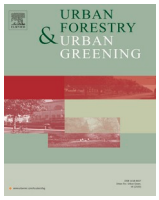
Urban Forestry & Urban Greening 75 (2022) 127695

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug



Exploring public preferences and preference heterogeneity for green and blue infrastructure in urban green spaces

Jan Macháč [a], Jan Brabec [a,*], Arne Arnberger [b]

[a] Faculty of Social and Economic Studies, J. E. Purkyně University in Ústí nad Labem, Czech Republic
[b] University of Natural Resources and Life Sciences, Institute for Landscape Development, Recreation and Conservation Planning, Vienna, Austria

ARTICLE INFO

Handling Editor: Wendy Chen

Keywords:
Green and blue infrastructure
Urban green space
Nature-based solutions
Preference heterogeneity
Discrete choice experiment
Willingness to pay

ABSTRACT

Green and blue urban infrastructure (GBI) has many positive functions often not recognised by residents (e.g., microclimate regulation, water retention, etc.). The question for urban planners who are aware of these functions when planning new GBI elements or revitalising existing GBI is how much they need to account for the preference heterogeneity of locals, who typically consider only aesthetic and recreational value. This study uses data from a discrete choice experiment among residents of the medium-sized Czech city of Liberec to reveal which combinations of nature-based or semi-natural GBI and recreational facilities respondents prefer and how strong their preferences are in terms of their willingness to pay. Overall, study respondents preferred nature-based GBI to semi-natural ones. A mixed-latent class model identified two groups of respondents who differ in preferences, trade-offs, and socio-demographic characteristics: (i) mostly older educated women who prefer nature-based elements and enjoy park infrastructure; (ii) mostly less educated men who dislike urban gardens and semi-natural streams and do not value park infrastructure. Based on the results, we recommend that spatial planners and green space managers design and implement more nature-based elements in Liberec, which are in line with the respondents' preferences.

1. Introduction

Green and blue infrastructure (GBI) is an inherent feature of today's cities. Bakay (2012) states that GBI is a system of different green and blue areas with different degrees of naturalness, while Hansen and Pauleit (2014) and Silva and da Wheeler (2017) define GBI as strategically planned networks of natural, nature-based, semi-natural or restored areas that have a local and global impact. According to sources such as the European Commission (2013), Beery et al. (2017), and Ghofrani et al. (2017), GBI includes natural, semi-natural, and artificially created multi-functional elements. Although considerable attention is paid to GBI, there is no uniform typology for it (Young et al., 2014). GBI can be categorised according to function, position, and scale (Ghofrani et al., 2017). Besides large-scale elements such as public parks, urban forests, rivers, and streams – which are considered the basis of urban GBI – there are also small-scale elements such as street greenery, front gardens, allotments, and community gardens. In contrast to grey infrastructure (e.g., streets, paved riverbeds, parking areas, and other places with impermeable surfaces), GBI provides a range of benefits in the form of ecosystem services (supporting, regulating, provisioning, and cultural services) for urban residents while at the same time supporting biodiversity. With growing urbanisation, people are increasingly taking the opportunities provided by such places to temporarily escape from everyday hectic city life, and therefore demand for green and blue amenities is going up (e.g., Choumert and Salanié, 2008; Frantzeskaki, 2019). It is also notable that the importance of urban green spaces has risen during the COVID-19 pandemic, mainly for the purpose of providing places of solace and respite, for allowing exercise and relaxation, and for supporting both mental and physical health (e.g., Dzhambov et al., 2021; Ugolini et al., 2020).

GBI is also becoming increasingly important in the context of climate change as an appropriate adaptation solution. Negative impacts of climate change significantly influence the quality of life in cities. GBI reduces urban heat islands, pollution in cities, and problems caused by storms and rainwater etc. According to researchers such as Wright (2011), Horwood (2011), and Gehrels et al. (2016), GBI also positively affects human health and the economy (e.g., it eliminates the loss of labour productivity that occurs during hot days (Daanen et al., 2013), increases land and property values for owners (Tu et al., 2016), reduces noise pollution (Calleja et al., 2017), and has positive health effects

* Correspondence to: Moskevská 54, Ústí nad Labem 400 96, Czech Republic.
E-mail address: jan.brabec@ujep.cz (J. Brabec).

https://doi.org/10.1016/j.ufug.2022.127695
Received 22 September 2021; Received in revised form 25 July 2022; Accepted 31 July 2022
Available online 1 August 2022

(Hartig et al., 2003; Tyrväinen et al., 2014; Ulrich et al., 1991; Wallner et al., 2018).

The main attractions of GBI as perceived by residents are its aesthetical value and the recreational functions it provides through urban greenery, water bodies, and associated facilities (Jim and Chen, 2006; Riechers et al., 2018); other services such as air quality control, thermal comfort, or noise reduction are usually perceived as less attractive depending on the local context (Buchel and Frantzeskaki, 2015). However, some questions regarding residents' preferences about the form of the GBI – e.g., is it more nature-based or is it semi-natural? – remain unanswered among the relevant stakeholders. Nature-based elements are elements that are mostly dominated by natural features, that enable natural processes to occur (European Commission, 2015), and that involve minimal intervention in ecosystems (e.g., natural wetlands). Meanwhile, according to Eggermont et al. (2015), semi-natural elements are sustainable and multifunctional ecosystems based on extensive or intensive management approaches (e.g., agricultural landscape). In contrast, according to Sowińska-Świerkosz et al. (2021), artificial elements are connected with the highest level of human intervention – the design and management of a new ecosystem (e.g., green roofs). The combination of GBI preferred by the residents together with the willingness to pay (WTP) for preferred GBI/element is a vital piece of information for spatial planners, who should take these preferences into account when designing public areas in the city.

Current assessments of GBI – such as by Voigt et al. (2014) – mostly do not take into account the differences between multidimensional benefits connected to nature-based or semi-natural forms of green and blue infrastructure (Daniels et al., 2018). As noted by Daniels et al. (2018), overly generalised indicators of green space quality are used, which do not provide sufficient information about the quality of GBI elements. Many authors argue that the distinction between nature-based and semi-natural GBI elements is not taken into account by either spatial planners or residents (e.g., Hofmann et al., 2012; Southon et al., 2017), although a number of exceptions can be found in Germany, where the criterion 'nature-based vs. semi-natural vs. artificial' is a part of the evaluation stage in the planning process (Biedermann et al., 2008; Daniels et al., 2018; Hetzel et al., 2014). Daniels et al. (2018) compared the nature-based and semi-natural variety for five structural park elements (water elements, lawns, flower beds, hedges, and margins), taking into consideration ecological, climatic, and social properties. The nature-based alternative of each element scored higher or the same as the semi-natural variety.

Residents are often not aware of benefits of GBI other than the recreational and aesthetic benefits (Syrbe et al., 2021). Functions such as microclimate regulation or water retention, for instance, are often only considered by land-use planners and other experts. Based on Daniels et al. (2018), nature-based GBI provides these functions to a greater extent compared to semi-natural parks or streams. Therefore, spatial planners prefer the extension and revitalisation of nature-based GBI over semi-natural alternatives (e.g., Hansen and Pauleit, 2014; Hostetler et al., 2011). An issue arises when residents' preferences do not match those of spatial planners, which is almost guaranteed due to the existence of preference heterogeneity. Birol et al. (2006) found that there is a considerable level of heterogeneity when people assess the ecological, social, and economic functions of greenery. Hence, designing open-space areas without taking into consideration people's preferences might lead to public outcry.

This paper explored which form of green infrastructure elements (nature-based or semi-natural) is preferred when combined with various forms of blue infrastructure and different levels of park facilities. Additionally, it considered whether people are willing to pay for their preferred form of GBI. Such information can help city representatives to communicate and explain planned changes to GBI in relation to the adaptation of cities to climate changes. It can also help spatial planners to design future GBI that will match people's preferences. To inform spatial planners about public preferences for urban green spaces, a discrete choice experiment and a latent class model were used to identify groups of residents of the Czech city of Liberec based on their GBI preferences.

2. Green and blue infrastructure – Preferences and willingness to pay

2.1. Public preferences regarding green and blue infrastructure

Many studies have examined people's preferences for urban greenery and water bodies, but they have produced inconsistent results regarding which form of GBI is best preferred. Whether a discrete choice experiment (e.g., Bullock, 2008) or other methods were used (e.g., Daniels et al., 2018; Derkzen et al., 2017), current knowledge of GBI remains insufficient and therefore more research is required to determine whether nature-based or semi-natural GBI is preferred in specific areas along with preferences on the optimal quality and quantity of recreational facilities.

A discrete choice experiment is among the most elaborate ways of revealing people's preferences regarding environmental goods (Harrison et al., 2018; Louda et al., 2021). It has frequently been used in environmental evaluation, including for urban open-space areas (e.g., Arnberger and Eder, 2015; Bullock, 2008; Nordh et al., 2011). Bullock (2008) found in his Dublin-based study that play facilities and a mixture of quiet and busy areas are preferred in local parks, whereas walking/seating facilities and adventure play facilities have a more important role in larger parks. Nature-based elements such as woodlands or lakes also appear to be appreciated more in larger parks. Nordh et al. (2011), meanwhile, used a choice-based conjoint analysis to reveal the preferences of Oslo residents and found that the presence of grass is the most important factor followed by trees and people (few rather than many people). Flowers and water features were less important, although their importance increased with respondents' age. Moreover, Arnberger and Eder (2015) showed that people prefer medium-sized green and manicured parks with park benches in which litter is not present and traffic noise cannot be heard.

