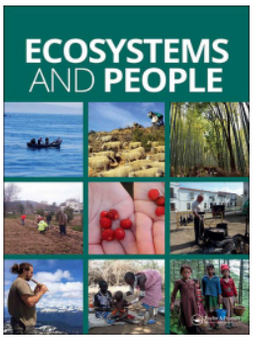

Ecosystems and People

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/tbsm22

Why do people visit or avoid public green spaces? Insights from an online map-based survey in Bochum, Germany

Claudia Romelli, Carl C. Anderson, Nora Fagerholm, Rieke Hansen & Christian Albert

To cite this article: Claudia Romelli, Carl C. Anderson, Nora Fagerholm, Rieke Hansen & Christian Albert (2025) Why do people visit or avoid public green spaces? Insights from an online map-based survey in Bochum, Germany, Ecosystems and People, 21:1, 2454252, DOI: 10.1080/26395916.2025.2454252

To link to this article: https://doi.org/10.1080/26395916.2025.2454252

ECOSYSTEMS AND PEOPLE
2025, VOL. 21, NO. 1, 2454252
https://doi.org/10.1080/26395916.2025.2454252

Taylor & Francis
Taylor & Francis Group

RESEARCH

OPEN ACCESS Check for updates

Why do people visit or avoid public green spaces? Insights from an online map-based survey in Bochum, Germany

Claudia Romelli [a*], Carl C. Anderson [a,b], Nora Fagerholm [c], Rieke Hansen [d] and Christian Albert [a,b]

[a]Institute of Geography, Ruhr University Bochum, Bochum, Germany; [b]Institute for Environmental Planning, Leibniz Universität Hannover, Hannover, Germany; [c]Department of Geography and Geology, University of Turku, Turku, Finland; [d]Department of Open Space Development, Hochschule Geisenheim University, Geisenheim, Germany

ABSTRACT

Public green spaces (PGS) have the capacity to fulfil the needs and interests of diverse groups of urban dwellers and thus contribute to their well-being. However, PGS designers and managers usually lack spatially disaggregated information on how PGS is used, by whom, and for what reasons. This study aims to assess spatial PGS visitation and avoidance patterns and their respective determinants using the city of Bochum, Germany as a case study. The research design consists of the design and application of an online map-based survey (public participation GIS – PPGIS) targeting residents and subsequent statistical and spatial analyses. Survey data include 807 completed surveys with 1084 marked visited points and 329 marked avoided points across the study area. Our results show both spatial clusters and co-occurrence of PGS visitation and avoidance. Respondents visit and avoid PGS for different reasons, which are linked to societal determinants (e.g. exercising or resting and relaxing), physical determinants (e.g. amount of grassy area or presence of trash) and sociodemographic background. Although reasons for PGS visitation and avoidance show limited spatial variation across different PGS, we find variation when disaggregating by gender and age. Insights generated can provide useful guidance for urban planners and policy makers for prioritising design and management actions to address reasons for avoidance of PGS, enhance their perceived quality and benefits, and craft PGS management concepts that better address place-specific conditions and preferences of different sociodemographic groups.

ARTICLE HISTORY
Received 30 April 2024
Accepted 9 January 2025

EDITED BY
Davide Geneletti

KEYWORDS
Public participation GIS (PPGIS); public green spaces; ecosystem services and disservices; connection to nature; urban green infrastructure

1. Introduction

In order to work towards sustainable futures and living conditions, it is crucial to understand human-nature interactions in urban areas (Acuto et al. 2018; Elmqvist et al. 2019). Substantial research has demonstrated the fundamental beneficial role of urban green and blue infrastructure. By offering diverse recreational opportunities, it contributes to urban residents' mental and physical health (Korpela and Ylén 2007; Honold et al. 2016; Kondo et al. 2018) and promotes social interaction (Peters et al. 2010; Clarke et al. 2023). Urban green spaces also provide a number of regulating ecosystem services, including the regulation of the local temperature, air purification, runoff mitigation and noise reduction (Gómez-Baggethun et al. 2013; Kowarik et al. 2017). Within the urban green infrastructure network, public green spaces (PGS) such as parks, urban forests or lakes have a particular role in offering space to interact with nature to enjoy these benefits, which should be accessible to every resident and are often especially valued by those who do not have access to private green spaces in the city (Coolen and Meesters 2012; Christoforidi et al. 2022).

Global population growth and urbanization continue to exert various pressures on urban green infrastructure, such as higher demand, use conflicts and disturbances caused by human activity and ecological shifts (Soga and Gaston 2022; Beery et al. 2023). Scholars have been therefore increasingly drawing their attention towards the human-nature interactions dichotomy, referring to connection and disconnection from nature (Beery et al. 2023), nature's values and disvalues (Lliso et al. 2022), and ecosystem services (ES) and disservices (ED) (Lyytimäki and Sipilä 2009; Blanco et al. 2019). ES and ED reflect the possibility of both beneficial and harmful contributions to human well-being resulting from direct sensory interactions with ecosystems (Soga and Gaston 2022) and the plurality of values individuals hold for nature (Jacobs et al. 2016; Pascual et al. 2021). Further factors then contribute to the actual perception of ES – accessibility, availability, and quality, including available facilities, maintenance, and absence of off-site and institutional

CONTACT Carl C. Anderson anderson@umwelt.uni-hannover.de
*New affiliation: Poliedra – Politecnico di Milano, Milano, Italy
Supplemental data for this article can be accessed online at https://doi.org/10.1080/26395916.2025.2454252

barriers (Schipperijn et al. 2010; Andersson et al. 2019; Palliwoda and Priess 2021; Wolff et al. 2022) – or of ED – mismanagement or anthropogenic disturbances such as the presence of litter, dangerous plants or animals, overcrowded areas, and noise (Palliwoda and Priess 2021; Röing et al. 2021). This interplay of personal, socio-cultural and ecological factors can cause the same interaction with nature to result in perceived ES by some and ED by others (e.g. trees that provide shade but also cause allergies) (von Döhren and Haase 2015; Fischer and Eastwood 2016; Rasmussen et al. 2017; Baumeister et al. 2022). In an urban context, ES and ED perception thus shapes preferences and potentially dual attitudes towards PGS, which we operationalize in this study as PGS visitation (intentional stay of at least 15 minutes) or PGS avoidance (intentional restraint from a possibly known PGS).

PGS visitation has been extensively researched from a range of thematic and methodological perspectives. Numerous studies have assessed the perceptions and distributions of benefits resulting from interactions with PGS (e.g. Buchel and Frantzeskaki 2015; Rall et al. 2017), also integrating the role of landscape features and use patterns (Bertram and Rehdanz 2015; Fischer et al. 2018). PGS users often appreciate cultural ES such as recreation, social interaction or aesthetic appreciation (Bertram and Rehdanz 2015; Rall et al. 2017), while regulating services like thermal comfort, air quality control or noise reduction are also commonly positively perceived (Buchel and Frantzeskaki 2015). Although assessments specifically addressing the ED associated with PGS visitation remain limited (von Döhren and Haase 2015), greater attention has been given to examining both positive and negative outcomes of PGS visitation. Assessments of ES and ED have been conducted with visitors of urban forests (Baumeister et al. 2022) or with local communities with regard to their neighbourhoods' environments (Ives et al. 2017; Larson et al. 2019; Rodgman et al. 2024) or to urban greening initiatives (Drew-Smythe et al. 2023). Palliwoda and Priess (2021) surveyed users of urban parks and brownfields to assess perceived benefits and disturbances/disservices and their differences across age groups. Employing participatory data, Raymond et al. (2016) identified the diversity of users of urban blue areas, their activities and 'perceived problems and unpleasant experiences'. In Phillips et al. (2022) factors contributing to negative and positive experiences in urban green spaces in the Brussels region were identified through survey data as pull and push factors encouraging or dissuading green space use. ES and ED perceptions have only rarely been studied in direct relation to PGS use or non-use. Therefore, we identify a key knowledge gap in understanding how attitudes towards PGS use are framed in relation to perceptions of either ES or ED. This goes along with the need of further research on the spatial patterns of PGS visitation and avoidance and of their determinants, as well as their variance across diverse user groups.

In this study, we investigate spatial patterns of PGS use and the factors influencing the decision to *visit* or *avoid* certain PGS to inform urban planning and decision-making. Based on the definition of urban green infrastructure by Pauleit et al. (2019), we define PGS as urban green and blue spaces potentially accessible to the public that provide multiple ES and ED. We operationalize ES and ED as 'reasons' to visit or avoid a PGS. We frame our reasons as identified activities and characteristics that can be communicated to the public and may influence visitation or avoidance. Thus, our 'reasons' do not always link directly to specific ES or ED, but rather to the flow of benefits or constraints associated to ES and ED, respectively. These flows are 'filtered' by physical (structure and composition of the urban landscape), societal (urban residents' appraisal of PGS) and institutional (rules and norms) determinants (Andersson et al. 2021). In this study we focus on societal and physical determinants by assessing reasons to visit or avoid a PGS as a combination of respondents' activities or experiences in PGS and the PGS' characteristics, i.e. stemming from a combination of various individual and spatial factors. We use the city of Bochum, Germany, as a case study as it offers a high number of PGS of different characteristics and sizes, dispersed relatively evenly across the urban fabric. We apply a public participation GIS (PPGIS) approach – an online survey with digital-mapping components (Fagerholm et al. 2021). PPGIS is commonly employed for recognizing values, perceptions, and attitudes associated with specific locations (Ives et al. 2017; Garcia-Martin et al. 2017; Zaman et al. 2022), as well as for investigating the spatial behaviours of individuals (e.g. Samuelsson et al. 2021) and is widely applied in the context of urban green infrastructure planning (Brown et al. 2020; Farkas et al. 2023).

