, =0 if otherwise	0.51	0.50	0	1	0.49 <sup>b</sup>
<i>Age</i>	Age in years	44.44	13.53	18	89	47.8 <sup>c</sup>
<i>Income</i>	Categorical dummy for net household income (= 1 if < 2 million JPY, ..., = 8 if > 14 million JPY)	3.36	1.58	1	8	3.39 <sup>d</sup>
<i>Interest</i>	Categorical dummy for interest in nature (= 1 if “I do not know,” = 2 if “Not interested at all”, = 3 if “Not very interested”, = 4 if “Somewhat interested”, = 5 if “Very interested”)	3.73	0.83	1	5	–
<i>Agri<sub>LC</sub></i>	Ratio of the agricultural landscape in the respondents' residential grids	0.21	0.26	0	0.93	–
<i>Waste<sub>LC</sub></i>	Ratio of wasteland in the respondents' residential grids	0.01	0.02	0	0.19	–
<i>Resi<sub>LC</sub></i>	Ratio of residential landscape in the respondents' residential grids	0.45	0.32	0	0.92	–
<i>Biodiv</i>	Estimated number of observable dragonfly species by Satoyama Index	0.19	0.15	0.00	0.58	–

<sup>a</sup>Average values in 2019

<sup>b</sup>Source: [https://www.pref.ishikawa.lg.jp/tokei\\_chosa/kensei/index.html](https://www.pref.ishikawa.lg.jp/tokei_chosa/kensei/index.html) (in Japanese)

<sup>c</sup>Source: [http://www.ipss.go.jp/syoushika/tohkei/Popular/P\\_Detail2021.asp?fname=T12-08.htm](http://www.ipss.go.jp/syoushika/tohkei/Popular/P_Detail2021.asp?fname=T12-08.htm) (in Japanese)

<sup>d</sup>Source: <https://www.mhlw.go.jp/toukei/itiran/roudou/chingin/kouzou/z2019/dl/08.pdf> (in Japanese)

**Table 4** Correspondence between subjective and preferred proximities: agricultural land

Preferred proximity	Agricultural land						Total
	Subjective proximity						
	1	2	3	4	5		
1	50	1	2	0	0	53	
2	22	112	14	1	2	151	
3	5	57	85	23	8	178	
4	5	17	35	72	43	172	
5	5	9	15	28	164	221	
Total	87	196	151	124	217	775	

1: 0 m, 2: 0–199 m, 3: 200–499 m, 4: 500–1000 m, 5: greater than 1000 m

**Table 5** Correspondence between subjective and preferred proximities: Satoyama land

Preferred proximity	Satoyama land						Total
	Subjective proximity						
	1	2	3	4	5		
1	12	0	1	0	5	18	
2	0	28	13	4	6	51	
3	0	19	37	18	19	93	
4	2	8	17	103	89	219	
5	2	2	11	23	356	394	
Total	16	57	79	148	475	775	

1: 0 m, 2: 0–199 m, 3: 200–499 m, 4: 500–1000 m, 5: greater than 1000 m

*Mrent* was assumed to be a fixed variable that is constant among all respondents. In contrast, Model 2 includes *Mrent* as a normally distributed random variable that varies among samples. Finally, Model 3 contains variables used in Model 2 and the squared variables of *ProxAgri* (*ProxAgri\_SQ*),

*ProxSato* (*ProxSato\_SQ*), and *Biodiv* (*Biodiv\_SQ*) to evaluate the non-linear effect of both proximities and biodiversity richness on people's preferences. The log-likelihood values of Models 1, 2, and 3 were  $-7197.636$ ,  $-6872.590$ , and  $-7096.995$ , respectively. Similar to the log-likelihood



**Table 6** Mixed logit model estimation results

Variables	Model 1		Model 2		Model 3	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
<i>ProxAgri</i> (100 m)	−0.066*** (0.007)	0.138*** (0.008)	−0.083*** (0.008)	0.149*** (0.009)	0.039** (0.018)	0.144*** (0.009)
<i>ProxAgri_SQ</i>					−0.004*** (0.001)	
<i>ProxSato</i> (100 m)	−0.020*** (0.006)	0.115*** (0.006)	−0.021*** (0.007)	0.132*** (0.007)	0.179*** (0.016)	0.141*** (0.007)
<i>ProxSato_SQ</i>					−0.011*** (0.001)	
<i>Biodiv</i>	−0.104*** (0.010)	0.179*** (0.012)	−0.136*** (0.012)	0.214*** (0.013)	−0.045 (0.030)	0.172*** (0.012)
<i>Biodiv_SQ</i>					0.000 (0.003)	
<i>Mrent</i> (1000 JPY)	−0.094*** (0.003)		−0.153*** (0.007)	0.144*** (0.008)	−0.093*** (0.003)	
Observations	24,800		24,800		24,800	
Log-likelihood	−7197.636		−6872.590		−7096.995	
AIC	14,403.272		13,753.180		14,207.989	
BIC	14,435.746		13,785.654		14,264.819	

S.D. indicates standard deviation of the estimated parameters. AIC and BIC indicate Akaike information criteria and Bayesian information criteria, respectively. Standard errors of the estimated parameters are shown in parentheses

\*\*\* and \*\* indicate  $p < 0.01$  and  $p < 0.05$ , respectively

values, we obtained identical results in terms of Akaike and Bayesian information criteria. As a result, Model 2 was the best fitted.

Model 1 estimated the coefficient value of *Mrent* (monthly rent at 1000 JPY) to be statistically and significantly negative for all models at the 1% level, although the estimated value of Model 2 slightly differed from that of Models 1 and 3. The negative coefficient of the monetary variable is consistent with the economic theory. In addition, Model 2 showed a statistically significant standard deviation for *Mrent* at the 1% level, which suggests heterogeneous preferences for monthly rent payments among valid respondents.