According to Klemm et al. (2015) and Derkzen et al. (2017), public preferences relate to the current state of GBI in the neighbourhood. The results of their analysis showed that residents preferred mostly adding no more of the same form of an existing element in an area. For instance, residents of areas that are richly endowed with green elements prefer the idea of adding a water element over the idea of adding more trees. Preferences may also depend on local conditions such as current diversity and accessibility of GBI, residents' income, and awareness of climate change risks.

2.2. Public preferences regarding green and blue infrastructure depending on socio-demographic characteristics

Preferences for environmental goods often depend on socio-demographic characteristics (SDC). Therefore, researchers tend to focus on identifying the preferences of specific population segments. Alves et al. (2008) studied the preferences of the elderly in Britain using a discrete choice experiment. To them, the most important characteristics of local parks were non-visible nuisance (dog fouling, vandalism), presence of trees, and utilities, while water features or the distance to the park were not seen as particularly relevant. By contrast, Arnberger et al. (2017) found in their choice experiment that the distance to the park and the presence of a water body were relevant to the elderly during summer heats. Toilets were considered to be important too. Ho et al. (2005) studied how preferences for urban parks differ based on ethnicity and gender in the eastern part of the USA. Only a few differences were found between males and females with women preferring traditional park landscapes to some extent.

Chen et al. (2018), meanwhile, showed in their study on rivers in two cities that women were more concerned about restoring urban rivers and

about the price than men were. Women did not find recreational facilities in the surrounding areas important. Respondents preferred good water quality and a high degree of naturalness but did not demand recreational facilities. Ode Sang et al. (2016) reported that women take part in activities in green spaces more often than men, prefer nature-based places, appreciate the aesthetic value of greenery, and derive greater utility from their time spent there. Caula et al. (2009) found that 72 % of Montpellier residents (France) prefer nature-based green spaces over ornamental ones. This preference was stronger for women, but they were less likely to contribute financially than men. On the contrary, Chen et al. (2009) found no evidence of gender or age having an effect on environmental aesthetic preferences among visitors to the Hangzhou Flower Garden in China.

Studies that use non-experimental methods also added to the general understanding of people's preferences. Madureira et al. (2018) used best-worst scaling to rank the importance of various public green space characteristics in Portuguese cities. Cleanliness and maintenance, richness of plant species, existence of water bodies, and sufficient numbers of benches were among the most desired characteristics, while other facilities or larger area size were not considered to be particularly important. Jim and Chen (2006) also found that cleanliness and proximity and the number of green areas were important to respondents. Water bodies were among the irrelevant characteristics. Chen et al. (2009) discovered that people in China mostly seek relaxation in an urban garden and express a desire for nature-based elements.

2.3. Willingness to pay for green and blue infrastructure

To assess how strong the demonstrated preferences are, they can be expressed in monetary terms. Hasan Basri (2011) explored which characteristics are the most important to residents of Kuala Lumpur and found that recreational facilities in the park are the most relevant, followed by amenities and nature-based attractions. A latent class model showed that visiting a park provides certain groups of people with a consumer surplus of around 20 EUR. He also discovered that people with a higher education are willing to pay more for a local park. Chen et al. (2018) found that people were willing to pay 18–50 EUR for good water quality but only 4–9 EUR for recreational facilities. Additional studies estimated WTP using non-experimental methods. López-Mosquera et al. (2014) found that people in Spain are willing to contribute 12.67 EUR a year to conserve a local park. Jim and Chen (2006) reported a monthly WTP of around 2 EUR for visiting urban green spaces in the Chinese city of Guangzhou. Tameko et al. (2011) discovered that 78% of people agreed with a higher entrance fee to the Warda Park in exchange for more amenities. The average WTP was estimated to be 0.5 EUR. Caula et al. (2009) reported that households are willing to contribute 0.18–0.28 % of their monthly income on average to support things like wildlife conservation in urban areas. Kim and Jin (2018) found that a 100 m^2 increase in the area of urban parks makes residents equally happy to raising their monthly salary by approximately 100 EUR. Vojáček and Louda (2017) and Louda et al. (2021) studied visitors' willingness to pay for sociocultural ecosystem services in the Ore Mountains in the Czech Republic. Although the study did not evaluate urban parks, the stated WTP for nature-based streams of 22 EUR per weekend-long trip can be used as a comparison for this study. Derkzen et al. (2017) found differences in residents' preferences regarding GBI of two neighbourhoods in Rotterdam. The general WTP for GBI differed significantly between the neighbourhoods, indicating the importance of SDC.

Altogether, the literature does not provide a unified view of people's preferences regarding GBI in urban areas. While it is relatively clear that people value urban parks and seem to enjoy the presence of trees and some facilities (e.g., Alves et al., 2008; Arnberger and Eder, 2015; Hasan Basri, 2011; Jim and Chen, 2006; Nordh et al., 2011), particularly inconsistent results are reported for the presence and form of water bodies and recreational facilities according to perceived importance and preferences among respondents (e.g., Alves et al., 2008; Arnberger et al., 2017; Chen et al., 2018; Hasan Basri, 2011; Madureira et al., 2018; Nordh et al., 2011). Additionally, estimates of people's WTP are too inconsistent to offer any clear guidance on the value of GBI. Compared to previous studies and articles focusing mostly on small-scale elements of GBI such as flower beds, hedges, and margins, we deal with large-scale elements at the level of public space such as parks and gardens and two basic forms of GBI (nature-based or semi-natural).

3. Methods

3.1. Study area

As a case study area, we selected the medium-sized city of Liberec in the Czech Republic to ensure continuity with previous research, which has analysed values of ecosystem services, biodiversity, and GBI in Liberec (Louda et al., 2020; Macháč et al., 2020; Syrbe et al., 2021). With approximately 103,000 residents, Liberec is located in the northern part of the Czech Republic. The total area of the city is 106 km^2. There are many locations in the city with both natural, nature-based, and semi-natural forms of GBI. More than one-third of the area is covered with agricultural land (fields, meadows) and forests, which cover the city's peri-urban areas. The GBI varies in many aspects such as size, function, etc. Mostly semi-natural elements can be found in the inner-city centre, while areas with nature-based elements are present at the periphery of the centre. No specific plans for substantial changes in the type of greenery exist in Liberec. At the same time, a wide spectrum of inhabitants lives there, differing both in socio-economic characteristics (e.g., education, wage) and in their relationship to nature (frequency and length of visits to urban green spaces). The research aimed to discover the general perception of GBI among Liberec residents and formulate recommendations for the city council.

3.2. Data collection

On-site preference data were collected in green spaces in the summer of 2018. The data collection process is illustrated in Fig. 1. For the development of the discrete choice experiment, an exploratory project phase as recommended by Johnston et al. (2017) identified GBI as important for the residents. This phase was based on face-to-face interviews with visitors to green spaces. The results showed that visitors prefer the following urban elements: urban forests, lakes, ponds, public parks, and rivers and streams, followed by other types of GBI such as meadows with fruit trees, street trees, etc. During these interviews, respondents also expressed their willingness to contribute voluntarily to maintaining the GBI in a hypothetical situation in which the city had no funding for greenery maintenance and would otherwise have to reduce the volume of greenery. These data were later used to set levels for the cost attribute.

In accordance with Johnston et al. (2017), the second stage of the exploratory phase pre-tested the choice experiment and the overall interview design, which helped in developing the choice tasks and the questionnaire. Close to 60 visitors from the target population were involved in this phase. Five attributes were used: costs, form of urban greenery, water elements, park facilities, and path type (asphalt, clay, gravel, unpaved surface). The quantitative evaluation of the pre-testing results led to dropping the path type from the choice experiment as it was unimportant to respondents.

The final round of interviews took place in July 2018. Data were collected on five consecutive days (Thursday–Monday) in order to capture both workday and weekend visitors. The face-to-face interviews were led by trained interviewers (mostly students) with printed coloured choice cards. The interviewers carefully explained the potential choices as well as the opt-out option and the costs associated with individual options to ensure that respondents understood the effect on their welfare, as this is crucial in stated preference evaluation (Johnston et al.,

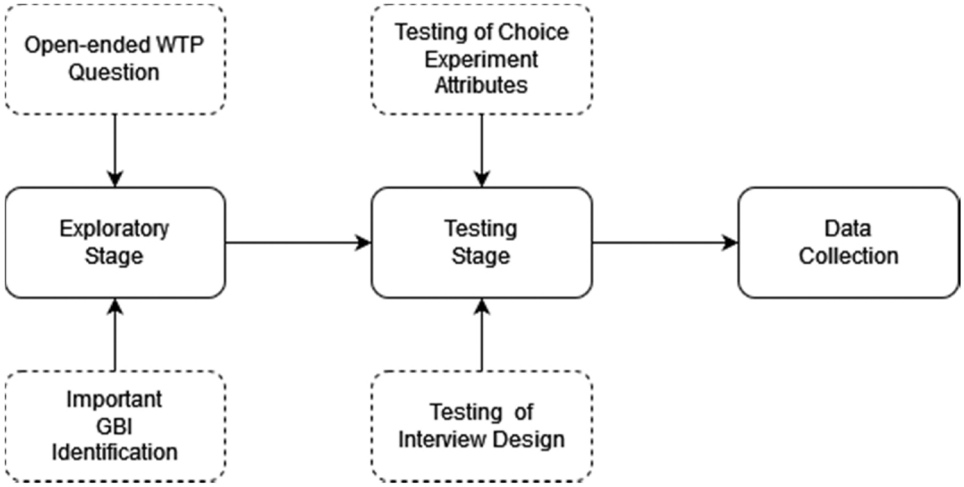


Fig. 1. Overview of data collection process.