The research is guided by the following questions:

(1) What is the spatial distribution of visited and avoided PGS across the study area and how do PGS visitation and avoidance relate spatially?
(2) What are determinants of PGS visitation and avoidance and how do they vary across the study area?
(3) To what degree do determinants of PGS visitation and avoidance vary based on respondents' sociodemographic characteristics?

We expect the generated insights to be useful for informing urban planners and decision-makers with specific information on residents' preferences and

needs regarding PGS visitation and avoidance. Identifying reasons behind PGS avoidance, as potential ED, allows for better understanding and supporting the design, planning, and management of PGS to ultimately enhance positive characteristics (and maximize ES), thus contributing to increased visitation. Moreover, the insights can contribute to the identification of social-ecological trade-offs and might help in the prevention or resolution of use conflicts, thus addressing equity issues in urban contexts. This is crucial evidence to improve the quality of life in urban areas, promote sustainability and enhance community well-being.

2. Methodology

2.1. Study area

The city of Bochum (145.4 km^2) is located in the state of North Rhine-Westphalia in the North-West of Germany (Figure 1). It has a population of 373,673 inhabitants (stand 03/2024). Bochum is one of the main cities of the Ruhr metropolitan region, one of Europe's largest metropolitan areas with more than 5 million inhabitants (Keil et al., 2021). During the 19th and 20th centuries, the economic profile of this region was marked by coal mining and the steel industry, playing a pivotal role in shaping the urban landscape. Despite its central location within a large urban-industrial centre, Bochum is a city rich in PGS. Urban forests cover approximately 14% of the city's area and other types of PGS like parks and playgrounds account for more than 6% of the city's landscape (Schmitt and Gausmann 2020). Bochum is delimited in its southern border by the Ruhr River, includes part of the Kemnader Dam and the smaller Ümminger Lake (both non-swimmable) (Figure 1).

The different elements of the landscape show a high degree of variety in terms of origin, anthropogenic influences and naturalness (Schmitt and Gausmann 2020). Most of the non-urban land use cover of the city includes rather small and scattered PGS within the urban fabric, while agricultural land and grassland also make up more than 12% of the total area (Schmitt and Gausmann 2020). This fragmentation is a result of the rapid population growth and polycentric urban development which occurred along the local economic growth (Hetzel 2013).

We expanded the case study area beyond the city's official municipal borders by adding a 1 km buffer to account for the seamless merging of municipalities and PGS crossing their boundaries, particularly in the densely urbanized area around Bochum. This extension provided study respondents with greater flexibility in mapping 'cross-border' visited or avoided PGS.

2.2. Research design

To design and conduct the PPGIS survey, we used the online community engagement platform and survey

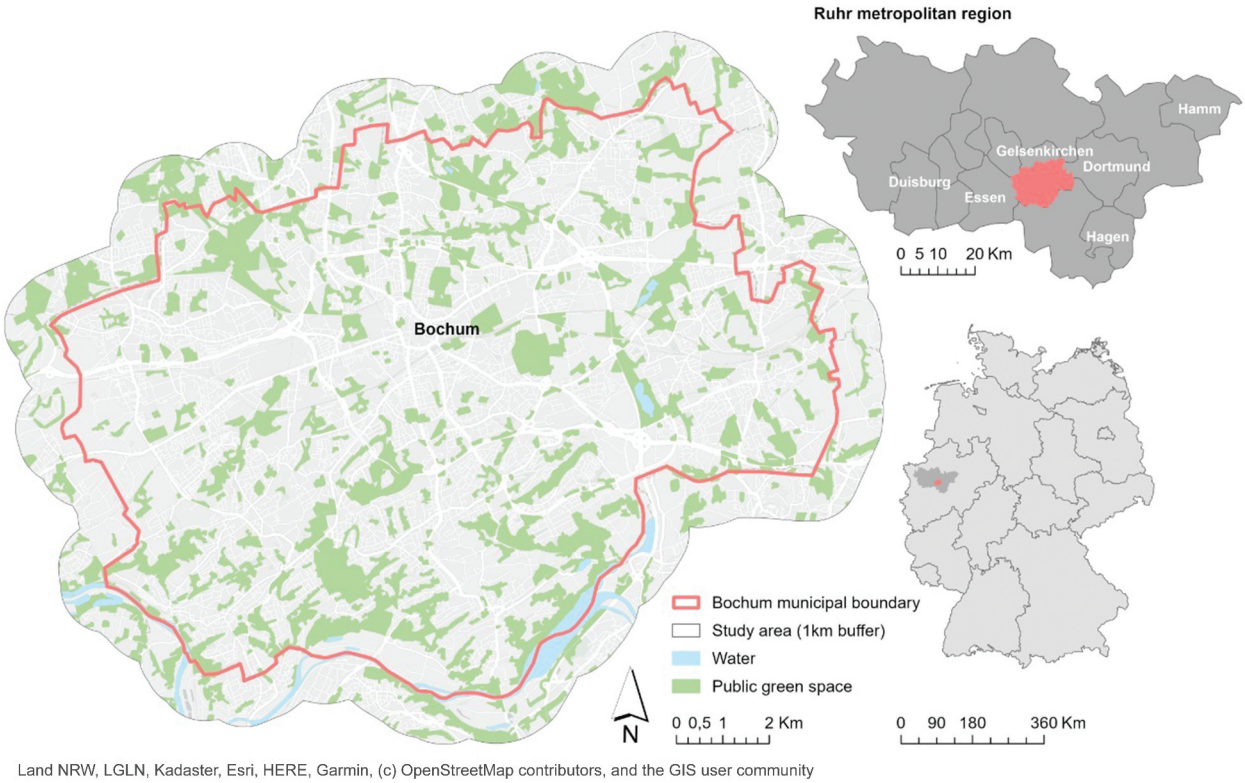

Figure 1. Bochum study area, including a 1 km buffer (left), located among main municipalities in the Ruhr metropolitan region (top right) and within German federal states (bottom right).

tool Maptionnaire™. Our survey was divided into 8 sections, 4 of which are analysed in this study, including sets of items referring to respondents' sociodemographic characteristics and map-based questions requiring respondents to locate on a map:

- up to two of their favourite PGS they had intentionally visited over the past year;
- one PGS (least favourite) that they had avoided over the past year.

For visited PGS, we asked participants for their two favourite ones 1) because we conducted the survey during wintertime, which might bias respondents' capability to recall recent PGS experiences and 2) to capture respondents' intentional and physical interactions with PGS instead of more indirect or incidental ones (since these might not provide the same wide spectrum of benefits) (Oh et al. 2021). Thus, we provided a definition of a visit as ' … an intentional trip to a green area where you spent at least 15 minutes'. To assess PGS avoidance, we asked participants to ' … identify one of your least favourite public green spaces in Bochum. These spaces can include areas you have visited, but you prefer to avoid'.

The map-based questions used an interactive map where participants could scroll and zoom in and out with OpenStreetMap (OpenStreetMap contributors 2015) as a base layer and a PGS semi-transparent overlay. In order to obtain a usable layer for respondents, the PGS layer was created using an aggregation of 4 land use types (14100 Green urban areas; 31000 Forests; 50000 Water; 32000 herbaceous vegetation) from the Urban Atlas 2018 dataset (European Environment Agency 2020). To check for accuracy, this was compared and adapted with ATKIS – Digital BasicLandscape Model (2023) data as well as a municipal green areas administrative layer provided by the city of Bochum. The base map and the city's PGS layer were combined to help respondents orientate and visualize PGS boundaries for more accurate placement of the points. The study area's 1 km-buffer zone was also visible.

Once respondents marked a PGS, both for visited and avoided, a pop-up window with further questions on respondents' reasons for visitation or avoidance appeared (Table 1). These items always refer to the PGS that was marked on the map.

We compiled the list of positive and negative PGS activities (societal determinants) based on items previously used in PPGIS studies which surveyed cultural ES and ED (Baumeister et al. 2020, 2022; Palliwoda and Priess 2021; Gottwald et al. 2022), landscape values (Garcia-Martin et al. 2017; Zaman et al. 2022) or other positive and negative values (Ives et al. 2017) or use attitudes (Samuelsson et al. 2021; Palliwoda et al. 2022) towards urban green spaces. Regarding the PGS characteristics (physical determinants) listed in Table 1, we considered studies on the recreational use and perception of green areas (Hermes et al. 2021; Röing et al. 2021), on the contribution of natural and artificial landscape features for the provision of ES (Baumeister et al. 2020) as well as results from citizens' surveys on their desired and undesired preferences for PGS features (Kabisch and Haase 2014; Haase et al. 2017; Palliwoda and Priess 2021). To allow respondents to fully express their reasons for PGS visitation or

Table 1. List of survey items (1–7 Likert) used to assess reasons for PGS visitation and avoidance.

PGS Visitation		PGS Avoidance	
I visited this PGS to:	How important were the following PGS characteristics for motivating your visit?	I avoided this PGS because:	How important were the following PGS characteristics for motivating your avoidance?
Activities	**PGS characteristics**	**Unpleasant experiences**	**PGS characteristics**
- Collect food (e.g. berries, mushrooms)	- Naturalness (i.e. not much human-made infrastructure)	- There are plants or animals I find dangerous or bothersome (e.g. roots, poisonous plants, broken-off branches, plunged fruits or leaves, unpleasant odours)	- Not enough grassy area
- Get exercise	- Amount of grassy area	- The location lacks necessary equipment or services	- Not enough forest area
- Appreciate natural beauty	- Amount of forest area	- The atmosphere is unpleasant	- No water/No access to water
- Meet friends or family	- Presence of water	- The scenery is not attractive	- No/Not enough shade
- Feel connected with nature	- Amount of shaded area	- I do not feel relaxed/calm here	- Distance from my house
- Cool down when temperatures are high	- Proximity to my house	- I feel that I do not belong here	- Certain plants or animals disturb/scare me
- See wildlife	- Easy to access (roads, paths, parking space, public transportation)	- I do not feel safe here	- The location is noisy
- Hear wildlife (e.g. birds singing)	- Many different plants and animals	- It is too hot on days of high temperatures	- The location is dirty/trashed
- Rest and relax	- Well maintained		- The location is crowded
- Become inspired (e.g. with new ideas)	- Human-made infrastructure		- The view is blocked (by buildings, infrastructure)
- Walk my dog	- Not so crowded		- Not enough/missing infrastructure (benches, toilets, kiosks, playgrounds)
- Take kids to play			- The place is difficult or impossible for me to access
			- Use of the location is restricted (by administrative rules, property, membership)

avoidance, which might not be completely covered by our predefined list, the survey included for both sections open questions.