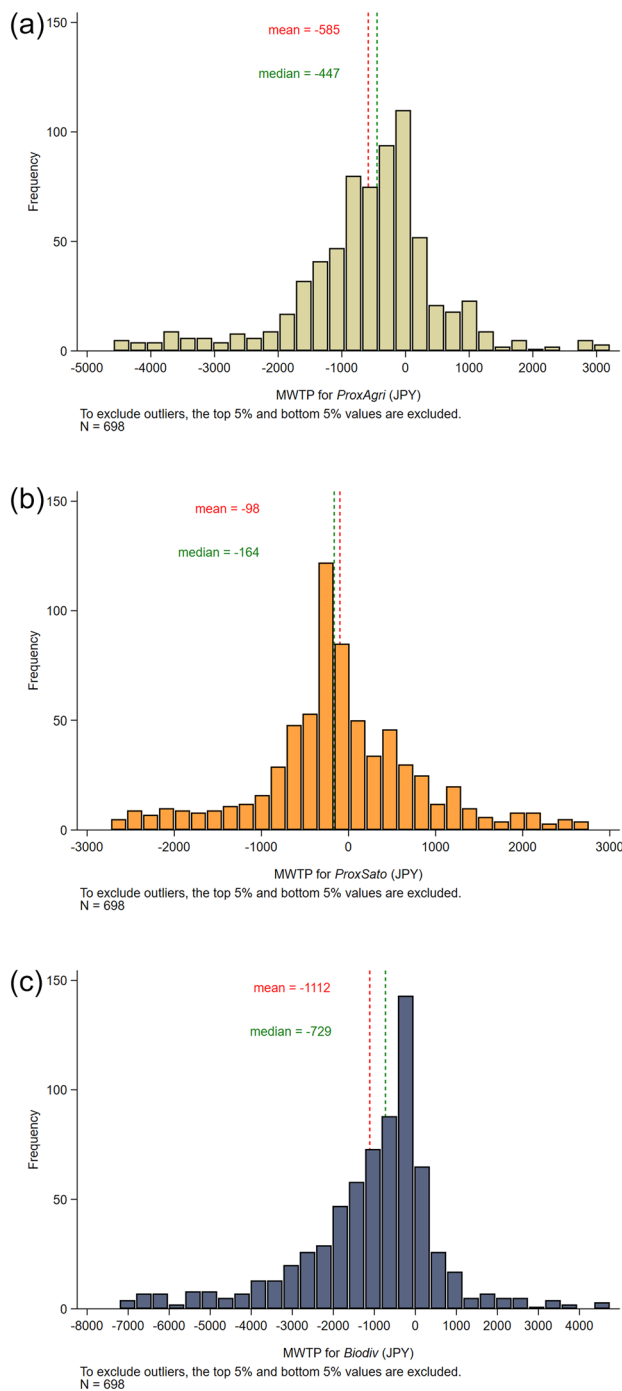
*ProxAgri* (proximity to urban agricultural land) showed statistically significant negative estimated mean values in Models 1 and 2 at the 1% level. The standard deviation differed significantly from zero at this level. This suggests that people have heterogeneous preferences with regard to proximity to it. In contrast, in Model 3, the mean value of *ProxAgri* was above zero with statistical significance at the 5% level because Model 3 includes the squared term *ProxAgri\_SQ*, whereas the standard deviation of *ProxAgri* differed significantly from zero at the 1% level as well as in Models 1 and 2. Furthermore, the mean value of *ProxAgri\_SQ* was negative, with 1% statistical significance in Model 3. The results suggest that the most desirable distance between urban agricultural land and respondents' locales exists.

*ProxSato* (proximity to satoyama land) identically showed negative mean values in Models 1 and 2 with a 1% statistical

significance. Additionally, the standard deviation values were significantly above zero at the 1% significance level for both models. These results imply preference heterogeneity in the proximity to satoyama land, as well as *ProxAgri*. By contrast, in Model 3, the mean value of *ProxSato* was significantly positive because of the squared term *ProxSato\_SQ*, and the standard deviation of *ProxSato* was significantly above zero at the 1% level. Additionally, *ProxSato\_SQ* showed a negative mean coefficient, with 1% statistical significance. The results suggest that, even in the case of *ProxSato*, the most desirable distance between satoyama land and respondents' locales exists.

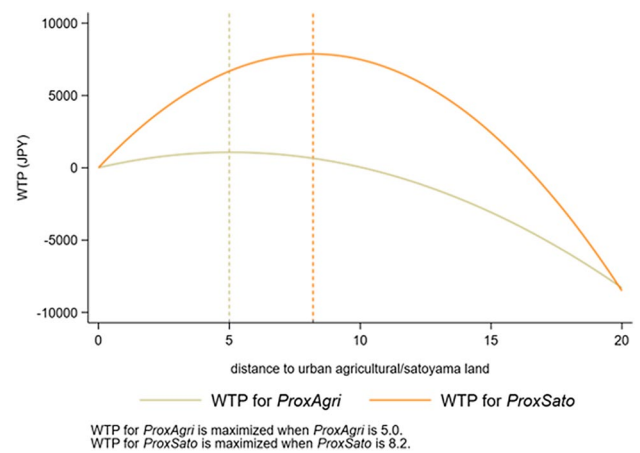
*Biodiv* (biodiversity richness represented by the number of observable dragonfly species around people's houses) showed negative mean values for Models 1 and 2 at the 1% statistical significance level with the values of standard deviation being significantly above zero. This suggests heterogeneity in people's preferences for biodiversity richness surrounding their residences. By contrast, in Model 3, the non-significant coefficient of *Biodiv* was estimated, whereas the standard deviation value was above zero at the 1% significance level. Moreover, *Biodiv\_SQ*, i.e., the squared term of *Biodiv*, showed a significantly negative mean coefficient in Model 3 at this level.

Figure 3a–c illustrate the distribution of marginal WTP among respondents for *ProxAgri*, *ProxSato*, and *Biodiv* respectively, calculated using Model 2 (the best-fitted model). First, the mean and median values of marginal WTP for *ProxAgri* were −489 and −381, respectively.



**Fig. 3** **a** The distribution of marginal WTP for *ProxAgri* estimated using Model 2. **b** The distribution of marginal WTP for *ProxSato* estimated using Model 2. **c** The distribution of marginal WTP for *Biodiv* estimated using Model 2

The distribution showed a more comprehensive range of respondents with a negative marginal WTP than those with



**Fig. 4** *ProxAgri* and *ProxSato* and corresponding WTPs estimated using Model 3

a positive marginal WTP. Second, *ProxSato* showed 178 and -57 for the mean and median values of marginal WTP, respectively. There was a broader range of people with positive marginal WTP values than those with negative marginal WTP values, which contrasts with the distribution of marginal WTP in *ProxAgri*. Third, the mean and median values of the marginal WTP for *Biodiv* were -1364 and -1048, respectively. The distribution of *Biodiv* was heavy-tailed in the negative direction, revealing that many respondents showed a negative marginal WTP.

Furthermore, Fig. 4 shows *ProxAgri* and *ProxSato* and the corresponding values of the WTPs calculated using Model 3. For example, when the distance between urban agricultural land and the residence is 100 m (*ProxAgri* = 1), the WTP for proximity to urban agricultural land is 381.314 (JPY). As seen in Fig. 4, when the distance between urban agricultural land and the residence is 500 m (*ProxAgri* = 5.0), the corresponding WTP value for *ProxAgri* is maximized at 1067.905 (JPY). Moreover, the corresponding WTP value for *ProxSato* is maximized at 7871.618 (JPY) when the distance between satoyama land and the residence is 820 m (*ProxSato* = 8.2).

Table 7 shows the estimation results of latent class logit models with two classes (2-class model) and three classes (3-class model). In this study, we divided the valid respondents into two or three classes, considering the meaningful interpretation of each class. Considering the log-likelihood values, 3-class model was the best fitted. As well as the results obtained by mixed logit models, the results of the latent class logit model emphasize the heterogeneity in people's preferences. The 3-class model, the best fitted among latent class models, revealed heterogeneity in