2017). It was explained that the voluntary contribution would reduce respondents' incomes if this contribution system was introduced, i.e., it would reduce their budget for other goods. The responses were recorded using tablets with software developed for on-site interviewing. The sample for the choice experiment consisted of 217 respondents. Orme (1998) presents a formula according to which as few as 56 respondents are required for a meaningful analysis with the choice experiment design used in this study.

The choice experiment was carried out in different types of green spaces in the city of Liberec. Each location can be classified as either a nature-based or a semi-natural form of GBI. The three main locations were as follows: (1) a nature-based park near the Harcov water reservoir (70.5 % of respondents in the final data set, N = 217); (2) the semi-natural park Budyšínská located near to the city centre (18.4 % of respondents); and (3) the only existing small public urban garden in the city centre near the Liberec Chateau (2.3 % of respondents) (see Fig. 2).

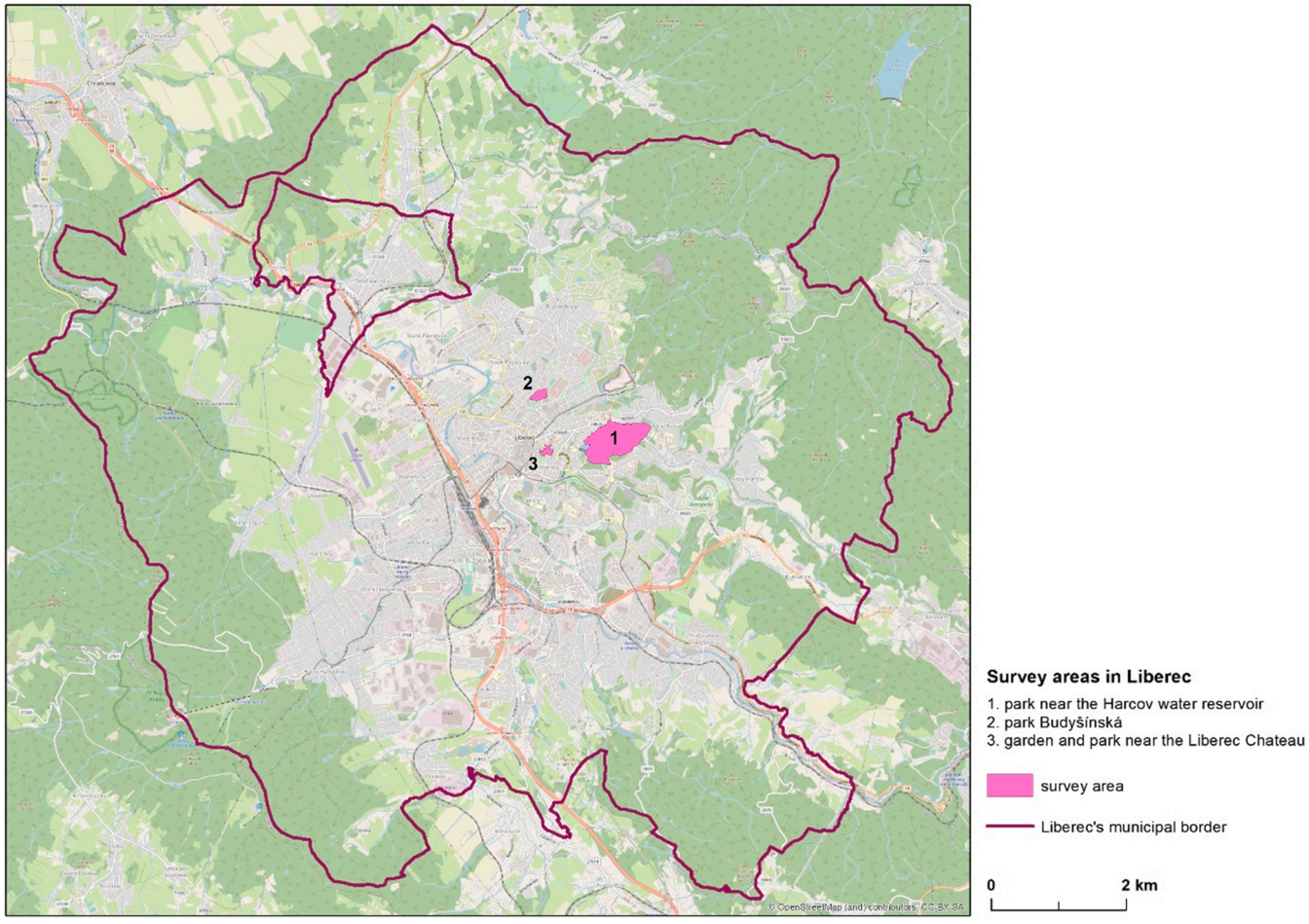


Fig. 2. Location of main data collection sites in Liberec.

Several questionnaires (8.8 %) were completed in other locations, mostly small semi-natural parks on the periphery of the city or more distant from the city centre.

After a brief introduction to the main objectives of the questionnaire, visitors were asked about their perception of the quality of maintenance of the city's green spaces, their feelings about visiting green spaces, and for a general assessment of GBI across the city (see Syrbe et al., 2021). Before the choice experiment, respondents were introduced to the studied GBI (attributes of the choice experiment) and to the payment vehicle. The interview concluded with questions concerning SDC. The interviews lasted 15 min on average. Thirty percent of the approached citizens refused to participate in the interview. The refusal rates differed slightly according to location: the rate was higher in the city centre (Park Budyšínská) and lower in the case of Harcov. Lack of time was the most frequent reason for refusal to participate.

3.3. Discrete choice experiment

The discrete choice experiment consisted of four textual attributes; three of them were image-assisted (Fig. 3). Each attribute was designed to have three levels (Fig. 3). A voluntary annual and continuous contribution to a transparent fund for financing public greenery was chosen as the payment vehicle (cost attribute). The levels of the cost attribute were set based on an open-ended question, which formed part of the exploratory phase. The mean value of WTP expressed by the visitors was 39 EUR. The annual voluntary contribution was therefore set at the levels of 8, 24, and 48 EUR for the choice experiment to ensure that the values were realistic, credible, and binding for different members of the population (Johnston et al., 2017).

Two attributes covered the form (nature-based or semi-natural) of park and stream types. To define the nature-based and semi-natural forms, we used similar criteria as those employed by Daniels et al. (2018) and Eggermont et al. (2015) for small-scale elements. Urban

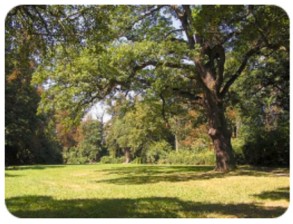
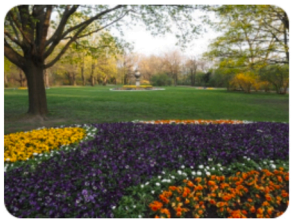
Attribute	Level 1	Level 2	Level 3
Annual voluntary contribution	8 EUR	24 EUR	48 EUR
Park type	Nature-based 	Semi-natural 	Urban garden 
Stream type	Nature-based 	Semi-natural 	Running in a pipe 
Facility	Benches 	Benches and waste bins 	Benches, bins and toilets 

Fig. 3. Overview of all attributes and attribute levels used in the choice experiment.

green spaces were defined as follows: a nature-based park, a semi-natural park, and an urban public garden with different degrees of naturalness and openness (Fig. 3). The stream was presented as nature-based, semi-natural, or a stream running in an underground pipe. The last level is identical to a scenario where no stream is visible and represents a common situation in urban parks in the Czech Republic. The last attribute represents three levels of basic park facilities: benches only; benches and waste bins; benches, waste bins and toilets.

A sequential orthogonal design was used to create the choice sets. With no previous expectations about sample preferences and no real limitations being imposed by the simple design, lower efficiency was chosen over possible biases coming from inappropriately constructed design (Bliemer and Rose, 2011). Each respondent was asked to make nine decisions in nine choice sets of the choice experiment, each set consisting of two cards with four attributes and their respective pictures (Fig. 4). Respondents were instructed to choose one of the two cards or to choose neither (opt-out). As was explained to the respondents, lack of money for upkeep of greenery in the case of opt-out would result in no new green areas and a slow deterioration of the current ones. Therefore, opt-out represents a gradual worsening of the current state. If respondents chose to opt out, they were asked about the reason for their decision.