Most of the survey's items were assessed with Likert 1 to 7 ranges from '1=strongly disagree' to '7=strongly agree' or '1=very low importance' to '7=very high importance'. The Likert items were designed as continuous ranges with two poles (1;7) and a 'neither agree nor disagree' mid-point (4), allowing participants to indicate their preferences on numeric values rather than discrete categories. We selected a 7-point range for the Likert items in order to capture higher variation in responses than possible with a 5-point scale (since e.g. aesthetic benefits may be important to most respondents), while increasing speed and readability compared to a 9-point range (Anderson et al. 2021). The full survey is available in Appendix 1.

The survey obtained approval from the Ethics Committee of the Faculty of Geosciences of the Ruhr-University Bochum and ensured ethical compliance by informing participants about this approval and requiring their explicit consent to the privacy policy prior to participation (see Appendix 1).

2.3. Data collection

Prior to the survey's official distribution to the public, we distributed a pilot version in December 2022 to students enrolled in two graduate university courses ($n = 35$) and asked them for feedback. We then further distributed this pilot version to contacts in local institutions who were informed and interested in our work (City of Bochum, Emscher Cooperative, Ruhr Regional Association). The final version of the questionnaire was distributed with a volunteer sampling strategy starting in January 2023. We shared it through local media, such as the university newsletter, newspapers, and radio and distributed posters and flyers with the survey's QR code. We also used social media channels and targeted city and neighbourhood Facebook groups, as well as relatable Instagram accounts. The survey was online from 9 January to 27 February 2023. Studies have shown that crowdsourced or volunteer sampling mostly leads to rather unbalanced respondent profiles (Kahila-Tani et al. 2019; Fagerholm et al. 2021) and especially certain groups like elderly people might encounter additional challenges due to limited access to online services and devices (Kyttä et al. 2023). To overcome these challenges, we collected on-site data at three senior homes, engaging elderly individuals. We provided assistance using tablets with participants who voluntarily chose to complete the survey.

2.4. Data pre-processing and analysis

We pre-processed the collected dataset using Excel by sorting and removing responses according to the following criteria: time taken to complete the survey less than 1 minute ($n = 150$); number of missing entries per respondent exceeds the designated cut-off point ($n = 66$; cut-off point = 36, chosen because it required respondents to answer at least beyond the sociodemographic section and as a natural break); respondents do not live in Bochum ($n = 115$). The total number of respondents living in the city of Bochum is 807 after pre-processing. On average, our sample is younger (below 50 years old) and more female-dominated compared to the municipal census. The sample also shows fewer respondents with a migration background and a higher proportion of respondents with a higher educational level (Table 2).

For the visualization and analysis of the georeferenced data we used ArcGIS Pro 3.2. To identify hotspots and coldspots of visitation and avoidance we used the Kernel density analysis tool for point features (Silverman 1986). This tool for spatial analysis calculates the density of point features within a specified region by using a Kernel function to assign weights to nearby areas based on their distance from each point. We used the default search radius and output cell size. We further explored spatial co-occurrence of PGS visitation and avoidance by calculating the total number of points within each PGS polygon. For these calculations, we considered a 100-meter buffer around each PGS to account for inaccurate placement of mapped points. We generated 3 types of PGS profiles for visualization and further analysis: (1) visitation hotspots (minimum of 5 visited points and double the number of avoided points); (2) avoidance hotspots (minimum of 5 avoided points and double the number of visited points); (3) mixed engagement PGS (minimum of 5 avoided points and 5 visited points in the same PGS).

To identify important reasons of visitation and avoidance, we considered the items reported in Table 1 and calculated mean values for all marked visited and avoided points. We thus ranked the average importance of each variable's score. Furthermore, we specifically looked into the average importance of these variables as reasons for visiting or avoiding each generated PGS profile. Therefore, we only considered points within each profiled PGS (with a 100 m buffer). Given the low number of visited points (4) placed by respondents on avoidance hotspots, we did not assess means of reasons for PGS visitation for this PGS profile.

For respondents' sociodemographic characteristics we measured the variables (1) gender, (2) nationality, (3) level of education, (4) age group, (5) income level and (6) length of residency in Bochum. Gender, nationality, and level of

Table 2. Comparison of respondents' sociodemographic characteristics with the study area's census data.

	City of Bochum	Survey (n = 807)
Gender (%)	49.3	35.8
Male	50.7	61.7
Female		.9
Other		1.6
NA		
Nationality (%)	83.5	92.7
German	16.5	5.9
Other		1.4
NA		
Age group (%)	8.4	19.8
18–24	14.8	23.3
25–34	12.2	14.3
35–44	12.5	13.1
45–54	14.6	15.5
55–64	11.1	9.9
65–74	11.5	3.2
75+		.9
NA		
Education level (%)	No equivalent data	43.9
Up to lower secondary		50
Higher secondary		3.4
Other		2.7
NA		
Income class (%)	No equivalent data	4.9
under 500€		6.7
500 to under 900€		8.2
900 to under 1300€		3.7
1300 to under 1500€		6.2
1500 to under 2000€		9.4
2000 to under 2600€		8.3
2600 to under 3200€		14.1
3200 to under 4500€		15.9
4500€ or more		22.6
NA		

Gender, nationality, age groups from Stadt Bochum (BoStatIS, stand: 31.12.2022). Data on the population's education level and income class could not be obtained in a format comparable to our sample.

education were coded as dichotomous variables. We omitted the option 'Other' from the gender variable during analysis due to the low number of responses ($n = 7$). Although survey participants could mark up to two visited PGS on the map, in order to avoid double counting, we only considered the data for the first marked visited point in the following analysis. We investigated variations among respondents' sociodemographic characteristics and the reasons for visitation or avoidance using (1) the Mann–Whitney U test for dichotomous items and (2) the Kruskal–Wallis H test for the remaining categorical independent items. For statistically significant results of the Kruskal–Wallis H test, a post-hoc test using Dunn's (1964) procedure with a Bonferroni adjustment for multiple comparisons was applied. For all statistical analyses we used the software IBM SPSS Statistics 29.0.0.0.

3. Results

3.1. Spatial distribution of visitation and avoidance

Respondents placed 1084 points on visited PGS and 329 points on avoided PGS. Both visited and avoided points show a dispersed distribution across the study area except in the north-west where there are few points (Figure 2). Visited points align on a centred north-south axis, with higher density towards the southern part of the study area. Avoided points distribute rather on the west-east axis and cluster over fewer areas in comparison to visited points. Hotspot and coldspot areas for both PGS visitation and avoidance are highlighted by the results of the Kernel density analysis (pink, violet and blue colours displaying 7 density classes in Figure 2). Clear visitation hotspots are concentrated along the central axis of the study area and coincide with PGS of both smaller and bigger size.

Reflecting the clear gap between the collected number of visited and avoided points, we find fewer hotspots of PGS avoidance. The biggest PGS avoidance hotspots correspond to Bochum's commercial city centre, and two other hotspots can be found around the study area's lakes. Coldspots of both visitation and avoidance (no colour highlight in Figure 2) comprise the north-western PGS in the study area, as well as PGS close to the eastern border of the city.

Spatial coincidence of PGS visitation and avoidance is observable at different levels in several PGS on the bivariate map (Figure 3). While some PGS emerge to be hotspots only, other PGS show combinations of engagement patterns (areas marked in brown). These are PGS that respondents assessed as both visited and avoided. Thus, we distinguish between 3 PGS profiles: visitation hotspots (26), avoidance hotspots (3) and mixed engagement PGS (10). Visitation hotspots include areas such as the large urban forest Weitmarer Holz, the Tippelsberg hill and the botanical garden of Ruhr University. Most of these areas present a mixture of urban forest and grassland features, often including water elements and some historical or cultural features and they lie adjacent or close to other bigger PGS (Figure 3). Avoidance hotspots are only few in comparison to visitation hotspots and correspond to two urban parks, Friedenspark and Apollonia-Pfaus Park, and Monte Schlacko area. These are PGS of small to medium size, embedded into the urban fabric and rather disconnected from other PGS. Mixed engagement PGS include the two lake areas of the city as well as several popular parks such as the Bochum City Park or the Westpark. A full list of the categorized PGS and their characteristics, including point counts, is provided in Appendix 2, Table S1.