**Table 7** Latent class logit model estimation results

Variables	2-Class model		3-Class model		
	Class 1	Class 2	Class 1	Class 2	Class 3
	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
<i>ProxAgri</i>	−0.082*** (0.006)	0.046*** (0.006)	0.046*** (0.005)	−0.127*** (0.008)	0.025* (0.014)
<i>ProxSato</i>	−0.066*** (0.005)	0.147*** (0.005)	0.147*** (0.007)	−0.085*** (0.006)	0.012 (0.012)
<i>Biodiv</i>	−0.081*** (0.009)	−0.019 (0.018)	−0.038** (0.018)	−0.121*** (0.011)	0.116*** (0.035)
<i>Mrent</i> (1000 JPY)	−0.084*** (0.003)	−0.052*** (0.006)	−0.054*** (0.005)	−0.047*** (0.003)	−0.475*** (0.031)
<b>Class membership parameters</b>					
<i>Male</i>	0.254 (0.162)	−	−0.163 (0.221)	0.120 (0.223)	−
<i>Age</i>	−0.017*** (0.006)	−	0.025*** (0.008)	0.007 (0.009)	−
<i>Income</i>	0.093* (0.049)	−	−0.049 (0.069)	0.100 (0.068)	−
<i>Interest</i>	0.293*** (0.089)	−	−0.032 (0.116)	0.414*** (0.124)	−
<i>Agri<sub>LC</sub></i>	0.173 (0.325)	−	0.230 (0.436)	0.045 (0.444)	−
<i>Waste<sub>LC</sub></i>	5.636 (3.717)	−	−4.645 (4.932)	0.458 (4.513)	−
<i>Resi<sub>LC</sub></i>	0.014 (0.268)	−	0.201 (0.365)	0.313 (0.368)	−
<i>Constant</i>	−0.329 (0.440)	−	0.024 (0.587)	−1.371** (0.619)	−
Observations	24,800		24,800		
Share size	0.635	0.365	0.334	0.477	0.189
Log-likelihood	−8268.913		−7841.461		
AIC	16,699.724		15,844.819		
BIC	16,569.826		15,738.922		

AIC and BIC indicate Akaike information criteria and Bayesian information criteria, respectively. Standard errors of estimated parameters are displayed in parentheses

\*\*\*, \*\*, and \* indicate  $p < 0.01$ ,  $p < 0.05$ , and  $p < 0.10$ , respectively

the respondents' preferences in more detail. In particular, respondents in Class 1 of the 3-class model (33.4%) showed similar preferences as respondents in Class 2 of the 2-class model, whereas the coefficient of *Biodiv* for Class 1 of the 3-class model was significantly below zero at the 5% level, which is in contrast to Class 2 of the 2-class model. Class 2 of the 3-class model (47.7%) showed coefficient values similar to those estimated for Class 1 of the 2-class model. Respondents in Class 2 of the 3-class model were negatively affected by proximity to agricultural land and biodiversity richness. Class 3 of the 3-class model (18.9%) exhibited a significantly positive coefficient for *ProxAgri* and *Biodiv* and a negative coefficient for *Mrent*. This class was the most responsive to *Mrent* among all classes. The results of class membership parameters revealed that respondents in Class 1 of the 3-class model were relatively younger, and those in Class 2 of the 3-class model were more interested in the environment compared to Class 3 of the 3-class model.

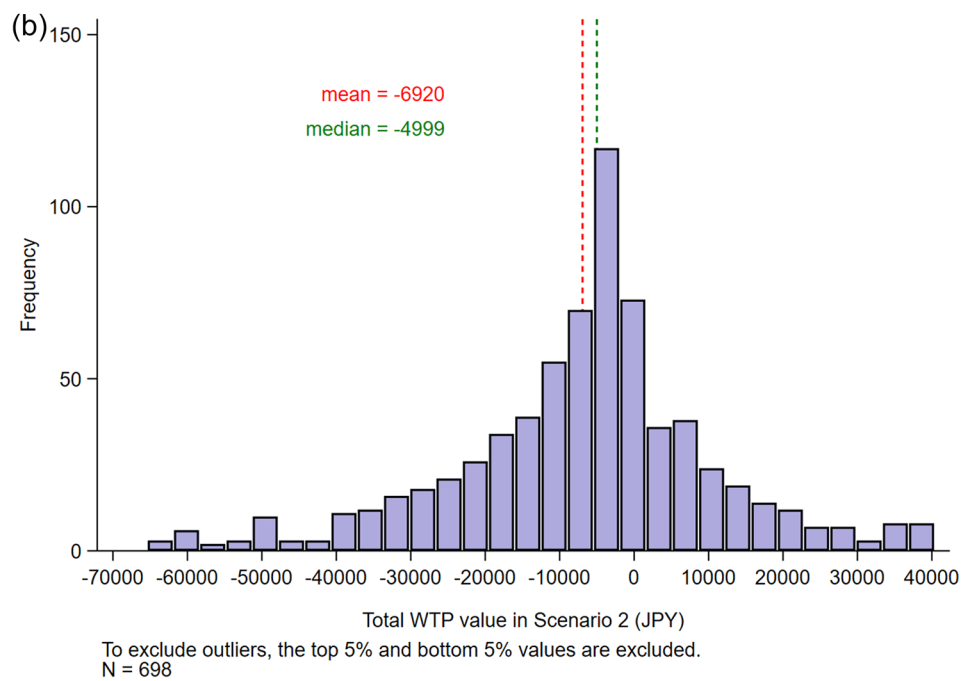
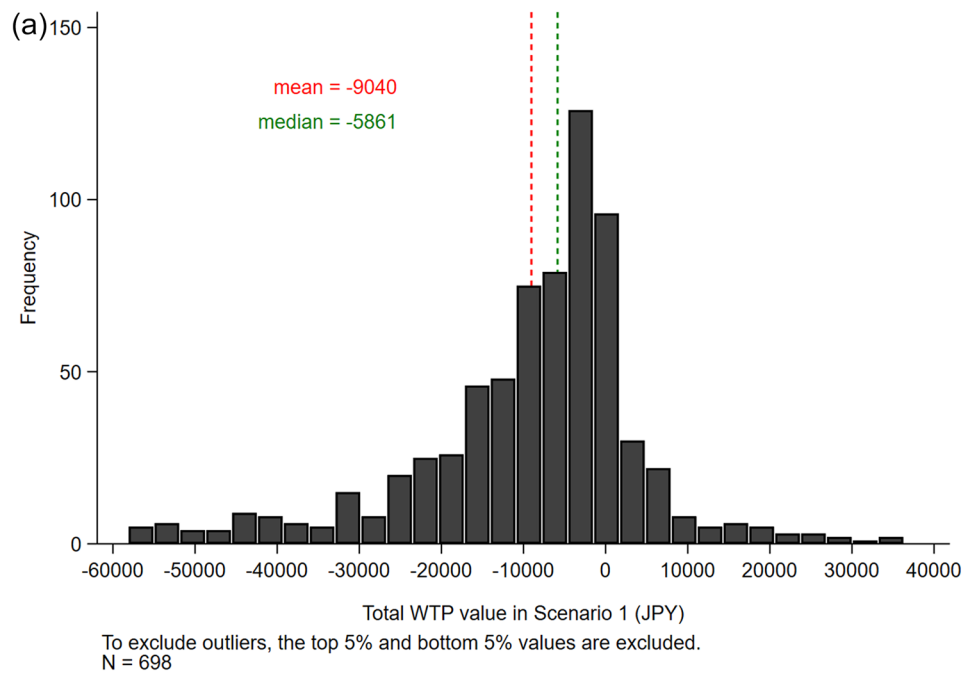
Additionally, the 2-class model revealed that the respondents in Class 1 (63.5% of valid respondents) showed negative coefficients for all variables with statistical significance at the 1% level, whereas respondents in Class 2 (36.5%)

showed positive coefficients for *ProxAgri* and *ProxSato* and a negative coefficient for *Mrent* at the same level. Moreover, the coefficient of *Mrent* for the participants in Class 1 was smaller than that for Class 2. The results of the 2-class model imply that 63.5% of the valid respondents did not prefer residences where the distance between urban agricultural land or satoyama and their residence increased; however, they also did not favor richer biodiversity around their locales. By contrast, 36.5% of the valid respondents preferred a longer distance between traditional urban agricultural land and satoyama, and their housing locales, moreover they did not respond favorably to the biodiversity richness surrounding their houses. Additionally, the results of the class membership parameters of the 2-class model revealed that respondents in Class 1 were relatively younger, had higher income, and were more interested in the environment with statistical significance compared to those in Class 2.