3.4. Analysis

Random utility theory (McFadden, 1973) postulates that respondents' choices can be modelled as a function of the attributes of the alternatives of a discrete choice experiment. Alternatives – in this case park scenarios – are defined as a particular combination of attributes (for example, blue and green infrastructure) and their levels (for example, forms of blue and green infrastructure). The selection of one park alternative over another implies that the utility of that alternative is greater than the utility of any other alternative presented (Louviere et al., 2000). The maximum likelihood analysis produces parameter estimates (part-worth utilities), standard errors, and z-values for each attribute level (Louviere et al., 2000).

A mixed-latent class choice (MLC) model was applied to account for visitor preference heterogeneity, which was observed during the exploratory phase and which could potentially skew the coefficients if not accounted for (van den Berg et al., 2010). Several previous studies suggested that there would be groups of people with a strong preference for either form (nature-based or semi-natural), indicating that it is not suitable to use a logit model as it cannot identify these groups (Johnston et al., 2017). Additionally, the assumption of independence of irrelevant alternatives does not hold in the sample. Therefore, an MLC model was used to achieve a better understanding of the composition of the preferences. Magidson and Vermunt (2002) showed that adding discrete unobserved variables allows the model to divide respondents with similar preferences into classes and estimate a separate regression for each of the identified classes. Several models were estimated using a limited number of draws and are summarised in Table 1 These models differed in the number of classes (cl in the table), selected distribution for the cost variable (n for normal, ln for lognormal), inclusion of interactions between socio-demographic variables and costs (Int), and inclusion of covariates (Cov) that helped with class selection. Several criteria can be used to identify the most suitable model, including the minimum Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC) (Kemperman and Timmermans, 2006). In general, the lower the BIC and AIC values, the more suitable the model. SDC (gender, education, age) were included as covariates to assist in explaining possible class differences.

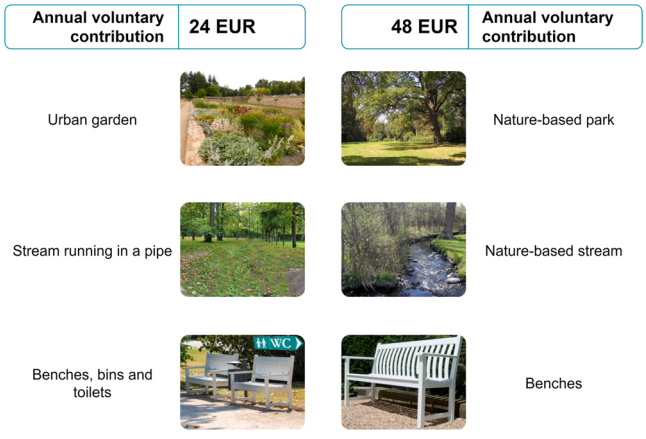


Fig. 4. Example of a choice card used in discrete choice experiment; an opt-out option was provided.

A model with two classes, lognormally distributed cost attribute and covariates but no interactions with the cost attribute was selected for a further analysis. While some models scored slightly better in the AIC, these models performed significantly worse in the BIC compared to the AIC, which tends to favour more complex models (Murphy, 2012). Two of the models failed to converge and are not reported in the table. The analysis was performed using the gmnl package in RStudio (Sarrias and Daziano, 2017). The model was estimated using the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm for maximisation on 10,000 draws as thousands of draws are suggested in the literature (Hensher et al., 2005). The cost attribute was divided by 100 to facilitate convergence (as other attributes were dummies) and therefore represents hundreds of Czech koruna (CZK). In the WTP section, all values are stated in euros (EUR).

4. Results

4.1. Sample characteristics

The model was estimated on 217 respondents, meaning that the estimate was based on 1953 observations. Women accounted for 53% of the sample (Table 2). The respondents' average age is 40 years. Approximately 70 % of the respondents are economically active (employed or self-employed). Almost 33% have a university degree, while 7 % have achieved only elementary education. Roughly 44 % of the respondents have a monthly income that falls between the minimum wage and the average wage, while almost 27 % earn more than the average wage. Based on Czech Statistical Office data, the sample characteristics correspond approximately to the characteristics of Liberec residents. There are marginally more women in the total city population of Liberec (51.6 % of the residents), which is slightly less than in our sample (Czech Statistical Office, 2020). The average age of the city population is slightly higher at 42 years (Czech Statistical Office, 2020). The categories from 15 to 40 years are more significantly represented in the sample, while the categories of the youngest and oldest residents are less well represented. There are no other updated characteristics available at the municipality level except the 10-year-old census. In

Table 1
Specifications of tested models.

Model specification	AIC	BIC
3cl, Int, ln, Cov	2506.7	2964.0
2cl, Int, ln, Cov	2594.7	2890.3
2cl, ln, Cov	**2568.3**	**2774.6**
3cl, n, Cov	2575.1	2898.6
2cl, n, Cov	2622.6	2828.9
3cl, Int, ln	2492.0	2904.7
2cl, Int, ln	2592.8	2866.0
2cl, ln	2577.7	2761.7
3cl, n	2541.3	2820.1
2cl, n	2617.6	2801.7

Table 2
Overview of respondents – socio-demographic characteristics (N = 217).

Socio-demographic characteristics		All
Age	Average/Median	40.1/ 36.0
Age per categories in %	0–14 years	0.9
	15–26 years	23.5
	27–40 years	33.2
	41–65 years	31.3
	66–85 years	11.1
	86 and elder	0.0
Gender	Females in %	53.5
Education in %	No school leaving certificate, primary school	6.9
	Secondary school	60,4
	University degree	32.7
Respondent income classification in %	Below minimum wage (EUR 473)	19.4
	Between minimum and average wage (EUR 1280)	43.8
	Above average wage	26.27
	No income (e.g., high school students)	2.3
	Unknown (chose not to answer this question)	8.3
Occupation in %	Economically active	70.5
	Pensioners	14.8
	Pupils, students	6.0
	On maternity / parental leave	6.4
	Housewife / husehusband	0.9
	Unemployed	1.4

comparison to the characteristics of residents of the whole Liberec Region, the sample had a higher proportion of university graduates and more residents belonging to the highest-income population. However, this is to be expected given that the city is the region's capital.

More than 50 % of the respondents visit green spaces several times a week and 36 % usually spend more than one hour in the green area where the interview took place (Table 3). Almost all participants (80 %) arrived on foot or by bicycle. The average self-assessed distance without outliers from the starting point (home/work/school, etc.) was 2 km. Most of the people stated that they considered all the attributes when making the decision. This applies also to those who frequently choose opt-out (29 % of the sample). When asked about the reason for choosing opt-out, these respondents mostly stated that the options were in their opinion too costly. Only a handful of respondents were unsatisfied with the combination of attributes that was presented to them.

4.2. Results of the mixed-latent class model

The MLC model identified two classes (Table 4). The first class covered 54 % of the sample. People in this class are on average more likely to be female, older, and hold a university degree. Also, they on average prefer to choose any of the options over choosing opt-out, as indicated by the fact that the coefficient is negative and significant. People in this class express a preference for nature-based parks compared to urban gardens. Semi-natural parks also seem to be slightly preferred to urban gardens, although the estimated coefficient is only 1.3 standard errors away from zero. Similarly, the results show a strong preference for nature-based streams and a much weaker preference for semi-natural streams compared to streams running in underground pipes. Regarding infrastructure, the results follow economic logic, with respondent preferring the option with the highest number of facilities. The cost attribute seems to be restrictive. Apart from semi-natural streams, all estimates of the mean value are statistically significant. All estimates of standard deviations are also statistically significant, although they are relatively large.

Table 3
Overview of respondents – habits related to visiting urban green spaces (N = 217).

Means of transport in %	On foot/Bicycle	80.2
	Public transport	9.7
	Car	9.2
	Other	0.9
Length of stay in %	Just walks through	15.2
	< 30 min	13.8
	< 1 h	35.0
	> 1 h	36.0
Distance from starting point to study area in km	Average	3.4
	No outliers (5 %)	2.0
Frequency of visiting study site in %	Daily	18.4
	Several times a week	35.0
	Several times a month	24.9
	Rarely	19.8
	First time at the study site	1.8

The second class consists of the remaining 46 % of the sample. These respondents clearly disliked urban gardens as both estimates of the mean value for nature-based parks and semi-natural parks are positive and statistically significant. There are only two more statistically significant coefficients that indicate a strong dislike towards semi-natural streams and towards costs. Estimates of standard deviations are not statistically significant except for costs and opt-out.

4.3. Willingness to pay

Since the MLC model estimates the parameters of distributions, WTP needs to be simulated on random draws from these distributions. The estimates presented in Table 5 follow the approach indicated by Rischatsch (2009) for the combination of lognormal distribution for price and normal distribution for the remaining attributes. The article also showed that one million draws is sufficient for convergence. However, such an approach tends to produce longish tails (Hensher and Greene, 2003). Therefore, 5 % of the lowest and the highest values were not considered in the analysis. It is necessary to point out that while Table 5 presents the WTP estimates for all attributes, not all of the coefficients were statistically significant at the 5 % confidence level in the MLC model, which is necessary for a meaningful interpretation. Moreover, even for the statistically significant coefficients the standard deviations of the simulated sample are relatively large, and the results based on the mean must be interpreted with caution. Indeed, authors often recommend using the median for interpretation instead as it is far more robust in regard to outliers (Onozaka and McFadden, 2011; Roe et al., 2001). Therefore, a median value of the whole sample is also presented in Table 5.