3.2. Reasons for PGS visitation and avoidance

Exercise is the highest rated reason for visiting PGS (6.27), followed by rest and relaxation (5.87) and appreciation of aesthetics (5.36). Most of the

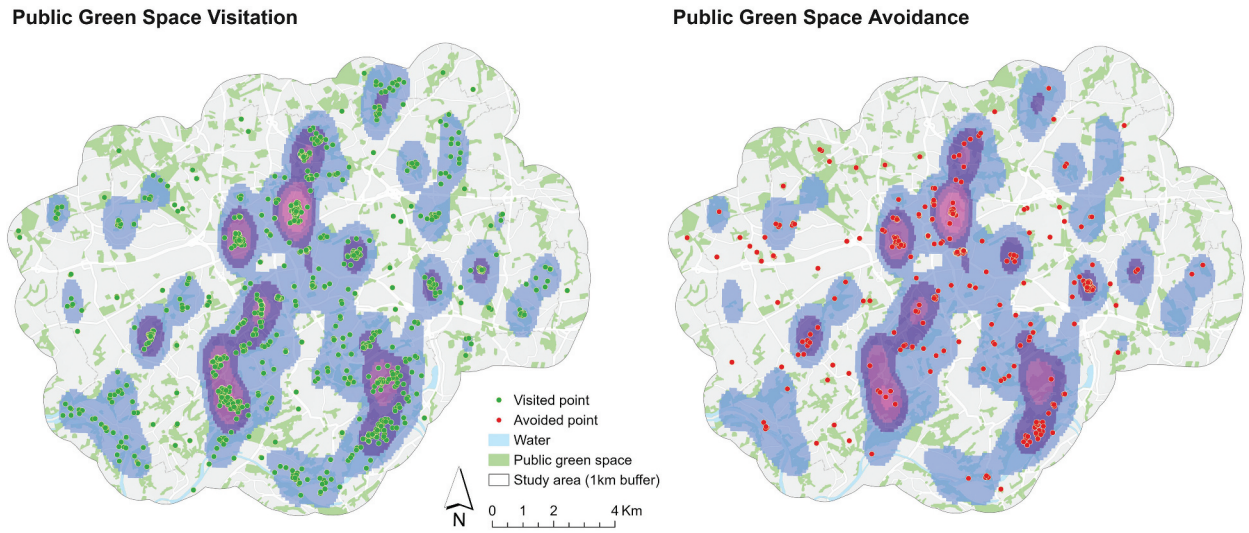

Figure 2. Distribution of visited points and hotspots/coldspots of public green space visitation (left) and public green space avoidance (right). Hotspots and coldspots are represented on a blue to pink gradient, where pink stands for high concentration of points and blue/light violet stands for low to moderate concentration of points. Areas without colour have a minimal density of points

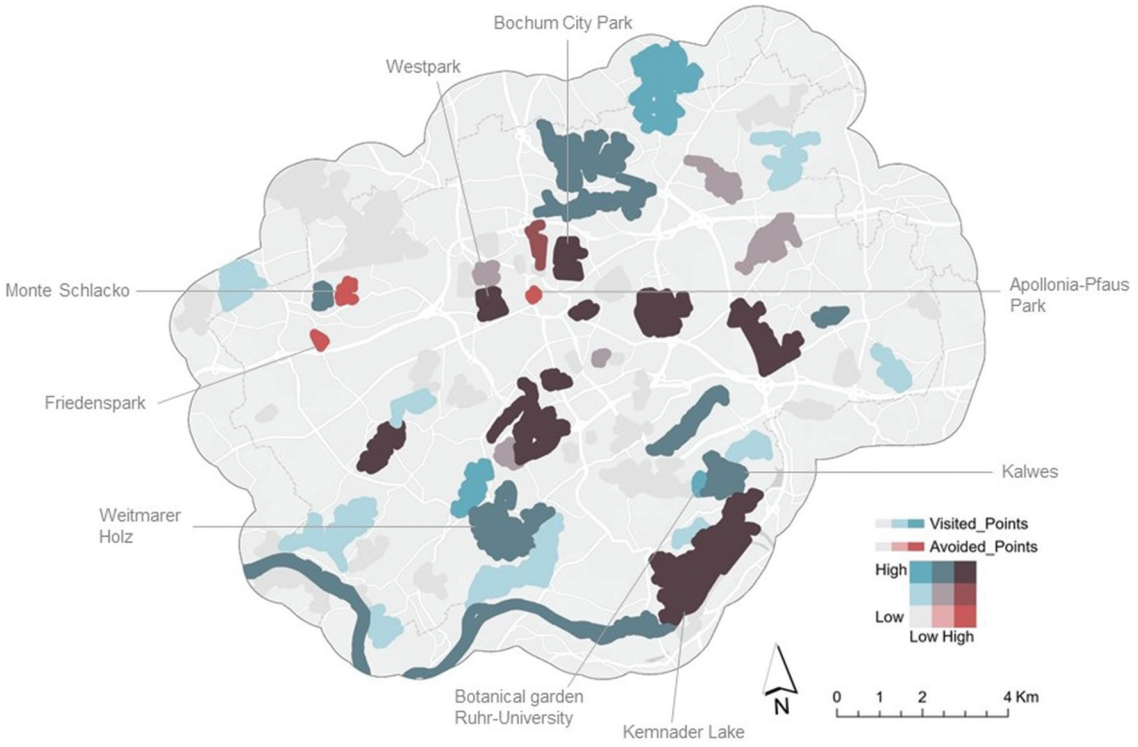

Figure 3. Bivariate map representing the spatial co-occurrence of visited and avoided points. PGS are considered with a 100-meter buffer.

remaining items score middle to high values of importance for reasons to visit a PGS. Seeing wildlife, walking the dog, bringing kids to play and collecting food are overall the weakest visitation reasons (Figure 4). As PGS characteristics, proximity to home (5.64), the amount of grassy area (5.39) and an easy access to the PGS (5.38) share rather high mean values. All other PGS characteristic items also score mean values slightly over the mid-point of the Likert scale (4), except artificial infrastructure such as benches or playgrounds.

We found that the individual spatial distribution of both reasons for PGS visitation and PGS avoidance mirrored the overall distribution of visited and avoided points depicted in Figure 2. Maps for each reason are provided in Figures S1-S4 in Appendix 3. We therefore took a closer look at the average importance of reasons for PGS visitation and avoidance

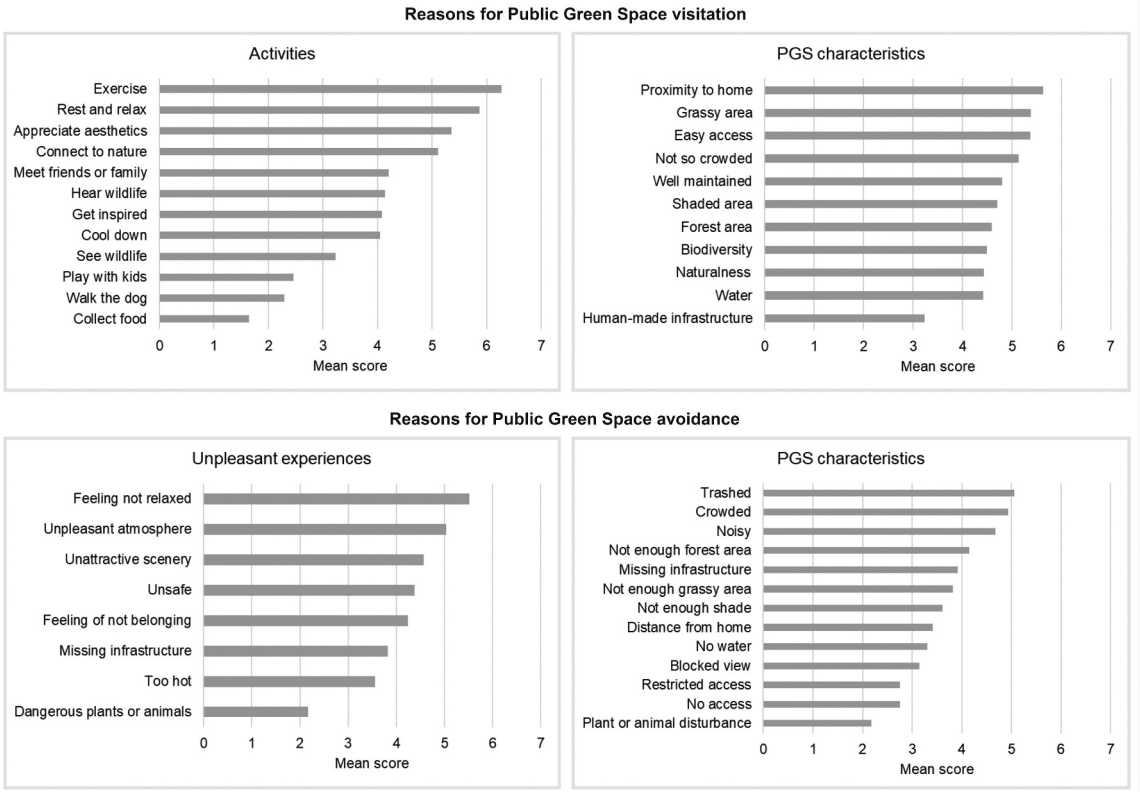

Figure 4. Ranked importance (1=very low importance to 7=very high importance) of mean values of elicited reasons for visiting PGS ($n = 1084$) – activities in PGS (upper left), PGS characteristics (upper right) – and reasons for avoiding PGS ($n = 329$) – unpleasant experiences in PGS (bottom left), PGS characteristics (bottom right).

across the generated PGS profiles (Figure 5), which revealed a pattern that closely mirrors the overall ranking assessed through respondents' scores for all PGS within the study area. Reasons of PGS visitation show similar mean scores between visitation hotspots and mixed engagement PGS. Exercising as well as resting and relaxing are the strongest reasons for visiting these PGS profiles. The remaining variables score only slightly different mean values, e.g. connecting to nature (5.54) and appreciating aesthetics (5.09) for visitation hotspots and mixed engagement PGS (4.56 and 5.09, respectively). In terms of PGS characteristics, naturalness, the amount of forest area and the presence of diverse plants and animals are slightly more prominent for visitation hotspots than mixed engagement PGS.

Reasons for PGS avoidance exhibited consistency across the 3 profiles too (Figure 5). 'Feeling not relaxed or calm' is the strongest reason to avoid either a visitation hotspot (4.63), an avoidance hotspot (5.50) or a mixed engagement PGS (5.54). The unpleasant atmosphere, feeling unsafe and feeling of not belonging are also relatively strong reasons for avoidance across the 3 PGS profiles. Feeling unpleasantly hot in a PGS stands out as a more important reason for avoidance hotspots (4.70). Missing infrastructure, a crowded, or a noisy PGS are important reasons of avoidance across the 3 PGS profiles. Presence of trash is also a strong reason for avoidance, with high mean values especially in avoidance hotspots (6). Lack of forest area (5.11), lack of shaded area (4.11) or of grassy area (4.61) are relatively important for avoidance hotspots too. Visitation hotspots and mixed engagement PGS share particularly the distance from home as further important reason of avoidance (3.31 and 3.73, respectively), as well as slightly higher importance of variables describing lack of accessibility.