### Simulated results

Finally, using Model 2, valid respondents' aggregated MTWP values were simulated under two hypothetical

**Fig. 5** **a** Distribution of aggregated MWTP value under scenario 1. **b** Distribution of aggregated MWTP value under scenario 2



scenarios. Scenario 1 is a hypothetical scenario in which agricultural land and satoyama are managed adjacent to residences (0 m), resulting in the richest biodiversity (8 species) in the vicinity of the residences. In contrast, Scenario 2 is another one in which agricultural land and satoyama are

managed away from residences (1000 m), resulting in the poorest biodiversity (0 species) in the vicinity of residences. Figure 5a, b shows the simulated distribution of aggregated MWTP values under scenarios 1 and 2, respectively. The simulated distributions show that the average value of the

total MWTP among valid respondents is larger in Scenario 2 than in Scenario 1. In other words, the simulation results suggest that, on average, the welfare of residents may be higher when agricultural land and satoyama are managed away from residences.

## Discussion

### People's perceptions and preferences for urban agriculture

This study evaluated people's perceptions and preferences regarding their proximity to urban agricultural land and satoyama. The estimation results obtained from the best-fitted model (i.e., Model 2 in mixed logit model and 3-class model in latent class model) provide some interesting discussion. One of the interesting findings is that more than half of respondents prefer long distances between agricultural land and satoyama and their residence, as seen in Table 7. This reflects the negative perception of agricultural land in urban areas (Lyytimäki and Sipilä 2009; Escobedo et al. 2011; Von Döhren and Haase 2015). People are more sensitive to the negative impact of being adjacent to urban agricultural land compared to its positive effects.

In addition, a comparison of urban agricultural land and satoyama revealed that people react more negatively to living in satoyama neighborhoods. This could be attributed to the fact that satoyama is a more complex land use pattern than traditional agricultural land and includes diverse elements beyond agricultural production. In particular, satoyama is not just an agricultural activity, but a comprehensive concept that consists of a lifestyle that is closely related to nature (Kobori and Primack 2003; Kadoya and Washitani 2011; Hashimoto et al. 2015). People may believe that living in the vicinity of satoyama means embracing such a lifestyle. Living in the vicinity of a satoyama landscape, while enjoying the richness of the landscape, may require acceptance of various negative impacts. For example, one may need to accept material problems such as allergic reactions, unpleasant smells, and inconveniences in daily life, as well as psychological problems such as loneliness and boredom (Lyytimäki and Sipilä 2009; Escobedo et al. 2011; Yumoto et al. 2012; Von Döhren and Haase 2015). As a result, they refrain from residing in satoyama neighborhoods compared to urban agricultural land.

We also found non-linear preferences for proximity to traditional agricultural land in urban areas (see Fig. 4). In particular, our estimated model reveals a squared association

in preferences for distances between urban agricultural land and satoyama and people's housing locales. This result is consistent with those from previous studies and highlights the complex effects of spatial distance on people's preferences (Bertram and Rehdanz 2015; Glenk et al. 2020; Kyoi 2021). A more detailed analysis of people's preferences for the distance to urban agricultural land and satoyama is needed in the future.

Furthermore, preferences for distance from agricultural land and satoyama were shown to be generally consistent with actual residential conditions. As Tables 4 and 5 show, those who prefer longer distances from the two types of land, live farther away from them, whereas those who prefer to live adjacent to them, live relatively close. This result suggests that people consider the distance to urban agricultural land and satoyama as a factor in their choice of a locale for living. Previous studies have suggested an association between the surrounding environment and people's residential choices (De Valck and Rolfe 2018; Glenk et al. 2020; Toledo-Gallegos et al. 2021), and our results support these suggestions.

### Heterogeneous preferences for urban agriculture

Another significant finding is that there is heterogeneity in respondents' preferences for proximity to urban agricultural land and satoyama from their residences. Mixed logit models estimated the values of the standard deviation of *ProxAgri* and *ProxSato* with statistical significance (see Table 6). This finding is consistent with those of previous studies that have proposed complex preferences for agricultural land in urban areas (Brinkley 2012; Specht et al. 2016; Sanyé-Mengual et al. 2018; Kyoi 2021). Our results also reveal the details of heterogeneity in people's preferences for the distance between urban agricultural and satoyama land, and their residences. We found that approximately 47% of people felt that the utility offered to them would improve by their residences neighboring urban agricultural land and satoyama, whereas 52% of people felt there would be a decline in utility by dwelling next to them (Table 7, 3-class model). These results suggest that, although some people dislike the existence of such land use next to their locale, a certain proportion of people favor short distances between urban agricultural land and their houses (Fig. 3a–c).

The potential heterogeneity in people's preferences for proximity to agricultural land in urban areas reflects the complex influence that traditional agricultural land and satoyama neighboring people's residences have on them. Previous studies have suggested both positive and negative

effects of agricultural land in metropolitan areas. Such land use may provide valuable landscapes but may also give rise to displeasing smells (Brinkley 2012; Sanyé-Mengual et al. 2018). The positive and negative effects of urban agricultural land can cause people to react differently. Some people may be sensitive to its scenic value and as a result desire close proximity to it, whereas others may choose to live far away from urban agricultural land to avoid the health hazards caused by it.

The latent class model also revealed the characteristics of those who preferred a shorter distance between agricultural land in urban areas and their locales (Table 7). In particular, the estimation results suggest that relatively young people with higher incomes and higher environmental interests feel that the utility that they receive is enhanced through shorter distances between urban agricultural land and their locales. This result is likely because younger and higher-income people have relatively lower health risks than those who are older and earn lower incomes, and thus, they are less affected by the adverse health impacts caused by proximity to urban agricultural land. Previous studies reviewed the negative health impacts of urban agriculture in both developing and developed countries including Japan (Orsini et al. 2013; Mok et al. 2014). In addition, people interested in the environment probably highly value agricultural landscapes, even in urban areas. These results support previous studies (Hake 2017; Lackey et al. 2021), including Albaladejo-García et al. (2021) that indicated younger people and those with relatively higher incomes give more importance to urban agriculture's cultural services (e.g., recreation, education, and well-being). Meanwhile, no effects on current residential landscapes were detected. This result contrasts with previous studies that have suggested a correlation between people's preferences for urban agricultural activities and their surrounding landscapes (Mancebo 2018; Albaladejo-García et al. 2021).

### People's preferences for biodiversity richness

Another interesting finding was the negative preference for biodiversity richness, represented by the number of observable dragonfly species around residential locales. In particular, latent class logit models revealed that approximately 81% of respondents felt that the utility would decrease if the biodiversity around their house becomes richer. This suggests that although people understand the importance of biodiversity preservation, they are opposed to biodiversity conservation practices in their residential neighborhoods

(Beaudet et al. 2022). In contrast, approximately 19% of respondents felt that their neighborhood's abundant biodiversity would enhance the utility. These results also imply heterogeneous preferences of people, whose residence neighbors urban agricultural and satoyama land, for biodiversity richness, which is in line with previous studies (Khan et al. 2021; Yang 2021).