The WTP estimate only states how much people are willing to pay for a level of an attribute compared to another level of the same attribute since there is no basis level for the attributes. Therefore, respondents in class 1 are willing to pay 160.4 EUR more for a nature-based stream compared to a stream ran in underground pipe and 14.4 EUR more for a semi-natural stream compared to a stream ran in underground pipe. This means that respondents in class 1 value a nature-based stream at 146 EUR more than a semi-natural stream when considering the median values. All other values can be interpreted in a similar way. The element the respondents in class 1 seem to be willing to pay the most for is a nature-based stream. On the other hand, respondents in class 2 are willing to pay to have semi-natural streams removed in favour of a stream running in a pipe.

5. Discussion

This study explored people's preferences for GBI in public urban areas, specifically what form of greenery, streams, and facilities are favoured by locals. The results revealed that visitors to green spaces prefer natural elements, whether parks or streams, and are willing to pay for them. However, we also identified some preference heterogeneity

Table 4
Results of mixed-latent class model.

Variable	Class 1				Class 2			
	Estimate	Std. Error	Pr (>|z|)		Estimate	Std. Error	Pr (>|z|)	
Optout	-3.8218	0.7929	1.436e-06	***	3.3298	2.5517	0.1919057	
Nature-based_park	2.2963	0.3213	8.977e-13	***	4.0724	0.8696	2.828e-06	***
Semi-natural_park	0.2975	0.2327	0.2010717		4.2431	0.9867	1.707e-05	***
Nature-based_stream	3.3696	0.4118	2.220e-16	***	-0.2420	0.6303	0.7010405	
Semi-natural_stream	0.6438	0.2264	0.0044728	**	-3.5079	0.8435	3.199e-05	***
All_infrastructure	0.9602	0.3289	0.0035144	**	0.4480	0.7934	0.5722999	
Bins_benches	0.4841	0.2261	0.0322743	*	-0.1989	0.5514	0.7181964	
Cost	-2.6516	0.4262	4.924e-10	***	-1.0732	0.4800	0.0253649	*
sd.Optout	4.2638	0.8767	1.155e-06	***	14.6082	4.2474	0.0005832	***
sd.Nature-based_park	1.3877	0.3282	2.366e-05	***	0.0311	0.4563	0.9456172	
sd.Semi-natural_park	1.2799	0.2339	4.463e-08	***	0.0784	1.2732	0.9508907	
sd.Nature-based_stream	1.6901	0.3600	2.673e-06	***	0.6252	0.9156	0.4946850	
sd.Semi-natural_stream	1.2242	0.2777	1.047e-05	***	0.8441	0.8081	0.2962275	
sd.All_infrastructure	1.1142	0.3124	0.0003615	***	0.0108	0.5232	0.9834807	
sd.Bins_benches	0.2300	0.6234	0.7121196		0.0284	0.6625	0.9657168	
sd.Cost	2.0508	0.3106	4.067e-11	***	1.5684	0.4977	0.0016256	**
(class)2	-0.1583	0.1001	0.1140225					
class2:Sex	-0.3084	0.1249	0.0135928	*				
class2:Elderly	-0.6412	0.2117	0.0024652	**				
class2:University	-0.9584	0.1440	2.906e-11	***				

*$p < .05$
**$p < .01$
***$p < .001$

Table 5
Willingness-to-pay estimates (in EUR).

	Attribute	Mean	Median	Standard deviation	5 % percentile	95 % percentile
Class 1	Nature-based park	368.0	101.0	633.9	2.9	1820.7
	Semi-natural park	43.3	4.3	185.5	-187.8	424.0
	Nature-based stream	551.2	160.4	927.7	7.4	2680.4
	Semi-natural stream	94.9	14.4	227.1	-88.5	599.5
	All infrastructure	144.4	29.2	281.8	-24.8	784.3
	Bins & benches	79.9	23.5	133.9	1.2	386.9
Class 2	Nature-based park	95.4	47.4	118.7	6.1	369.6
	Semi-natural park	99.4	49.4	123.7	6.3	385.1
	Nature-based stream	-5.0	-1.3	13.0	-33.7	10.4
	Semi-natural stream	-81.0	-39.6	101.9	-317.0	-4.9
	All infrastructure	10.5	5.2	13.1	0.7	40.7
	Bins & benches	-4.6	-2.3	5.8	-18.0	-0.3

and identified two classes among respondents. While both classes preferred nature-based elements, people in class 2 showed a strong dislike towards semi-natural streams but liked semi-natural parks. Additionally, they did not deem park infrastructure to be that important. The classes also differed in their trade-offs and in terms of their willingness to pay for the GBI.

5.1. Preferences for green and blue infrastructure

The demand for GBI has significantly increased in recent years (Choumert and Salanié, 2008; Ghofrani et al., 2017) and so has the knowledge about the services they provide, whether connected to recreation, property values, or ecosystem services (e.g., Jim and Chen, 2006; Tu et al., 2016; Zellner et al., 2016). However, little attention has been paid to whether people prefer semi-natural or nature-based elements, where the latter provide these services to a greater extent (Daniels et al., 2018).

5.1.1. Park preferences

In accordance with Bullock (2008), Caula et al. (2009), and Hasan Basri (2011), the MLC model showed that the majority of respondents prefer parks with nature-based elements. Both semi-natural parks and public urban gardens were viewed as significantly worse options by respondents in class 1, while respondents in class 2 only disliked urban gardens. In contrast, Arnberger and Eder (2015) identified a preference among Vienna park visitors for flower beds. The shared negative preference for urban gardens may be explained by people's preference for trees (Alves et al., 2008; Nordh et al., 2011), which are rare elements in urban gardens. Respondents often mentioned that they are missing nature-based elements in urban gardens. Respondents may have viewed urban gardens as too semi-natural and too open in comparison to the alternative of a nature-based park. It should also be noted that there are only a small number of urban gardens in Liberec and therefore only a few questionnaires were collected there.

5.1.2. Stream preferences

The results for the form of water body highlight yet another difference between the classes. The model indicated a clear preference for nature-based streams for respondents in class 1, but these respondents still preferred some visible water body in the form of a semi-natural stream over no visible water body. On the other hand, respondents in class 2 did not enjoy the presence of semi-natural streams, which decreased their utility compared to parks with natural streams or no water body at all. The preference found for water bodies in class 1 supports the findings of Arnberger et al. (2017) and Madureira et al. (2018), while the outcomes for respondents in class 2 correspond to the findings of researchers such as Nordh et al. (2011) and Alves et al. (2008).

5.1.3. Facility preferences

While some researchers find that park facilities are important (e.g., Bullock, 2008; Madureira et al., 2018), other researchers have reported a lower significance for recreational facilities (Arnberger and Eder, 2015; Chen et al., 2018). These conflicting results may be attributable to preference heterogeneity because inconsistency was also detected among Liberec residents. The MLC model revealed preference for more infrastructure among respondents in class 1. The visitors' preferences for toilets are in line with the findings of Kemperman and Timmermans (2006) and Arnberger et al. (2017). These results follow the economic logic of more infrastructure being seen as the better option. The results for respondents in class 2 were not statistically significant, and they focused more on the park design.

5.1.4. Socio-demographic characteristics

Several SDC were tested as covariates in the MLC model as a means of distributing respondents into classes, and these turned out to be statistically significant. Therefore, a member of class 1 is more likely to be female with a university degree and of higher age. Hasan Basri (2011) showed that men were more heavily represented in classes that demonstrate higher willingness to pay, which contradicts our results because the WTP among respondents in class 1 seems to be larger on average.

The same model was also estimated with interaction terms between costs and SDC. Although the results are not reported in the paper, we can say based on the results how sensitivity to costs changes if the respondent is a woman, is elderly, has above-average income, or has a university degree. However, these estimates were not statistically significant for class 1. For class 2, the model indicated that women and people with a university degree were slightly less sensitive to prices and therefore would be more willing to pay for their preferred attributes. This is a common finding, but it stands in contrast with the findings of Engel and Pötschke (1998), who found that women are less willing to accept higher prices or taxes for the sake of the environment.

5.2. Influence of payment vehicle and location

The MLC model revealed that people in class 1 are willing to pay extra for nature-based elements. Specifically, they value nature-based parks approximately 101 EUR a year more than urban gardens and 97 EUR a year more than semi-natural parks. Nature-based streams were viewed as 146 EUR and 160 EUR a year more valuable than semi-natural streams and streams running in underground pipes, respectively. All available park infrastructure appeared to be worth approximately 29 EUR a year more than just benches, while adding toilets to bins and benches increases the WTP by almost 6 EUR a year. Respondents in class 2 expressed their WTP almost 50 EUR a year to have a nature-based or semi-natural park over an urban garden. They are also willing to pay nearly 40 EUR a year not to have a semi-natural stream in a park, while being almost indifferent to any differences between a nature-based stream and a stream running in an underground pipe. The WTP for park infrastructure was very low in class 2.