3.3. Sociodemographic characteristics and PGS visitation and avoidance

Overall, the findings indicate a greater prevalence of significant variations in factors related to PGS visitation compared to those associated with PGS avoidance. Comparing male and female respondents across reasons for PGS visitation, we find that female respondents generally rated the importance of certain reasons for PGS visitation – 'appreciate aesthetics', 'meet friends or family', 'rest and relax', 'naturalness', 'proximity to home', 'easy access' – slightly to moderately higher than male respondents ($p < .05$) (Table 3). Mean importance of human-made infrastructure for visiting a PGS scored a slightly higher value among male respondents (3.36) than female respondents (2.96, $p < .05$). We found gender-related differences in few reasons for PGS avoidance – 'missing infrastructure', 'feeling of not belonging', and

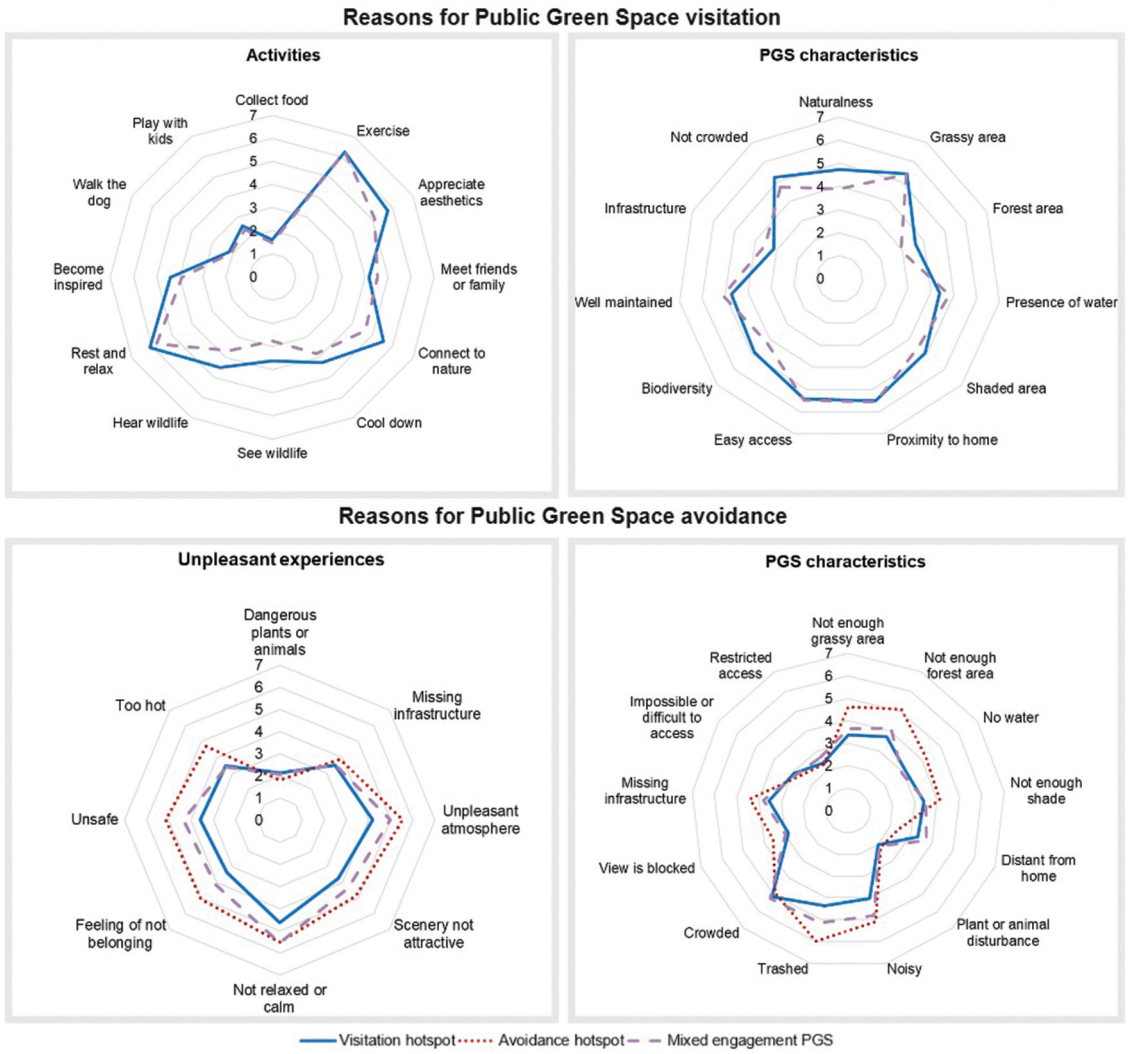

Figure 5. Mean values (1=very low importance to 7=very high importance) of reasons for public green space visitation (visitation hotspot, $n = 476$; mixed engagement PGS, $n = 392$) and reasons for public green space avoidance (visitation hotspot, $n = 40$; avoidance hotspot, $n = 24$; mixed engagement PGS, $n = 193$) according to public green space profiles.

'restricted use' – with mean scores overall higher among male respondents ($p < .05$) (Table 3).

We did not find significant differences across nationality groups for reasons for PGS visitation except for the amount of forest area, which scored higher mean values across non-German respondents ($p < .05$) (Table 4). Non-German respondents also assigned significantly higher importance to feeling unsafe ($p > .01$) and the distance from home ($p < .05$) as reasons for PGS avoidance, while the unpleasant atmosphere is on average a stronger reason for PGS avoidance across German respondents ($p < .05$). Regarding respondents' educational background, we found a significant difference ($p < .05$) in higher mean scores of respondents with a lower educational background for the item 'walk the dog' as a reason for PGS visitation. All other measured items' mean scores did not show statistically significant variations across levels of educational background.

Results of the Kruskal–Wallis H test showed that mean scores of several reasons for PGS visitation exhibited statistically significant variations across age groups (Table 4). Most reasons for PGS visitation scored different mean values predominantly between age groups 18–24, 25–34 and 55–64. A few items showed variance across all age groups, i.e. 'cool down', 'play with kids', 'proximity to my home', with significant ascending mean scores from younger to older age groups. Other items showed more specific variations in the distribution of mean scores across age groups. We find that exercising as reason for PGS visitation is rated significantly higher by mid- to older age groups (35 to 74 years old) than the youngest category (18–24 years old) ($p < .05$). Meeting friends and family has a higher importance for visiting a PGS for respondents between 18 and 34 years old and 75+ than those in category 55–64 ($p < .05$). In terms of reasons for PGS avoidance, we find that older respondents between 55 and 74 years old rated the importance of 'crowded' ($p < .01$) and lack of accessibility ($p < .05$) on average higher than younger adults.

Table 3. Results of the Mann-Whitney test for comparison of the distribution of reasons for PGS visitation and avoidance across gender, nationality and education classes. The table displays only the test results for the items showing statistically significant variations in the distribution of mean values.

		Gender			Nationality			Education		
	n	Male	Female	p	German	Other	p	Up to lower secondary	Higher secondary	p
PGS Visitation										
Appreciate aesthetics	556	5.16	**5.49**	.003	-	-	-	-	-	-
Meet friends or family	516	3.90	**4.31**	.016	-	-	-	-	-	-
Rest and relax	554	5.77	**6.00**	.030	-	-	-	-	-	-
Naturalness	476	4.25	**4.70**	.012	-	-	-	-	-	-
Proximity	492	5.62	**5.98**	.025	-	-	-	-	-	-
Access	496	5.08	**5.61**	.001	-	-	-	-	-	-
Infrastructure	471	**3.36**	2.96	.014	-	-	-	-	-	-
Forest area	471	-	-	-	4.71	**5.52**	.045	-	-	-
Walk the dog	447	-	-	-	-	-	-	**2.59**	2.06	.019
PGS avoidance										
Missing infrastructure	258	**4.15**	3.42	.012	-	-	-	-	-	-
Sense of not belonging	263	**4.56**	4.04	.046	-	-	-	-	-	-
Restricted use	216	**3.19**	2.53	.007	-	-	-	-	-	-
Danger	263	-	-	-	2.01	**3.87**	.001	-	-	-
Unpleasant atmosphere	277	-	-	-	**5.12**	4.18	.043	-	-	-
Distance	227	-	-	-	3.30	**4.85**	.013	-	-	-

Table 4. Results of the Kruskal–Wallis H test for comparison of the distribution of reasons for PGS visitation and avoidance across age groups.