### Policy implications for utilization of urban agriculture

This study proposes some practical policy implications, which could contribute to the decisions made by urban planners and policymakers for utilizing urban agriculture to enhance urban areas' sustainability and accomplish SDG 11. In particular, this study suggests that urban planners and policymakers need to manage and supply agricultural land in urban areas far from populated places. Our study highlights the Not-in-my-backyard (NIMBY) phenomenon (Dear 1992). In particular in the context of the current study, though people recognize the importance of agricultural land for society (MAFF 2021), they do not welcome such land use neighboring their locales. Therefore, it is necessary for urban planners and policymakers to support agricultural activities in peri-urban areas when providing urban agricultural land. (Zasada 2011; Brinkley 2012). Jansma and Wertheim-Heck (2022) emphasized the importance of recognizing the value of peri-urban agriculture and discussed the significance of involving its practitioners in the policy-making process.

In addition, urban planners and policymakers should be cautious regarding the intensity of urban agriculture. This is because urban planners and policymakers may face trade-offs with regard to its intensity and public acceptance. Supporting urban agricultural landscapes, such as satoyama, where there are various land uses, including high-intensity agriculture, could provoke adverse reactions from inhabitants. However, some contiguous areas of urban agricultural land are necessary to ensure that cities continue to receive the effective services provided by the ecosystem (Batáry et al. 2015). Therefore, urban planners and policymakers should explore the intensity of urban agriculture, simultaneously addressing both of the adverse reactions of residents and the enabling of ecosystem services. They should also carefully analyze the spatial arrangement, including the distance between populated and urban agricultural land areas. The Japanese government attempts to utilize urban agriculture's multifunctional role in urban design (MAFF 2022). However, the results of this study

suggest that residents generally have negative preferences for urban agriculture in their neighborhoods. To further expand urban agriculture, the government must address residents' adverse reactions.

### Limitations and future works

Although the findings of this study significantly contribute to the literature relating utilization of urban agriculture, there are several limitations and directions for future work to be undertaken. First, it is essential to expand the study to other sites, such as more urbanized areas, so that the results and implications of this study can be generalized. In this study, we collected respondents from Ishikawa Prefecture in Japan, where people are assumed to be familiar with the agricultural context. Collecting respondents from more urbanized areas, such as Tokyo, could help obtain more generalizable results.

Second, other evaluation methods, such as the hedonic price model, should be employed in future studies. In this study, a choice experiment was conducted to investigate respondents' hypothetical choices for multiple residences. However, hypothetical choices in the stated preference method could cause bias (e.g., hypothetical bias). Investigations using the revealed preference method, such as the hedonic price model, and a comparison of the results among several studies regarding people's preferences for urban agriculture can be vital for obtaining more credible implications.

Third, it should be acknowledged that the respondents of this study could be biased potentially because online survey instruments were used. The online survey employed in this study potentially limits the characteristics of respondents. That is, respondents were limited to those who met two conditions: they have access to the Internet and are registered with an online survey company. While the survey results (see "[Survey results](#)") suggests that no bias in the socioeconomic attributes of the respondents is observed, it does not indicate that the representativeness of the respondents is fully ensured. This limitation of this study should be recognized.

Fourth, other characteristics would influence residents' heterogeneous preferences for geographical proximity to the agricultural land. Potential factors are, for example, educational levels and environmental education experiences. However, due to the limitation of the survey instrument, data on these factors were unavailable for this study. This point should be acknowledged as a limitation of this study.

In future work, more variables need to be obtained and included in the model to analyze the preference heterogeneity of residents.

### Conclusion

This study evaluates people's perceptions and preferences for the distance between urban agricultural land and their residential locales and discusses the possibility of utilizing urban agriculture to improve the sustainability of urban areas. An online survey and choice experiment was conducted with respondents from Ishikawa Prefecture in Japan, who are assumed to be familiar with the agricultural context. Mixed logit and latent class logit models revealed heterogeneity in people's preferences for proximity to agricultural lands in urban areas. In particular, 48.5% of our valid respondents felt that the utility that they receive would increase by shorter distances from urban agricultural land, whereas 32.2% of our valid respondents felt that it would decrease. Additionally, the model revealed the heterogeneity in preferences for biodiversity richness, surrounding respondents' residences.

Enhancing the sustainability of cities through the achievement of SDG 11 is an important goal not only for the current, but also for future generations in order to continue to inhabit cities. To achieve this goal, we need to explore a new direction of urban design to reduce the environmental burdens imposed by cities. One possibility is the further utilization of urban agriculture (Ayambire et al. 2019; Lange-meyer et al. 2021). Social science can play a significant role in policy decision-making concerning its further utilization because the perceptions and preferences of urban residents significantly impact the expansion and redesign of cities. Residents' demands and desires may pressure urban planners and policymakers to make decisions and determine the direction of urban change. Therefore, future research should closely examine the perceptions and preferences of residents regarding the implementation of urban agriculture and other specific measures to improve urban sustainability.

### Appendix

See Tables 8 and 9.

**Table 8** List of questions listed in this study's questionnaire

	Question	Response alternatives
<b>Attitudes and concerns about the natural environment</b>		
1	How interested are you in nature?	<ol style="list-style-type: none"> <li>1. I am very interested</li> <li>2. Somewhat interested</li> <li>3. Not very interested</li> <li>4. Not at all interested</li> <li>5. I do not know</li> </ol>
2	What do you think is the best policy for agriculture and rural areas in the future?	<ol style="list-style-type: none"> <li>1. National land and environmental conservation</li> <li>2. Economic efficiency and effectiveness</li> <li>3. Both</li> <li>4. Others</li> <li>5. I do not know</li> </ol>
3	Would you like to be involved in environmental activities in rural areas that have lost vitality due to the stagnation of agriculture, depopulation, and aging population?	<ol style="list-style-type: none"> <li>1. I would like to actively visit such areas to help with farming, environmental conservation, festivals, and other activities to keep the traditional culture alive</li> <li>2. If I have an opportunity, I would like to visit ...</li> <li>3. I would not like to visit ...</li> <li>4. Others</li> <li>5. I do not know</li> </ol>
4	Have you ever heard about biodiversity?	<ol style="list-style-type: none"> <li>1. I know what the word means</li> <li>2. I do not know what that means, but I have heard it before</li> <li>3. I have never heard of it</li> <li>4. I do not know</li> </ol>
5	What are your thoughts on the efforts being made to protect various living beings and their environment to preserve biodiversity?	<ol style="list-style-type: none"> <li>1. Priority should be given to preserving an environment where a wide variety of organisms can live, even if human life is restricted to some extent</li> <li>2. Promote conservation of the environment for a wide variety of living things to the extent that it does not restrict human life</li> <li>3. To ensure the richness and convenience of human life, it is inevitable that the environment, which houses a wide variety of living beings, will be lost</li> <li>4. Others</li> <li>5. I do not know</li> </ol>
<b>Housing characteristics</b>		
6	Mention the 8-digit number that represents the 1 km <sup>2</sup> grid of your location	
7	What is the floor plan of the house you currently live in? Which type of house do you currently live in?	<ol style="list-style-type: none"> <li>1. Detached house</li> <li>2. Large apartment</li> <li>3. Small apartment</li> </ol>
9	What is the area of the house?	
10	How old is your house? (As of 2020)	
11	Which floor do you live on?	
12	What is the distance from your residence to the nearest train station?	Approximately minutes by (foot, bicycle, car, or public transport)
13	What is the distance from your residence to the nearest shopping mall?	Approximately minutes by (foot, bicycle, car, or public transport)
14	What is the distance from your residence to the nearest school?	Approximately minutes by (foot, bicycle, car, or public transport)
15	What is the distance from your residence to the nearest park?	Approximately minutes by (foot, bicycle, car, or public transport)