This study found that respondents from class 1 were willing to pay 160 EUR per year for the presence of natural streams, while Vojáček and Louda (2017) found a WTP for natural streams of 23 EUR per weekend-long visit in the Ore Mountains compared to a situation where regulated streams are present in the area. The WTP per visit found in our study seems to be lower as it would take only 7 visits to a local park to match the WTP found by Vojáček and Louda (2017). However, respondents reported that they visit urban parks more frequently, which is probably caused by the fact that people regard a weekend-long trip to the Ore Mountains as a special event (such as a family trip) and are willing to spend more than for a regular visit to an urban park.

A possible limitation of this study is the setting of the payment vehicle – the cost attribute. Entrance fees to urban parks are almost never used in the Czech Republic and voluntary contributions are also scarce. The amount voluntarily contributed is lower compared to that seen in studies carried out in Western Europe, which Silló (2016) found to be the case in the majority of the post-communist countries. Alternatively, a tax can be levied or increased. However, there are no local taxes in the Czech Republic except the property tax, and using this might be problematic as it differs significantly based on whether one lives in a flat or a house. A national tax works better in this sense, but a tax is a non-specific payment, and it is difficult to connect such a money transfer to a local urban park. Unfamiliarity with such procedures might make the results implausible (Morrison et al., 2000). Moreover, people generally refuse to give up more income on behalf of the national government. Also, a tax does not provide the option to opt out of the payment and makes studying WTP impossible. Therefore, a voluntary contribution was chosen as the payment vehicle. This solution is possibly not as distortive as the options mentioned above, but it still has some flaws. For instance, it could be vulnerable to free riders – people who enjoy GBI but rely on other people's payments – and thus it could bias the WTP estimate.

Additionally, setting the levels for the cost attribute was a challenge even though they were based on the results of a previous open-ended questionnaire about voluntary contributions for GBI in Liberec. Based on the open-ended answers, the mean WTP for GBI in their neighbourhood expressed by the respondents was 39 EUR, which is slightly lower than the maximum value used in the choice sets. This suggests that the costs were not strictly binding for a certain number of people and the levels could have been set higher. One possible implication is that urban planners do not need to be afraid to increase investments in GBI even if it means transferring a part of the financial burden to the public or the private sector. On the other hand, opt-out was chosen in 29% of the responses, which indicates that some people were not willing to pay for any of the offered combinations of attributes. Some of the respondents utilised this option quite frequently.

The places in which the data collection took place may also lead to a possible bias if the individual places are visited by different categories of people. People who prefer grey infrastructure may not visit green areas and thus are not represented in the studied sample. This does not bias the results found in this paper in terms of preferences regarding various forms of GBI – one can assume that these people did not care – but some attention should be paid to the extrapolation of these WTP findings to the rest of the population. The WTP presented in this paper corresponds to a sample in which half the people visit a green space more than once a week. People who rarely visit parks may have lower WTP, while people who prefer grey infrastructure might even have zero WTP. However, assuming zero WTP is an extreme case (Johnston et al., 2017), which means that it is rational to expect their WTP to be lower than that of those who visit GBI frequently but that it should still be higher than zero. Mell et al. (2013) studied preferences regarding both grey infrastructure and green infrastructure. They found that approximately 25 % of people were not willing to pay for green elements. Therefore, a different design would be desirable to study the population as a whole.

6. Conclusion

This paper investigated green space preferences and preference heterogeneity among residents of the city of Liberec using an image-assisted discrete choice experiment. The analysis focused only on residents currently utilising urban greenery. The results show that respondents preferred nature-based parks, although almost half also showed a significant preference for semi-natural parks. Urban gardens were given little to no support. More than half of the respondents also enjoyed nature-based streams, while the remaining half mostly disliked semi-natural streams. Park facilities do not seem to affect people's choices to any great extent, but when the coefficients were significant, they followed the economic logic of more being better. The findings appear to justify the presence of various forms of parks in cities as there is clearly no best combination of elements that people can reach a

consensus on. Moreover, it transpires that people are ready to pay for their preferred elements, although some people (class 1) seem to be more willing to pay than others.

The findings could encourage urban planners and landscape architects to more consistently consider differentiation between nature-based and semi-natural elements. They might design GBI with higher degrees of naturalness when planning extensions to current urban open spaces (e.g., Hansen and Pauleit, 2014; Hostetler et al., 2011). It becomes easier for stakeholders to communicate changes to urban GBI when knowing they have the support of the public. However, it is clear that at least some artificial greenery is needed to satisfy the broader society.

Overall, the results indicate the dominant preference regarding the form of GBI. Although a higher number of respondents would be desirable for the extrapolation of the findings, these results can be partly transferred to other cities as Chen et al. (2018) showed that the pattern of public preferences remained stable between two cities. Having said this, the results cannot be easily transferred to other nature-based elements such as meadows because the maintenance differs for each form and type of GBI – such as less frequent mowing – which people may dislike (e.g., Garbuzov et al., 2015). For practical use by urban planners, it would be useful to perform a preference analysis for other GBI elements (lawns, flower beds, hedges, or green roofs) such as in the cases of Daniels et al. (2018) or Arnberger and Eder (2015) and to involve in further analysis also those residents who currently do not visit urban green spaces. Such an analysis may reveal that these people actually enjoy GBI but in the form of elements that are not present in their neighbourhood.

CRediT authorship contribution statement

Jan Macháč: Conceptualization; Funding acquisition; Investigation; Methodology; Writing – original draft & editing. **Jan Brabec:** Data curation; Formal analysis; Methodology; Software; Writing – original draft. **Arne Arnberger:** Formal analysis; Methodology; Supervision; Validation; Writing – review & editing.

Declaration of Competing Interest

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

Data availability

Data will be made available on request.

Acknowledgements

This work was supported by the Operational Programme Research, Development and Education of the Czech Republic for financing the project Smart City – Smart Region – Smart Community (grant number: CZ.02.1.01/0.0/0.0/17_048/0007435) and the Cooperation Programme for the Promotion of Cross-border Cooperation between the Free State of Saxony and the Czech Republic 2014–2020 (BIDELIN project; grant number: 100282320). The Ministry of Education, Youth and Sports of the Czech Republic, Saxon State Ministry for Regional Development.

References

Alves, S., Aspinall, P.A., Ward Thompson, C., Sugiyama, T., Brice, R., Vickers, A., 2008. Preferences of older people for environmental attributes of local parks: the use of choice-based conjoint analysis. Facilities 26, 433–453. https://doi.org/10.1108/02632770810895705.

Arnberger, A., Eder, R., 2015. Are urban visitors' general preferences for green-spaces similar to their preferences when seeking stress relief? Urban For. Urban Green. 14, 872–882. https://doi.org/10.1016/j.ufug.2015.07.005.

Arnberger, A., Allex, B., Eder, R., Ebenberger, M., Wanka, A., Kolland, F., Wallner, P., Hutter, H.-P., 2017. Elderly resident's uses of and preferences for urban green spaces during heat periods. Urban For. Urban Green. 21, 102–115. https://doi.org/10.1016/j.ufug.2016.11.012.

Bakay, E., 2012. The role of housing estates' green surfaces in forming the city climate of Budapest. Appl. Ecol. Environ. Res. 10, 1–16.

Beery, T.H., Raymond, C.M., Kyttä, M., Olafsson, A.S., Plieninger, T., Sandberg, M., Stenseke, M., Tengö, M., Jönsson, K.I., 2017. Fostering incidental experiences of nature through green infrastructure planning. Ambio 46, 717–730. https://doi.org/10.1007/s13280-017-0920-z.

van den Berg, V.A.C., Kroes, E., Verhoef, E.T., 2010. Biases in willingness-to-pay measures from multinomial logit estimates due to unobserved heterogeneity (SSRN Scholarly Paper No. ID 1539880). Soc. Sci. Res. Netw., Rochester, NY. https://doi.org/10.2139/ssrn.1539880.

Biedermann, U., Werking-Radtke, J., Woike, M., 2008. Numerische Bewertung von Biotoptypen für die Eingriffsregelung in NRW. Landesanstalt für Natur, Umwelt und Verbraucherschutz (LANUV) NRW, Recklinghausen, Germany.

Birol, E., Karousakis, K., Koundouri, P., 2006. Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of Cheimaditida wetland in Greece. Ecol. Econ. 60, 145–156. https://doi.org/10.1016/j.ecolecon.2006.06.002.

Bliemer, M.C.J., Rose, J.M., 2011. Experimental design influences on stated choice outputs: an empirical study in air travel choice. Transp. Res. Part A: Policy Pract. 45, 63–79. https://doi.org/10.1016/j.tra.2010.09.003.

Buchel, S., Frantzeskaki, N., 2015. Citizens' voice: a case study about perceived ecosystem services by urban park users in Rotterdam. Neth. Ecosyst. Serv. 12, 169–177. https://doi.org/10.1016/j.ecoser.2014.11.014.