		Age groups						
	n	18–24	25–34	35–44	45–54	55–64	65–74	75+
PGS visitation								
Collect food	494	1.27_{a}*	1.52	1.65	1.90	1.84_{a}*	1.95	1.91
Exercise	578	$5.94_{a,b,c,d}$*	6.17	6.48_{a}*	6.51_{b}*	6.56_{c}**	6.35_{d}*	6.75
Meet friends and family	519	4.47_{a}*	4.55_{b}*	4.36	3.72	$3.40_{a,b,c}$*	3.45	5.36_{c}*
Connect with nature	551	$4.48_{a,b}$*,$_{c}$**	$4.62_{d,f}$*,$_{e}$**	$4.76_{g,h}$*	5.27	$5.67_{c,e}$**,$_{g}$*	$5.54_{a,d}$*	$6.31_{b,f,h}$*
Cool down	517	$2.92_{a,c,e}$**,$_{b,d}$*	3.60_{f}*	4.10_{a}**	4.08_{b}*	4.54_{c}**,$_{f}$*	4.30_{d}*	5.00_{e}**
See wildlife	509	2.51_{a}*,$_{b}$**	2.78_{c}*	3.25	3.65_{a}*	3.66_{b}**,$_{c}$*	3.44	3.38
Hear wildlife	526	$3.47_{a,b}$**,$_{c}$*	$3.45_{d,e}$**,$_{f}$*	4.03	$4.68_{a,d}$**	$4.91_{b,e}$**	$4.72_{c,f}$*	4.47
Become inspired	525	3.40_{a}**	3.87	4.19	4.24	4.41_{a}**	4.12	4.56
Walk the dog	467	1.93	1.76_{a}**	2.17	2.87	3.02_{a}**	2.56	1.92
Play with the kids	472	$1.22_{a,b,c,d,e}$**	2.03_{f}**,$_{g}$*	$3.86_{a,f}$**	2.83_{b}**	2.63_{c}**	2.96_{d}**	4.33_{e}**,$_{g}$*
Naturalness	480	4.46_{a}*	$4.15_{b,c}$*	4.36_{d}*	4.55	5.03_{b}*	4.46	$6.00_{a,c,d}$*
Shaded area	476	4.33_{a}**	4.50_{b}**	4.83	4.69	$5.36_{a,b}$**	4.66	5.56
Proximity to my home	495	5.33_{a}*,$_{b}$**	5.91_{f}*	5.80_{c}**	5.86_{d}*	6.17_{a}*	5.86_{e}*	$6.94_{b,c}$**,$_{d,e,f}$*
Easy to access	499	5.15_{a}**	5.41_{b}**	5.26_{c}**	5.49_{d}*	5.62	5.38_{e}*	$6.50_{a,b,c}$**,$_{d,e}$*
Biodiversity	479	4.17_{a}**	4.35_{b}**	4.36_{c}*	5.02	$5.34_{a,b}$**,c*	4.74	4.69
Human-made infrastructure	476	2.77	2.96_{a}**	3.24	3.10_{b}*	3.06_{c}*	4.25_{a}**,$_{b,c}$*	2.77
PGS avoidance								
Crowded	228	$3.70_{a,b}$**	4.90	4.87	4.52	5.77_{a}**	6.10_{b}**	7.00
Impossible or difficult to access	213	2.55	2.59	2.03_{a}*	2.67	3.58_{a}*	3.29	1.00

The table displays only the variables which showed significant H test results. Matching subscript letters denote pairs of age group classes with statistically significant differences of mean scores as found by the pairwise comparison performed during post hoc analysis. Significant levels are shown as follows: *$p < .05$, **$p < .01$.

The length of respondents' residency in the study area also significantly influenced the importance assigned to certain reasons for PGS visitation, i.e. 'exercise', 'appreciate aesthetics', 'cool down', 'see wildlife', 'hear wildlife', 'walk the dog' and 'play with kids'. Overall, mean scores of the mentioned items increased with growing length of residency in Bochum. Across these groups we also find a statistically significant higher mean score for the importance of a crowded PGS as reason for PGS avoidance. All other measured variables did not show any statistically significant variances (Appendix 2, Table S2).

Across income classes we only find three items showing statistically significant differences in mean score distribution: 'cool down' and 'play with kids' as reasons for PGS visitation and 'crowed' as reason for PGS avoidance. Particularly, respondents with a monthly net income lower than 1300€ assigned lower scores to visiting a PGS to play with kids than respondents in higher income classes (above 3200€ monthly net income). As far

as the importance of 'crowded' as reason for PGS avoidance, our results show multiple differences across most of the income classes provided (Appendix 2, Table S3).

4. Discussion

Our findings provide spatial information about PGS visitation and avoidance as well as characteristics of their determinants in relation to users' preferences, activities and sociodemographic profile. This evidence can be used by local plan and decision makers to address existing impairments in avoidance hotspots, maintain positive elements of visitation hotspots and consider trade-offs in mixed engagement PGS. Specific information on reasons for PGS visitation and avoidance and their variance across sociodemographic groups can support practitioners in designing inclusive PGS, where citizens' views and demands are reflected.

4.1. Spatial interplay of PGS visitation and avoidance

Overall, the mapping activity conducted in our study revealed a notable inclination towards expressing PGS visitation over PGS avoidance. Only 41% of respondents indicated avoidance of specific PGS, while a majority (67%) marked up to two visited PGS. Similar discrepancies have been shown by studies focusing on ES and ED (Larson et al. 2019; Pinto et al. 2021; Baumeister et al. 2022). The ease of recognizing visited, or rather favourite, PGS likely stems from psychological factors contributing to clearer memories of positive experiences within pleasant places, also known as positivity bias (Walker et al. 2003). People tend to be satisfied when they visit PGS that are easily accessible and align with their preferences. A lack of negatively-perceived green spaces also likely stems simply from these being infrequently visited (or avoided) and thus less cognitively 'available' for recall when responding to the survey.

Nonetheless, distinct spatial patterns of visitation and avoidance emerged from our spatial analysis. PGS visitation hotspots predominantly cluster near one another and are larger PGS (e.g. Weitmarer Holz and areas along the Ruhr River). Possible explanations include larger PGS being more well-known and accessible but also their relative overall ES provision, supported in part by their proximity to other PGS that creates a network of green spaces. Conversely, PGS avoidance hotspots are small to medium-sized PGS with isolated locations within the urban fabric. In this context, size and connectivity emerge as critical factors that influence green space use, as they likely contribute to both the physical accessibility and the experiential quality of the PGS. Visitors' perceptions of PGS may also vary depending on the density of their surrounding built-up area (Kyttä et al. 2013; Kothencz and Blaschke 2017; Fagerholm et al. 2022) and possibly their proximity with respect to respondents' home locations (Ives et al. 2017; Schindler et al. 2022). Overall, our findings underscore the role of creating a network of accessible and high-quality PGS, aligning with residents' 'favourite' places to visit. Of course, small-scale elements such as pocket parks or green wedges should also be prioritized, as their role in providing ES fundamental to city dwellers' well-being is crucial on an everyday basis (Fagerholm et al. 2022).

4.2. Average importance of reasons for PGS visitation and avoidance

As for the specific reasons for PGS visitation, we found proximity to place of residence together with exercising, resting and relaxing, and appreciating natural beauty as most important. These results align well with Bijker and Sijtsma (2017), who found that physical activity, relaxing, and nature watching were the most common activities in neighbourhood PGS for respondents in three different European countries. Similarly, Hermes et al. (2021) found accessibility and exercising as important reasons for nature-based recreation in nearby green areas in Germany. As most important negative PGS characteristics, respondents rated too crowded, trashed, or noisy, which are commonly associated with generally negative experiences as per findings from other surveys (e.g. Rall et al. 2017). Analysis of push-pull factors conducted by Phillips et al. (2022) also revealed that naturalness contributes to positive experiences in urban green areas, while noisiness, busyness, and lack of cleanliness or of facilities can cause negative experiences. Yet the same study also identified how certain factors show duality in their perception, i.e. are positive for certain individuals and negative for others (Phillips et al. 2022), which reflects the use pattern represented by mixed engagement PGS in our study. As PGS serve as focal points for many individuals with diverse interests, this can lead to potential conflicts among users, which can result in negative experiences in natural settings (Raymond et al. 2016; Palliwoda and Priess 2021). Aligning with findings from Andersson et al. (2021), PGS visitation in our study relates not only to spatial-physical reasons, but also to societal factors. Our research thus highlights the challenges urban decision-makers and planners encounter in balancing the diversity of user groups, activities, interests, and just ES provision. However, it also shows that monitoring the provision of both ES and ED serves as an

effective approach to spatially target PGS where ED management and mitigation is needed (Campagne et al. 2018), in order to maximize ES and ultimately enhance PGS visitation.

4.3. PGS profiling

Reasons for visitation and avoidance of PGS profiles (visitation hotspots, avoidance hotspots, mixed engagement PGS) mirrored their overall average scores in the study area. This suggests a certain level of homogeneity in preferences or perceptions regarding PGS among the respondents, regardless of the specific characteristics of the different PGS. Madureira et al. (2018) also found homogeneous preferences for urban green space characteristics across Portuguese cities. Homogeneity of reasons for PGS visitation highlights the need to have PGS that are distributed and easily accessible across the whole city. While certain studies (e.g. Pinto et al. 2021) emphasize that multifunctionality enhances the use of PGS, Hansen and Pauleit (2023) underscore that it cannot compensate for a lack of urban green and blue infrastructure overall. The lack of variance across PGS profiles also suggests that certain factors, such as urban design features, accessibility, or overall neighbourhood characteristics, have a more dominant influence on PGS visitation and avoidance compared to the specific attributes of individual PGS. We observe how distance from home and lack of accessibility stand out as reasons for avoiding visitation hotspots and mixed engagement PGS. This underlines the role of just and equitable distribution of urban green areas across neighbourhoods (Kabisch and Haase 2014; Sousa Silva et al. 2018; Luca et al. 2021) and reinforces our recommendations for planning an accessible and quality network of PGS where ES provision is enhanced. For instance, planners could leverage similarities among PGS profiles and use strong reasons for PGS visitation to guide improvements in avoidance hotspots. A closer analysis of specific PGS elements (e.g. tree species, water elements) could also offer planners deeper insights for the optimization of PGS (Phillips et al. 2022). We highlight the importance of providing an overall fair distribution of PGS, given the role of proximity and distance from respondents' homes as determining PGS visitation and PGS avoidance respectively, along with tackling institutional barriers that may hinder access and cause conflicts between user groups.

For the city of Bochum, we therefore recommend prioritizing investments into the safeguarding and enhancement of PGS quality or urban forests such as Weitmarer Holz or Kalwes, that are among PGS visitation hotspots. We also recommend the consideration of reasons for avoidance – too crowded, trashed, noisy PGS – which concern citizens at both avoidance hotspots, e.g. Friedenspark or Apollonia-Pfaus park, and mixed engagement PGS.