Table 8 (continued)

	Question	Response alternatives
16	What is the distance from your residence to the nearest hospital?	Approximately minutes by (foot, bicycle, car, or public transport)
17	The respondent's housing demographics	<ul style="list-style-type: none"> <li>✓ Live in a rented apartment</li> <li>✓ Owned residences</li> <li>✓ Owned residences and had already finished paying the house mortgage</li> </ul>
18	Monthly rent	1: –29,999; 2: 30,000–34,999; ...; 20: 120,000–
19	Subjective proximity to agricultural land	1: 0 m; 2: 200 m; 3: 500 m; 4: 1000 m; 5: more than 1000 m
20	Subjective proximity to satoyama	1: 0 m; 2: 200 m; 3: 500 m; 4: 1000 m; 5: more than 1000 m
21	Most preferred proximity to agricultural land	1: 0 m; 2: 200 m; 3: 500 m; 4: 1000 m; 5: more than 1000 m
22	Most preferred proximity to satoyama	1: 0 m; 2: 200 m; 3: 500 m; 4: 1000 m; 5: more than 1000 m
<b>Choice experiment: 1–8</b>		
<i>Socioeconomic characteristics of respondents</i>		
24	What is your zip code?	
25	How many years have you lived in the area where you currently reside?	
26	What is your occupation?	Private employee; public servant; student; self-employed; agricultural worker, forestry and fishery worker; homemaker; part-time employee; pensioner; others
27	Please indicate your household's annual income (including tax)	1: –200; 2: 200–399; ...; 8: 1400–
28	Please indicate the number of people in your household (including you)	

All the questions above were translated from Japanese. The questions were given to subjects in Japanese.

**Table 9** The respondents' current monthly rent and corresponding monthly rents used in choice experiment (80, 90, 100, 110, and 120% of current monthly rent)

Current monthly rent (JPY)	80%	90%	100%	110%	120%
Less than 30,000	24,000	27,000	30,000	33,000	36,000
30,000–35,000	26,000	29,250	32,500	35,750	39,000
35,000–40,000	30,000	33,750	37,500	41,250	45,000
40,000–45,000	34,000	38,250	42,500	46,750	51,000
45,000–50,000	38,000	42,750	47,500	52,250	57,000
50,000–55,000	42,000	47,250	52,500	57,750	63,000
55,000–60,000	46,000	51,750	57,500	63,250	69,000
60,000–65,000	50,000	56,250	62,500	68,750	75,000
65,000–70,000	54,000	60,750	67,500	74,250	81,000
70,000–75,000	58,000	65,250	72,500	79,750	87,000
75,000–80,000	62,000	69,750	77,500	85,250	93,000
80,000–85,000	66,000	74,250	82,500	90,750	99,000
85,000–90,000	70,000	78,750	87,500	96,250	105,000
90,000–95,000	74,000	83,250	92,500	101,750	111,000
95,000–100,000	78,000	87,750	97,500	107,250	117,000
100,000–105,000	82,000	92,250	102,500	112,750	123,000
105,000–110,000	86,000	96,750	107,500	118,250	129,000
110,000–115,000	90,000	101,250	112,500	123,750	135,000
115,000–120,000	94,000	105,750	117,500	129,250	141,000
More than 120,000	96,000	108,000	120,000	132,000	144,000

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## References

- Ackerman K, Conard M, Culligan P et al (2014) Sustainable food systems for future cities: the potential of urban agriculture. *Econ Soc Rev* 45:189–206
- Albaladejo-García JA, Alcon F, Martínez-Paz JM (2021) Economic valuation of allotment gardens in peri-urban degraded agroecosystems: the role of citizens' preferences in spatial planning. *Sustain Cities Soc* 68:102771. <https://doi.org/10.1016/j.scs.2021.102771>
- Arata L, Guastella G, Pareglio S et al (2021) Do city dwellers care about peri-urban land use? The case of environment-friendly agriculture around Milan. *J Environ Plan Manag* 64:1044–1066. <https://doi.org/10.1080/09640568.2020.1799765>
- Artmann M, Sartison K (2018) The role of urban agriculture as a nature-based solution: a review for developing a systemic assessment framework. *Sustainability* 10:1937. <https://doi.org/10.3390/su10061937>
- Ayambire RA, Amponsah O, Peprah C, Takyi SA (2019) A review of practices for sustaining urban and peri-urban agriculture: implications for land use planning in rapidly urbanising Ghanaian cities. *Land Use Policy* 84:260–277. <https://doi.org/10.1016/j.landusepol.2019.03.004>
- Azunre GA, Amponsah O, Peprah C et al (2019) A review of the role of urban agriculture in the sustainable city discourse. *Cities* 93:104–119. <https://doi.org/10.1016/j.cities.2019.04.006>
- Bakhtiari F, Jacobsen JB, Strange N, Helles F (2014) Revealing lay people's perceptions of forest biodiversity value components and their application in valuation method. *Glob Ecol Biogeogr* 1: 27–42. <https://doi.org/10.1016/j.gecco.2014.07.003>
- Batáry P, Dicks LV, Kleijn D, Sutherland WJ (2015) The role of agri-environment schemes in conservation and environmental management. *Conserv Biol* 29:1006–1016. <https://doi.org/10.1111/cobi.12536>
- Beaudet C, Tardieu L, David M (2022) Are citizens willing to accept changes in public lighting for biodiversity conservation? *Ecol Econ* 200:107527. <https://doi.org/10.1016/j.ecolecon.2022.107527>
- Bergstrom JC, Ready RC (2009) What have we learned from over 20 years of farmland amenity valuation research in North America? *Rev Agric Econ* 31:21–49. <https://doi.org/10.1111/j.1467-9353.2008.01424.x>
- Berman JD, Ebisu K (2020) Changes in US air pollution during the COVID-19 pandemic. *Sci Total Environ* 739:139864. <https://doi.org/10.1016/j.scitotenv.2020.139864>
- Bertram C, Rehdanz K (2015) The role of urban green space for human well-being. *Ecol Econ* 120:139–152. <https://doi.org/10.1016/j.ecolecon.2015.10.013>
- Botzat A, Fischer LK, Kowarik I (2016) Unexploited opportunities in understanding liveable and biodiverse cities. A review on urban biodiversity perception and valuation. *Glob Environ Change* 39:220–233. <https://doi.org/10.1016/j.gloenvcha.2016.04.008>
- Bretzel F, Caudai C, Tassi E et al (2018) Culture and horticulture: protecting soil quality in urban gardening. *Sci Total Environ* 644:45–51. <https://doi.org/10.1016/j.scitotenv.2018.06.289>
- Brinkley C (2012) Evaluating the benefits of peri-urban agriculture. *J Plan Lit* 27:259–269. <https://doi.org/10.1177/0885412211435172>