Bullock, C.H., 2008. Valuing urban green space: hypothetical alternatives and the status quo. J. Environ. Plan. Manag. 51, 15–35. https://doi.org/10.1080/09640560701712242.

Calleja, A., Díaz-Balteiro, L., Iglesias-Merchan, C., Soliño, M., 2017. Acoustic and economic valuation of soundscape: an application to the 'Retiro' Urban Forest Park. Urban For. Urban Green. 27, 272–278. https://doi.org/10.1016/j.ufug.2017.08.018.

Caula, S., Hvenegaard, G.T., Marty, P., 2009. The influence of bird information, attitudes, and demographics on public preferences toward urban green spaces: The case of Montpellier, France. Urban For. Urban Green. 8, 117–128. https://doi.org/10.1016/j.ufug.2008.12.004.

Chen, B., Adimo, O.A., Bao, Z., 2009. Assessment of aesthetic quality and multiple functions of urban green space from the users' perspective: the case of Hangzhou Flower Garden, China. Landsc. Urban Plan. 93, 76–82. https://doi.org/10.1016/j.landurbplan.2009.06.001.

Chen, W.Y., Hua, J., Liekens, I., Broekx, S., 2018. Preference heterogeneity and scale heterogeneity in urban river restoration: a comparative study between Brussels and Guangzhou using discrete choice experiments. Landsc. Urban Plan. 173, 9–22. https://doi.org/10.1016/j.landurbplan.2018.01.010.

Choumert, J., Salanié, J., 2008. Provision of urban green spaces: some insights from economics. Landsc. Res. 33, 331–345. https://doi.org/10.1080/01426390802045996.

Czech Statistical Office, 2020. Population of selected cities with more than 5,000 inhabitants: by sex and age, 31 December 2019.

Daanen, H.A., Jonkhoff, W., Bosch, P., ten Broeke, H., 2013. The effect of global warming and urban heat islands on mortality, morbidity and productivity in The Netherlands, In: Proceedings. Presented at the 15th International Conference on Environmental Ergonomics, Queenstown, New Zealand, p. 16.

Daniels, B., Zaunbrecher, B.S., Paas, B., Ottermanns, R., Ziefle, M., Roß-Nickoll, M., 2018. Assessment of urban green space structures and their quality from a multidimensional perspective. Sci. Total Environ. 615, 1364–1378. https://doi.org/10.1016/j.scitotenv.2017.09.167.

Derkzen, M.L., van Teeffelen, A.J.A., Verburg, P.H., 2017. Green infrastructure for urban climate adaptation: how do residents' views on climate impacts and green infrastructure shape adaptation preferences? Landsc. Urban Plan. 157, 106–130. https://doi.org/10.1016/j.landurbplan.2016.05.027.

Dzhambov, A.M., Lercher, P., Browning, M.H.E.M., Stoyanov, D., Petrova, N., Novakov, S., Dimitrova, D.D., 2021. Does greenery experienced indoors and outdoors provide an escape and support mental health during the COVID-19 quarantine? Environ. Res. 196, 110420 https://doi.org/10.1016/j.envres.2020.110420.

Eggermont, H., Balian, E., Azevedo, J.M.N., Beumer, V., Brodin, T., Claudet, J., Fady, B., Grube, M., Keune, H., Lamarque, P., Reuter, K., Smith, M., van Ham, C., Weisser, W. W., Le Roux, X., 2015. Nature-based solutions: new influence for environmental management and research in Europe. GAIA - Ecol. Perspect. Sci. Soc. 24, 243–248. https://doi.org/10.14512/gaia.24.4.9.

Engel, U., Pötschke, M., 1998. Willingness to pay for the environment: social structure, value orientations and environmental behaviour in a multilevel perspective. Innov.: Eur. J. Soc. Sci. Res. 11, 315–332. https://doi.org/10.1080/13511610.1998.9968571.

European Commission, 2013. Green Infrastructure (GI). Enhancing Europe's natural capital. Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions (COM (2013) 249 final), Brussels 6. 5.2013.

European Commission, 2015. Towards an EU Research and Innovation policy agenda for nature-based solutions & re-naturing cities. Final report of the Horizon 2020 expert group on Nature-based solutions and re-naturing cities.

Frantzeskaki, N., 2019. Seven lessons for planning nature-based solutions in cities. Environ. Sci. Policy 93, 101–111. https://doi.org/10.1016/j.envsci.2018.12.033.

Garbuzov, M., Fensome, K.A., Ratnieks, F.L.W., 2015. Public approval plus more wildlife: twin benefits of reduced mowing of amenity grass in a suburban public park in Saltdean, UK. Insect Conserv. Divers. 8, 107–119. https://doi.org/10.1111/icad.12085.

Gehrels, H., Meulen, S., van der Schasfoort, F., Bosch, P., Brolsma, R., Dinther, D., Geerling, G.J., Goossens, G.J., jong Merijn, D., Kok, S., Massop, H.T.L., Jacobs, M.C., 2016. Designing Green and Blue Infrastructure to Support Healthy Urban Living. TO2 Fed.

Ghofrani, Z., Sposito, V., Faggian, R., 2017. A comprehensive review of blue-green infrastructure concepts. Int. J. Environ. Sustain. 6. https://doi.org/10.24102/ijes.v6i1.728.

Hansen, R., Pauleit, S., 2014. From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for urban areas. Ambio 43, 516–529. https://doi.org/10.1007/s13280-014-0510-2.

Harrison, P.A., Dunford, R., Barton, D.N., Kelemen, E., Martín-López, B., Norton, L., Termansen, M., Saarikoski, H., Hendriks, K., Gómez-Baggethun, E., Czúcz, B., García-Llorente, M., Howard, D., Jacobs, S., Karlsen, M., Kopperoinen, L., Madsen, A., Rusch, G., van Eupen, M., Verweij, P., Smith, R., Tuomasjukka, D., Zulian, G., 2018. Selecting methods for ecosystem service assessment: a decision tree approach. Ecosyst. Serv., SI: Synth. Open. 29, 481–498. https://doi.org/10.1016/j.ecoser.2017.09.016.

Hartig, T., Evans, G.W., Jamner, L.D., Davis, D.S., Gärling, T., 2003. Tracking restoration in natural and urban field settings. J. Environ. Psychol. Restor. Environ. 23, 109–123. https://doi.org/10.1016/S0272-4944(02)00109-3.

Hasan Basri, B., 2011. Valuing the Attributes of Malaysian Recreational Parks: A Choice Experiment Approach (Thesis). Newcastle University.

Hensher, D.A., Greene, W.H., 2003. The mixed logit model: The state of practice. Transportation 30, 133–176. https://doi.org/10.1023/A:1022558715350.

Hensher, D.A., Rose, J.M., Rose, J.M., Greene, W.H., 2005. Applied Choice Analysis: A Primer. Cambridge University Press,.

Hetzel, I., Müller-Pfannenstiel, K., Zintl, R., Langensiepen, I., Stellmach, M., 2014. Bayerische Kompensationsverordnung (BayKompV) Arbeitshilfe zur Biotopwertliste - Verbale Kurzbeschreibungen.

Ho, C.-H., Sasidharan, V., Elmendorf, W., Willits, F.K., Graefe, A., Godbey, G., 2005. Gender and ethnic variations in urban park preferences, visitation, and perceived benefits. J. Leis. Res. 37, 281–306. https://doi.org/10.1080/00222216.2005.11950054.

Hofmann, M., Westermann, J.R., Kowarik, I., van der Meer, E., 2012. Perceptions of parks and urban derelict land by landscape planners and residents. Urban For. Urban Green. 11, 303–312. https://doi.org/10.1016/j.ufug.2012.04.001.

Horwood, K., 2011. Green infrastructure: reconciling urban green space and regional economic development: lessons learnt from experience in England's north-west region. Local Environ. 16, 963–975. https://doi.org/10.1080/13549839.2011.607157.

Hostetler, M., Allen, W., Meurk, C., 2011. Conserving urban biodiversity? Creating green infrastructure is only the first step. Landsc. Urban Plan., Landsc. Urban Plan. 100 (100), 369–371. https://doi.org/10.1016/j.landurbplan.2011.01.011.

Jim, C.Y., Chen, W.Y., 2006. Recreation–amenity use and contingent valuation of urban greenspaces in Guangzhou, China. Landsc. Urban Plan. 75, 81–96. https://doi.org/10.1016/j.landurbplan.2004.08.008.

Johnston, R.J., Boyle, K.J., Adamowicz, W., (Vic), Bennett, J., Brouwer, R., Cameron, T. A., Hanemann, W.M., Hanley, N., Ryan, M., Scarpa, R., Tourangeau, R., Vossler, C. A., 2017. Contemporary guidance for stated preference studies. J. Assoc. Environ. Resour. Econ. 4, 319–405. https://doi.org/10.1086/691697.

Kemperman, A.D.A.M., Timmermans, H.J.P., 2006. Heterogeneity in urban park use of aging visitors: a latent class analysis. Leis. Sci. 28, 57–71. https://doi.org/10.1080/01490400500332710.