4.4. Influence of sociodemographic characteristics on reasons for visitation and avoidance

We found that reasons for visiting PGS varied significantly more than reasons for avoidance based on sociodemographic factors. Specifically, gender differences were notable, with female respondents placing greater importance than males on factors such as appreciating aesthetics, socializing, naturalness, and ease of access. In a representative study in Denmark, Schipperijn et al. (2010) found similar gender-related differences in the importance attributed to reasons for visiting urban green space such as stress reduction, relaxation, enjoying the weather, and fresh air. Older respondents tended to prioritize activities like cooling down and exercising in PGS, as well as valuing social interactions and accessibility more than younger respondents. Significantly higher mean scores were also given to reasons for PGS visitation by residents who have lived longer in the study area. Longer and more frequent exposure to certain PGS might improve knowledge and awareness and thus the understanding and experience with certain benefits. In a PPGIS study from Gottwald et al. (2022) respondents with more environmental local knowledge could attribute more place meanings to mapped places. Conversely to other studies (e.g. Riechers et al. 2018; Larson et al. 2019; Pinto et al. 2021), differences in monthly net income and respondents' education level did not play a significant role in the decision to visit or avoid a PGS in our study area.

4.5. Limitations of the study and future research

Despite the advantages of using random sampling methods to collect spatial data through PPGIS (Brown and Kyttä 2014; Kyttä et al. 2023), we decided to use a non-random sampling strategy due to time and resource constraints. Therefore, we cannot make extrapolative statements about the population of Bochum as a whole, and our findings should thus be seen as only suggesting potentially broader trends. Moreover, we only conducted limited targeted outreach with one socio-demographic group (the elderly living at senior homes), potentially representing the digital divide. This effort proved to be highly time-intensive and was therefore discontinued after $n = 40$ additional responses. This underscores the challenges of adequate representation of different societal groups, which often require tailored strategies and activities for participation. Additionally, if the sample predominantly consists of individuals with similar

preferences or backgrounds, it may not reflect the full spectrum of reasons that could vary across PGS profiles.

Another limitation is the length and complexity of the PPGIS survey, which included multiple sections and many items (23 reasons for PGS visitation, 21 reasons for PGS avoidance). This may also explain the lower response rate for PGS avoidance, as it followed the PGS visitation mapping activity in the questionnaire. Although we recognize the similarities among some items, exploratory factor analysis did not create meaningful factor loadings and thus did not allow us to cluster responses for analysis and communication. Further methodological factors such as survey design, question wording, or data analysis techniques could have influenced the variance observed across the sample. For example, our question framing of 'favourite' and 'least favourite' PGS led respondents to focus on PGS at the extremes of the like-dislike spectrum, potentially overlooking regularly visited PGS where ES and ED perception might be more nuanced. An inherent limitation is thus our understanding of 'everyday' PGS with average preference scores and the highlighting of 'mixed engagement' PGS as those with more polarized perceptions. Additionally, capturing the diversity of reasons of visitation and avoidance using pre-defined items is challenging, especially given the diversity of ES and ED and corresponding residents' perceptions and values. Particularly for mixed engagement PGS, more specific and subjective motives for responses could help further explain variation.

Further exploration of ES and ED dynamics and their role in shaping urban dwellers' motivation for visiting PGS has the potential to create strong evidence for targeted just and inclusive decision making and planning. Further studies could delve deeper into the specific attributes and characteristics of specific PGS, shedding light on the factors that contribute to their dual roles in serving as hubs for both visitation and avoidance behaviours. Hereby a promising approach could be a study design with a focus on few PGS and the specific likes and dislikes of the same individual within the same PGS. Particularly, it would be insightful to investigate those factors leading to switches in ES or ED perception, as in Rasmussen et al. (2017), as well as expanding the empirical research on accessibility issues leading to ES or ED, by including frameworks considering multidimensional barriers (Wolff et al. 2022).

5. Conclusion

This study offered a comprehensive investigation of PGS use patterns in terms of both visitation and avoidance as a result of perceived ES or ED. A key finding of this study is that, regardless of the specific profiling of a PGS (i.e. visitation hotspots, avoidance hotspots, or mixed engagement) and individual preferences or sociodemographic factors, the strongest reasons for visitation and avoidance remain consistent. This consistency can serve as a valuable guide for planners and decision-makers at different levels by highlighting the importance of more universal factors such as availability, accessibility, and connectivity in the design and management of PGS.

For practical implementation, decision-makers, city authorities and private developers can integrate these findings into planning frameworks by focusing on improving the physical and social accessibility of PGS, ensuring that spaces are connected throughout neighbourhoods, and addressing common deterrents such as safety concerns or maintenance issues. Beyond universal improvements, planners should also consider specific user groups, particularly in communities with diverse needs, to design tailored solutions that reflect the multifunctional nature of PGS. For example, targeted strategies like offering a variety of amenities, removing barriers to access, or enhancing ecological functions can maximize ES provision and reduce avoidance. Furthermore, these insights can inform cross-sectoral collaboration, extending beyond city authorities to involve health organizations, community groups, and urban developers in creating PGS that serve broader societal goals, such as improving public health, enhancing biodiversity, and fostering social cohesion.

Acknowledgement

We thank Dr. Sarah Gottwald for the support and feedback on the survey design and methodology; the city of Bochum for providing detailed GIS data on municipal land use; Ruhr University Bochum for the support in survey outreach and dissemination; and all the survey participants.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Claudia Romelli http://orcid.org/0000-0002-1174-3200
Carl C. Anderson http://orcid.org/0000-0002-5344-9800
Nora Fagerholm http://orcid.org/0000-0001-5020-0746
Rieke Hansen http://orcid.org/0000-0002-4230-1579
Christian Albert http://orcid.org/0000-0002-2591-4779

References

Acuto M, Parnell S, Seto KC. 2018. Building a global urban science. Nat Sustain. 1(1):2–4. doi: 10.1038/s41893-017-0013-9.

Anderson CC, Renaud FG, Hanscomb S, Munro KE, Gonzalez-Ollauri A, Thomson CS, Pouta E, Soini K, Loupis M, Panga D, et al. 2021. Corrigendum: public acceptance of nature-based solutions for natural hazard risk reduction: survey findings from three study sites in Europe. Public Acceptance Of Nat-Based Sol For Nat Hazard Risk Reduct: Survey Findings From Three Study Sites In Eur Front Environ Sci. 9:9. doi: 10.3389/fenvs.2021.678938.

Andersson E, Borgström S, Haase D, Langemeyer J, Mascarenhas A, McPhearson T, Wolff M, Łaszkiewicz E, Kronenberg J, Barton DN, et al. 2021. A context-sensitive systems approach for understanding and enabling ecosystem service realization in cities. Ecol Soc. 26(2):35. doi: 10.5751/ES-12411-260235.

Andersson E, Langemeyer J, Borgström S, McPhearson T, Haase D, Kronenberg J, Barton DN, Davis M, Naumann S, Röschel L, et al. 2019. Enabling green and blue infrastructure to improve contributions to human well-being and equity in Urban Systems. Bioscience. 69 (7):566–574. doi: 10.1093/biosci/biz058.

ATKIS - Digital Basic Landscape Model. 2023. Data Set]. http://data.europa.eu/88u/dataset/d2eaa212-f68d-4e2d-a7e7-8e8063d1b855.

Baumeister CF, Gerstenberg T, Plieninger T, Schraml U. 2020. Exploring cultural ecosystem service hotspots: linking multiple urban forest features with public participation mapping data. Urban Forestry & Urban Greening. 48:126561. doi: 10.1016/j.ufug.2019.126561.

Baumeister CF, Gerstenberg T, Plieninger T, Schraml U. 2022. Geography of disservices in urban forests: public participation mapping for closing the loop. Ecosystems People. 18(1):44–63. doi: 10.1080/26395916.2021.2021289.

Beery T, Stahl Olafsson A, Gentin S, Maurer M, Stålhammar S, Albert C, Bieling C, Buijs A, Fagerholm N, Garcia-Martin M, et al. 2023. Disconnection from nature: expanding our understanding of human–nature relations. People Nat. 5 (2):470–488. doi: 10.1002/pan3.10451.

Bertram C, Rehdanz K. 2015. Preferences for cultural urban ecosystem services: comparing attitudes, perception, and use. Ecosystem Serv. 12:187–199. doi: 10.1016/j.ecoser.2014.12.011.

Bijker RA, Sijtsma FJ. 2017. A portfolio of natural places: using a participatory GIS tool to compare the appreciation and use of green spaces inside and outside urban areas by urban residents. Landscape Urban Plann. 158:155–165. doi: 10.1016/j.landurbplan.2016.10.004.

Blanco J, Dendoncker N, Barnaud C, Sirami C. 2019. Ecosystem disservices matter: towards their systematic integration within ecosystem service research and policy. Ecosystem Serv. 36:100913. doi: 10.1016/j.ecoser.2019.100913.

Brown G, Kyttä M. 2014. Key issues and research priorities for public participation GIS (PPGIS): a synthesis based on empirical research. Appl Geogr. 46:122–136. doi: 10.1016/j.apgeog.2013.11.004.

Brown G, Reed P, Raymond CM. 2020. Mapping place values: 10 lessons from two decades of public participation GIS empirical research. Appl Geogr. 116:102156. doi: 10.1016/j.apgeog.2020.102156.

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

Campagne CS, Roche PK, Salles J. 2018. Looking into Pandora's box: ecosystem disservices assessment and correlations with ecosystem services. Ecosystem Serv. 30:126–136. doi: 10.1016/j.ecoser.2018.02.005.

Christoforidi I, Kollaros D, Papadakaki M, Psaroudaki A, Antoniou T, Daliakopoulos IN. 2022. A novel index for assessing perceived availability and public demand for urban green space: application in a Mediterranean island. Urban Forestry & Urban Greening. 69:127498. doi: 10.1016/j.ufug.2022.127498.