- Brown G, Glanz H (2018) Identifying potential NIMBY and YIMBY effects in general land use planning and zoning. *Appl Geogr* 99:1–11. <https://doi.org/10.1016/j.apgeog.2018.07.026>
- Carlsson F, Frykblom P, Johan Lagerkvist C (2005) Using cheap talk as a test of validity in choice experiments. *Econ Lett* 89:147–152. <https://doi.org/10.1016/j.econlet.2005.03.010>
- ChoiceMetrics (2018) Ngene 1.2 user manual and reference guide
- Clinton N, Stuhlmacher M, Miles A et al (2018) A global geospatial ecosystem services estimate of urban agriculture. *Earths Future* 6:40–60. <https://doi.org/10.1002/2017ef000536>
- d'Amour CB, Reitsma F, Baiocchi G et al (2017) Future urban land expansion and implications for global croplands. *Proc Natl Acad Sci USA* 114:8939–8944. <https://doi.org/10.1073/pnas.1606036114>
- De Valck J, Rolfe J (2018) Spatial heterogeneity in stated preference valuation: status, challenges and road ahead. *Int Rev Environ Resour Econ* 11:355–422. <https://doi.org/10.1561/101.00000097>
- Dear M (1992) Understanding and overcoming the NIMBY syndrome. *J Am Plan Assoc* 58:288–300. <https://doi.org/10.1080/0194369208975808>
- Demuzere M, Orru K, Heidrich O et al (2014) Mitigating and adapting to climate change: multi-functional and multi-scale assessment of green urban infrastructure. *J Environ Manag* 146:107–115. <https://doi.org/10.1016/j.jenvman.2014.07.025>
- Dramstad WE, Fjellstad WJ (2011) Landscapes: bridging the gaps between science, policy and people. *Landsc Urban Plan* 100:330–332. <https://doi.org/10.1016/j.landurbplan.2011.02.003>
- Escobedo FJ, Kroeger T, Wagner JE (2011) Urban forests and pollution mitigation: analyzing ecosystem services and disservices. *Environ Pollut* 159:2078–2087. <https://doi.org/10.1016/j.envpol.2011.01.010>
- FAO (2011) Noto's satoyama and satoumi, Japan. In: Globally Important Agricultural Heritage Systems. <https://www.fao.org/giahs/giahsaroundtheworld/designated-sites/asia-and-the-pacific/notos-satoyama-and-satoumi/detailed-information/en/>. Accessed 14 Feb 2022
- Ferreira AJD, Guilherme RIMM, Ferreira CSS, de Oliveira MDFML (2018) Urban agriculture, a tool towards more resilient urban communities? *Curr Opin Environ Sci Health* 5:93–97. <https://doi.org/10.1016/j.coesh.2018.06.004>
- Fukamachi K (2017) Sustainability of terraced paddy fields in traditional satoyama landscapes of Japan. *J Environ Manag* 202:543–549. <https://doi.org/10.1016/j.jenvman.2016.11.061>
- Galli A, Iha K, Moreno Pires S et al (2020) Assessing the ecological footprint and biocapacity of Portuguese cities: critical results for environmental awareness and local management. *Cities* 96:102442. <https://doi.org/10.1016/j.cities.2019.102442>
- Glaeser EL, Kahn ME (2010) The greenness of cities: carbon dioxide emissions and urban development. *J Urban Econ* 67:404–418. <https://doi.org/10.1016/j.jue.2009.11.006>
- Glenk K, Johnston RJ, Meyerhoff J, Sagebiel J (2020) Spatial dimensions of stated preference valuation in environmental and resource economics: methods, trends and challenges. *Environ Resour Econ* 75:215–242. <https://doi.org/10.1007/s10640-018-00311-w>
- Goertzen D, Suhling F (2013) Promoting dragonfly diversity in cities: major determinants and implications for urban pond design. *J Insect Conserv* 17:399–409. <https://doi.org/10.1007/s10841-012-9522-z>
- Hake BJ (2017) Gardens as learning spaces: intergenerational learning in urban food gardens. *J Intergener Relatsh* 15:26–38. <https://doi.org/10.1080/15350770.2017.1260369>
- Hara Y, McPhearson T, Sampei Y, McGrath B (2018) Assessing urban agriculture potential: a comparative study of Osaka, Japan and New York city, United States. *Sustain Sci* 13:937–952. <https://doi.org/10.1007/s11625-018-0535-8>
- Hashimoto S, Nakamura S, Saito O et al (2015) Mapping and characterizing ecosystem services of social–ecological production landscapes: case study of Noto, Japan. *Sustain Sci* 10:257–273. <https://doi.org/10.1007/s11625-014-0285-1>
- Hashimoto S, DasGupta R, Kabaya K et al (2019) Scenario analysis of land-use and ecosystem services of social-ecological landscapes: implications of alternative development pathways under declining population in the Noto Peninsula, Japan. *Sustain Sci* 14:53–75. <https://doi.org/10.1007/s11625-018-0626-6>
- Hole AR (2007) Fitting mixed logit models by using maximum simulated likelihood. *Stata J* 7:388–401. <https://doi.org/10.1177/1536867X0700700306>
- Huber J, Zwerina K (1996) The importance of utility balance in efficient choice designs. *J Mark Res* 33:307–317. <https://doi.org/10.1177/002224379603300305>
- Ishikawa Prefecture (2018) Ishikawa in statistics 2018
- Iwata Y, Fukamachi K, Morimoto Y (2011) Public perception of the cultural value of satoyama landscape types in Japan. *Landsc Ecol Eng* 7:173–184. <https://doi.org/10.1007/s11355-010-0128-x>
- Jansma JE, Wertheim-Heck SCO (2022) Feeding the city: a social practice perspective on planning for agriculture in peri-urban Oosterveld, Almere, the Netherlands. *Land Use Policy* 117:106104. <https://doi.org/10.1016/j.landusepol.2022.106104>
- Jin J, He R, Wang W, Gong H (2018) Valuing cultivated land protection: a contingent valuation and choice experiment study in China. *Land Use Policy* 74:214–219. <https://doi.org/10.1016/j.landusepol.2017.09.023>
- Kabisch N, Frantzeskaki N, Pauleit S, Naumann S, Davis M, Artmann M, Haase D, Knapp S, Korn H, Stadler J, Zaunberger K (2016) Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecol Soc* 21(2). <https://doi.org/10.5751/ES-08373-210239>
- Kadoya T, Washitani I (2011) The Satoyama Index: a biodiversity indicator for agricultural landscapes. *Agr Ecosyst Environ* 140:20–26. <https://doi.org/10.1016/j.agee.2010.11.007>
- Khan I, Lei H, Muhammad I, Zhao M (2021) Do residential localities matter? Revisiting preference heterogeneity and ranking of ecological attributes of an inland river basin. *Sci Total Environ* 763:142970. <https://doi.org/10.1016/j.scitotenv.2020.142970>
- Kobori H, Primack RB (2003) Participatory conservation approaches for satoyama, the traditional forest and agricultural landscape of Japan. *Ambio* 32:307–311
- Kyoi S (2021) People's avoidance of neighboring agricultural urban green infrastructure: evidence from a choice experiment. *Sustainability* 13:6930. <https://doi.org/10.3390/su13126930>
- La Rosa D, Barbarossa L, Privitera R, Martinico F (2014) Agriculture and the city: a method for sustainable planning of new forms of agriculture in urban contexts. *Land Use Policy* 41:290–303. <https://doi.org/10.1016/j.landusepol.2014.06.014>
- Lackey NQ, Tysor DA, McNay GD et al (2021) Mental health benefits of nature-based recreation: a systematic review. *Ann Leis Res* 24:379–393. <https://doi.org/10.1080/11745398.2019.1655459>
- Langemeyer J, Madrid-Lopez C, Beltran AM, Mendez GV (2021) Urban agriculture—a necessary pathway towards urban resilience and global sustainability? *Landsc Urban Plan*. <https://doi.org/10.1016/j.landurbplan.2021.104055>
- Le T, Wang Y, Liu L et al (2020) Unexpected air pollution with marked emission reductions during the COVID-19 outbreak in China. *Science* 369:702–706. <https://doi.org/10.1126/science.abb7431>
- Liu G, Yang Z, Chen B, Ulgiati S (2011) Monitoring trends of urban development and environmental impact of Beijing, 1999–2006. *Sci Total Environ* 409:3295–3308. <https://doi.org/10.1016/j.scitotenv.2011.05.045>