Kim, D., Jin, J., 2018. Does happiness data say urban parks are worth it? Landsc. Urban Plan. 178, 1–11. https://doi.org/10.1016/j.landurbplan.2018.05.010.

Klemm, W., Heusinkveld, B.G., Lenzholzer, S., van Hove, B., 2015. Street greenery and its physical and psychological impact on thermal comfort. Landsc. Urban Plan. 138, 87–98. https://doi.org/10.1016/j.landurbplan.2015.02.009.

López-Mosquera, N., García, T., Barrena, R., 2014. An extension of the theory of planned behavior to predict willingness to pay for the conservation of an urban park. J. Environ. Manag. 135, 91–99. https://doi.org/10.1016/j.jenvman.2014.01.019.

Louda, J., Dubová, L., Macháč, J., Brabec, J., Hrbková, K., Meyer, P., Prošková, R., Pudil, M., Janďourek, J., Cudlín, P., 2020. Městská příroda v Liberci: Co nám přináší a co potřebuje (Urban nature in Liberec: What it brings us and what it needs).

Louda, J., Vojáček, O., Slavíková, L., 2021. Achieving robust and socially acceptable environmental policy recommendations: lessons from combining the choice experiment method and institutional analysis focused on cultural ecosystem services. Forests 12, 484. https://doi.org/10.3390/f12040484.

Louviere, J.J., Hensher, D.A., Swait, J.D., 2000. Stated Choice Methods: Analysis and Applications. Cambridge University Press,.

Macháč, J., Hekrle, M., Meyer, P., Staňková, N., Brabec, J., Sýkorová, M., 2020. Cultural ecosystem services and public preferences: How to integrate them effectively into Smart City planning?, in: 2020 Smart City Symposium Prague (SCSP). Presented at the 2020 Smart City Symposium Prague (SCSP), pp. 1–6. https://doi.org/10.1109/SCSP49987.2020.9133798.

Madureira, H., Nunes, F., Oliveira, J.V., Madureira, T., 2018. Preferences for urban green space characteristics: a comparative study in three Portuguese cities. Environments 5, 23. https://doi.org/10.3390/environments5020023.

Magidson, J., Vermunt, J.K., 2002. A non-technical introduction to latent class models. Stat. Innov., Belmont, MA.

McFadden, D., 1973. Conditional logit analysis of qualitative choice behavior. In: Zarembka, P. (Ed.), Frontiers in Econometrics. Academic Press, New York, pp. 105–142.

Mell, I.C., Henneberry, J., Hehl-Lange, S., Keskin, B., 2013. Promoting urban greening: valuing the development of green infrastructure investments in the urban core of Manchester, UK. Urban For. Urban Green. 12, 296–306. https://doi.org/10.1016/j.ufug.2013.04.006.

Morrison, M.D., Blamey, R.K., Bennett, J.W., 2000. Minimising payment vehicle bias in contingent valuation studies. Environ. Resour. Econ. 16, 407–422. https://doi.org/10.1023/A:1008368611972.

Murphy, K.P., 2012. Machine Learning: A Probabilistic Perspective. The MIT Press,, Cambridge, MA (Illustrated edition).

Nordh, H., Alalouch, C., Hartig, T., 2011. Assessing restorative components of small urban parks using conjoint methodology. Urban For. Urban Green. 10, 95–103. https://doi.org/10.1016/j.ufug.2010.12.003.

Ode Sang, Å., Knez, I., Gunnarsson, B., Hedblom, M., 2016. The effects of naturalness, gender, and age on how urban green space is perceived and used. Urban For. Urban Green. 18, 268–276. https://doi.org/10.1016/j.ufug.2016.06.008.

Onozaka, Y., McFadden, D.T., 2011. Does local labeling complement or compete with other sustainable labels? A conjoint analysis of direct and joint values for fresh produce claim. Am. J. Agric. Econ. 93, 693–706. https://doi.org/10.1093/ajae/aar005.

Orme, B., 1998. Sample Size Issues for Conjoint Analysis Studies. Sawtooth Software Technical Paper,, Sequim.

Riechers, M., Barkmann, J., Tscharntke, T., 2018. Diverging perceptions by social groups on cultural ecosystem services provided by urban green. Landsc. Urban Plan. 175, 161–168. https://doi.org/10.1016/j.landurbplan.2018.03.017.

Rischatsch, M., 2009. Simulating WTP values from random-coefficient models (Working Paper No. 0912). Working Paper.

Roe, B., Teisl, M.F., Levy, A., Russell, M., 2001. US consumers' willingness to pay for green electricity. Energy Policy 29, 917–925. https://doi.org/10.1016/S0301-4215(01)00006-4.

Sarrias, M., Daziano, R., 2017. Multinomial logit models with continuous and discrete individual heterogeneity in R: the gmnl package. J. Stat. Softw. 79, 1–46. https://doi.org/10.18637/jss.v079.i02.

Silló, Á., 2016. The development of volunteering in post-communist societies. A review. Acta Univ. Sapien. Soc. Anal. 6, 18.

Silva, J.M.C., da, Wheeler, E., 2017. Ecosystems as infrastructure. Perspect. Ecol. Conserv. 15, 32–35. https://doi.org/10.1016/j.pecon.2016.11.005.

Southon, G.E., Jorgensen, A., Dunnett, N., Hoyle, H., Evans, K.L., 2017. Biodiverse perennial meadows have aesthetic value and increase residents' perceptions of site quality in urban green-space. Landsc. Urban Plan. 158, 105–118. https://doi.org/10.1016/j.landurbplan.2016.08.003.

Sowińska-Świerkosz, B., Wójcik-Madej, J., Michalik-Śnieżek, M., 2021. An assessment of the ecological landscape quality (ELQ) of nature-based solutions (NBS) based on existing elements of green and blue infrastructure (GBI). Sustainability 13, 11674. https://doi.org/10.3390/su132111674.

Syrbe, R.-U., Neumann, I., Grunewald, K., Brzoska, P., Louda, J., Kochan, B., Macháč, J., Dubová, L., Meyer, P., Brabec, J., Bastian, O., 2021. The value of urban nature in terms of providing ecosystem services related to health and well-being: an empirical comparative pilot study of cities in Germany and the Czech Republic. Land 10, 341. https://doi.org/10.3390/land10040341.

Tameko, A., Donfouet, H., Sikod, F., 2011. The economic valuation of improved urban parks: a case study of Warda Park. J. Sustain. Dev. 4, p271. https://doi.org/10.5539/jsd.v4n1p271.

Tu, G., Abildtrup, J., Garcia, S., 2016. Preferences for urban green spaces and peri-urban forests: an analysis of stated residential choices. Landsc. Urban Plan. 148, 120–131. https://doi.org/10.1016/j.landurbplan.2015.12.013.

Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., Kagawa, T., 2014. The influence of urban green environments on stress relief measures: a field experiment. J. Environ. Psychol. 38, 1–9. https://doi.org/10.1016/j.jenvp.2013.12.005.

Ugolini, F., Massetti, L., Calaza-Martínez, P., Cariñanos, P., Dobbs, C., Ostoić, S.K., Marin, A.M., Pearlmutter, D., Saaroni, H., Šaulienė, I., Simoneti, M., Verlič, A., Vuletić, D., Sanesi, G., 2020. Effects of the COVID-19 pandemic on the use and perceptions of urban green space: an international exploratory study. Urban For. Urban Green. 56, 126888 https://doi.org/10.1016/j.ufug.2020.126888.

Ulrich, R.S., Simons, R.F., Losito, B.D., Fiorito, E., Miles, M.A., Zelson, M., 1991. Stress recovery during exposure to natural and urban environments. J. Environ. Psychol. 11, 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7.

Voigt, A., Kabisch, N., Wurster, D., Haase, D., Breuste, J., 2014. Structural diversity: a multi-dimensional approach to assess recreational services in urban parks. Ambio 43, 480–491. https://doi.org/10.1007/s13280-014-0508-9.

Vojáček, O., Louda, J., 2017. Economic value of ecosystem services in the eastern Ore mountains. E+M 20, 4–18. https://doi.org/10.15240/tul/001/2017-3-001.

Wallner, P., Kundi, M., Arnberger, A., Eder, R., Allex, B., Weitensfelder, L., Hutter, H.-P., 2018. Reloading pupils' batteries: impact of green spaces on cognition and wellbeing. Int. J. Environ. Res. Public Health 15, 1205. https://doi.org/10.3390/ijerph15061205.

Wright, H., 2011. Understanding green infrastructure: the development of a contested concept in England. Local Environ. 16, 1003–1019. https://doi.org/10.1080/13549839.2011.631993.

Young, R., Zanders, J., Lieberknecht, K., Fassman-Beck, E., 2014. A comprehensive typology for mainstreaming urban green infrastructure. Journal of Hydrology, Water governance across competing scales. Coupling Land Water Manag. 519, 2571–2583. https://doi.org/10.1016/j.jhydrol.2014.05.048.

Zellner, M., Massey, D., Minor, E., Gonzalez-Meler, M., 2016. Exploring the effects of green infrastructure placement on neighborhood-level flooding via spatially explicit simulations. Comput., Environ. Urban Syst. 59, 116–128. https://doi.org/10.1016/j.compenvurbsys.2016.04.008.