- Louviere JJ, Hensher DA, Swait JD (2000) Stated choice methods: analysis and applications. Cambridge University Press, Cambridge
- Lyytimäki J, Sipilä M (2009) Hopping on one leg—the challenge of ecosystem disservices for urban green management. *Urban for Urban Green* 8:309–315. <https://doi.org/10.1016/j.ufug.2009.09.003>
- Madureira H, Nunes F, Oliveira JV et al (2015) Urban residents' beliefs concerning green space benefits in four cities in France and Portugal. *Urban Urban Green* 14:56–64. <https://doi.org/10.1016/j.ufug.2014.11.008>
- MAFF (2021) FY2020 Summary of the annual report on food, agriculture and rural areas in Japan
- MAFF (2022) FY2021 summary of the annual report of food, agriculture and rural areas in Japan
- Mancebo F (2018) Gardening the city: addressing sustainability and adapting to global warming through urban agriculture. *Environments* 5:38. <https://doi.org/10.3390/environments5030038>
- Mariel P, Arata L (2022) Incorporating attitudes into the evaluation of preferences regarding agri-environmental practices. *J Agric Econ* 73:430–451. <https://doi.org/10.1111/1477-9552.12456>
- Martínez-Paz JM, Albaladejo-García JA, Barreiro-Hurle J et al (2021) Spatial effects in the socioeconomic valuation of peri-urban ecosystems restoration. *Land Use Policy* 105:105426. <https://doi.org/10.1016/j.landusepol.2021.105426>
- McFadden D, Train K (2000) Mixed MNL models for discrete response. *J Appl Econ* 15:447–470. [https://doi.org/10.1002/1099-1255\(200009/10\)15:5%3c447::aid-jae570%3e3.0.co;2-1](https://doi.org/10.1002/1099-1255(200009/10)15:5%3c447::aid-jae570%3e3.0.co;2-1)
- Ministry of Land, Infrastructure, Transport and Tourism (2021) National land numerical information. <https://nlftp.mlit.go.jp/ksj/>. Accessed 1 Feb 2022
- Mok H-F, Williamson VG, Grove JR et al (2014) Strawberry fields forever? Urban agriculture in developed countries: a review. *Agron Sustain Dev* 34:21–43. <https://doi.org/10.1007/s13593-013-0156-7>
- Mori K, Christodoulou A (2012) Review of sustainability indices and indicators: towards a new City Sustainability Index (CSI). *Environ Impact Assess Rev* 32:94–106. <https://doi.org/10.1016/j.eiar.2011.06.001>
- Nijkamp P, Vindigni G, Nunes PALD (2008) Economic valuation of biodiversity: a comparative study. *Ecol Econ* 67:217–231. <https://doi.org/10.1016/j.ecolecon.2008.03.003>
- Orsini F, Kahane R, Nono-Womdim R, Gianquinto G (2013) Urban agriculture in the developing world: a review. *Agron Sustain Dev* 33:695–720. <https://doi.org/10.1007/s13593-013-0143-z>
- Pacifico D, Yoo H (2013) Lclogit: a stata command for fitting latent-class conditional logit models via the expectation-maximization algorithm. *Stata J* 13:625–639. <https://doi.org/10.1177/1536867X1301300312>
- Pearson LJ, Pearson L, Pearson CJ (2010) Sustainable urban agriculture: stocktake and opportunities. *Int J Agric Sustain* 8:7–19. <https://doi.org/10.3763/ijas.2009.0468>
- Sahlén G, Ekstubbé K (2001) Identification of dragonflies (Odonata) as indicators of general species richness in boreal forest lakes. *Biodivers Conserv* 10:673–690
- Sanyé-Mengual E, Specht K, Krikser T et al (2018) Social acceptance and perceived ecosystem services of urban agriculture in Southern Europe: the case of Bologna. Italy. *Plos One* 13:e0200993. <https://doi.org/10.1371/journal.pone.0200993>
- Seto KC, Reenberg A, Boone CG et al (2012) Urban land teleconnections and sustainability. *Proc Natl Acad Sci USA* 109:7687–7692. <https://doi.org/10.1073/pnas.1117622109>
- Silva A, Nayga RM, Campbell BL, Park JL (2011) Revisiting cheap talk with new evidence from a field experiment. *J Agric Resour Econ* 36:280–291
- Specht K, Weith T, Swoboda K, Siebert R (2016) Socially acceptable urban agriculture businesses. *Agron Sustain Dev* 36:17. <https://doi.org/10.1007/s13593-016-0355-0>
- Toledo-Gallegos VM, Long J, Campbell D et al (2021) Spatial clustering of willingness to pay for ecosystem services. *J Agric Econ* 72:673–697. <https://doi.org/10.1111/1477-9552.12428>
- Tornaghi C (2014) Critical geography of urban agriculture. *Prog Hum Geogr* 38:551–567. <https://doi.org/10.1177/0309132513512542>
- Train KE (2009) Discrete choice methods with simulation, 2nd edn. Cambridge University Press, Cambridge
- Viana CM, Freire D, Abrantes P et al (2022) Agricultural land systems importance for supporting food security and sustainable development goals: a systematic review. *Sci Total Environ* 806:150718. <https://doi.org/10.1016/j.scitotenv.2021.150718>
- Von Döhren P, Haase D (2015) Ecosystem disservices research: a review of the state of the art with a focus on cities. *Ecol Indic* 52:490–497. <https://doi.org/10.1016/j.ecolind.2014.12.027>
- Walls M, Kousky C, Chu Z (2015) Is what you see what you get? The value of natural landscape views. *Land Econ* 91:1–19
- Yang J (2021) The heterogeneous preferences for conservation and management in urban wetland parks: a case study from China. *Urban for Urban Green* 60:127064. <https://doi.org/10.1016/j.ufug.2021.127064>
- Yang X, Burton M, Cai Y, Zhang A (2016) Exploring heterogeneous preference for farmland non-market values in Wuhan, central China. *Sustainability* 8:1–13. <https://doi.org/10.3390/su8010012>
- Yumoto T, Iwata Y, Morimoto Y (2012) Evaluating cultural values of the satoyama using the preference method. *Glob Environ Res* 16:153–162
- Zasada I (2011) Multifunctional peri-urban agriculture—a review of societal demands and the provision of goods and services by farming. *Land Use Policy* 28:639–648. <https://doi.org/10.1016/j.landusepol.2011.01.008>

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