Clarke M, Cadaval S, Wallace C, Anderson E, Egerer M, Dinkins L, Platero R. 2023. Factors that enhance or hinder social cohesion in urban greenspaces: a literature review. Urban Forestry & Urban Greening. 84:127936. doi: 10.1016/j.ufug.2023.127936.

Coolen H, Meesters J. 2012. Private and public green spaces: meaningful but different settings. J Hous The Built Environ. 27(1):49–67. doi: 10.1007/s10901-011-9246-5.

Drew-Smythe JJ, Davila YC, McLean CM, Hingee MC, Murray ML, Webb JK, Krix DW, Murray BR. 2023. Community perceptions of ecosystem services and disservices linked to urban tree plantings. Urban Forestry & Urban Greening. 82:127870. doi: 10.1016/j.ufug.2023.127870.

Dunn OJ. 1964. Multiple comparisons using rank sums. Technometrics. 6(3):241–252. doi: 10.1080/00401706.1964.10490181.

Elmqvist T, Andersson E, Frantzeskaki N, McPhearson T, Olsson P, Gaffney O, Takeuchi K, Folke C. 2019. Sustainability and resilience for transformation in the urban century. Nat Sustain. 2(4):267–273. doi: 10.1038/s41893-019-0250-1.

European Environment Agency. 2020. Jul *2021*.Urban atlas land Cover/land use 2018 (vector. Europe. 6–yearly. doi: 10.2909/fb4dffa1-6ceb-4cc0-8372-1ed354c285e6.

Fagerholm N, Raymond CM, Olafsson AS, Brown G, Rinne T, Hasanzadeh K, Broberg A, Kyttä M. 2021. A methodological framework for analysis of participatory mapping data in research, planning, and management. Int J Geographical Inf Sci. 35 (9):1848–1875. doi: 10.1080/13658816.2020.1869747.

Fagerholm N, Samuelsson K, Eilola S, Giusti M, Hasanzadeh K, Kajosaari A, Koch D, Korpilo S, Kyttä M, Legeby A, et al. 2022. Analysis of pandemic outdoor recreation and green infrastructure in Nordic cities to enhance urban resilience. Npj Urban Sustainability. 2(25). doi: 10.1038/s42949-022-00068-8.

Farkas JZ, Hoyk E, Morais MBD, Csomós G. 2023. A systematic review of urban green space research over the last 30 years: a bibliometric analysis. Heliyon. 9(2): e13406. doi: 10.1016/j.heliyon.2023.e13406.

Fischer A, Eastwood A. 2016. Coproduction of ecosystem services as human–nature interactions—an analytical framework. Land Use Policy. 52:41–50. doi: 10.1016/j.landusepol.2015.12.004.

Fischer LK, Honold J, Botzat A, Brinkmeyer D, Cvejić R, Delshammar T, Elands B, Haase D, Kabisch N, Karle SJ, et al. 2018. Recreational ecosystem services in European cities: sociocultural and geographical contexts matter for park use. Ecosystem Serv. 31:455–467. doi: 10.1016/j.ecoser.2018.01.015.

Garcia-Martin M, Fagerholm N, Bieling C, Gounaridis D, Kizos T, Printsmann A, Müller M, Lieskovský J, Plieninger T. 2017. Participatory mapping of landscape values in a pan-European perspective. Landscape Ecol. 32(11):2133–2150. doi: 10.1007/s10980-017-0531-x.

Gómez-Baggethun E, Gren Å, Barton D. [N David N], Langemeyer, J M, T O, Andersson P, Hamstead Z E, & Kremer P. In Elmqvist T, Fragkias M, Goodness J, Güneralp B, P J. Marcotullio R. McDonald I, Parnell S, Schewenius M, Sendstad M, Seto KC. 2013. Urban ecosystem services. In: Wilkinson C, editor. Urbanization, biodiversity and ecosystem services: challenges and opportunities. Dordrecht: Springer Netherlands; p. 175–251. 10.1007/978-94-007-7088-1_11.

Gottwald S, Albert C, Fagerholm N. 2022. Combining sense of place theory with the ecosystem services concept: empirical insights and reflections from a participatory mapping study. Landscape Ecol. 37 (2):633–655. doi: 10.1007/s10980-021-01362-z.

Haase D, Kabisch S, Haase A, Andersson E, Banzhaf E, Baró F, Brenck M, Fischer LK, Frantzeskaki N, Kabisch N, et al. 2017. Greening cities – to be socially inclusive? About the alleged paradox of society and ecology in cities. Habitat Int. 64:41–48. doi: 10.1016/j.habitatint.2017.04.005.

Hansen R, Pauleit S. 2023. Planning multifunctional urban green infrastructure for compact cities in Europe. In: Breuste J, Artmann M, Ioja C Qureshi S, editors. Making green cities. Cities and nature. Cham: Springer. doi: 10.1007/978-3-030-73089-5_31.

Hermes J, Haaren CV, Schmücker D, Albert C. 2021. Nature-based recreation in Germany: insights into volume and economic significance. Ecol Econ. 188:107136. doi: 10.1016/j.ecolecon.2021.107136.

Hetzel I. 2013. Physische Geographie von Bochum und Herne. Veröffentlichungen Des Bochumer Botanischen Vereins. 5(2):7–32.

Honold J, Lakes T, Beyer R, van der Meer E. 2016. Restoration in urban spaces. Environ And Behav. 48 (6):796–825. doi: 10.1177/0013916514568556.

Ives CD, Oke C, Hehir A, Gordon A, Wang Y, Bekessy SA. 2017. Capturing residents' values for urban green space: mapping, analysis and guidance for practice. Landscape And Urban Plann. 161:32–43. doi: 10.1016/j.landurbplan.2016.12.010.

Jacobs S, Dendoncker N, Martín-López B, Barton DN, Gomez-Baggethun E, Boeraeve F, McGrath FL, Vierikko K, Geneletti D, Sevecke KJ, et al. 2016. A new valuation school: integrating diverse values of nature in resource and land use decisions. In: van Reeth, W., van Zanten, B. T., Wam, H. K. Washbourne. Ecosystem services Vol. 22, 213–220. C.-L. 10.1016/j.ecoser.2016.11.007.

Kabisch N, Haase D. 2014. Green justice or just green? Provision of urban green spaces in Berlin, Germany. Landscape Urban Plann. 122:129–139. doi: 10.1016/j.landurbplan.2013.11.016.

Kahila-Tani M, Kyttä M, Geertman S. 2019. Does mapping improve public participation? Exploring the pros and cons of using public participation GIS in urban planning practices. Landscape Urban Plann. 186:45–55. doi: 10.1016/j.landurbplan.2019.02.019.

Keil P, Hering D, Schmitt T, & Zepp H, editors 2021. Positionen einer regionalen Biodiversitätsstrategie Ruhrgebiet: Offensive Grüne Infrastruktur 2030. Essen: Regionalverband Ruhr. https://nbn-resolving.org/urn:nbn:de:101:1-20211123124533938078 56.

Kondo MC, Fluehr JM, McKeon T, Branas CC. 2018. Urban green space and its impact on human health. Int J Environ Res Public Health. 15(3):445. doi: 10.3390/ijerph15030445.

Korpela KM, Ylén M. 2007. Perceived health is associated with visiting natural favourite places in the vicinity. Health & Place. 13(1):138–151. doi: 10.1016/j.healthplace.2005.11.002.

Kothencz G, Blaschke T. 2017. Urban parks: visitors' perceptions versus spatial indicators. Land Use Policy. 64:233–244. doi: 10.1016/j.landusepol.2017.02.012.

Kowarik I, Bartz R, Brenck M, Hansjürgens B. 2017. Ecosystem services in the city: protecting health and enhancing quality of life: summary for decision-makers. Berlin, Leipzig: Naturkapital Deutschland - TEEB DE.

Kyttä M, Broberg A, Tzoulas T, Snabb K. 2013. Towards contextually sensitive urban densification: location-based softGIS knowledge revealing perceived residential environmental quality. Landscape and Urban Plann. 113:30–46. doi: 10.1016/j.landurbplan.2013.01.008.

Kyttä M, Fagerholm N, Hausner VH, Broberg A. 2023. Maptionnaire. In: C. M. Burnett, editor. Evaluating participatory mapping software. 1st ed. Cham: Springer International Publishing; Imprint Springer; p. 71–91. 10.1007/978-3-031-19594-5_4.

Larson KL, Corley EA, Andrade R, Hall SJ, York AM, Meerow S, Coseo P, Childers DL, Hondula DM. 2019. Subjective evaluations of ecosystem services and disservices: an approach to creating and analyzing robust survey scales. Ecol Soc. 24(2). doi: 10.5751/ES-10888-240207.

Lliso B, Lenzi D, Muraca B, Chan KMA, Pascual U. 2022. Nature's disvalues: what are they and why do they matter? Curr Opin In Environ Sustainability. 56:101173. doi: 10.1016/j.cosust.2022.101173.

Luca CD, Libetta A, Conticelli E, Tondelli S. 2021. Accessibility to and availability of urban green spaces (UGS) to support health and wellbeing during the COVID-19 pandemic—the case of Bologna. Sustainability. 13(19):11054. doi: 10.3390/su131911054.

Lyytimäki J, Sipilä M. 2009. Hopping on one leg – the challenge of ecosystem disservices for urban green management. Urban Forestry & Urban Greening. 8 (4):309–315. doi: 10.1016/j.ufug.2009.09.003.

Madureira H, Nunes F, Oliveira J, Madureira T. 2018. Preferences for urban green space characteristics: a comparative study in three Portuguese cities. Environments. 5(2):23. doi: 10.3390/environments5020023.

Oh RYR, Fielding KS, Le Nghiem TP, Chang C-C, Shanahan DF, Gaston KJ, Carrasco RL, Fuller RA, Geneletti D. 2021. Factors influencing nature interactions vary between cities and types of nature interactions. People Nat. 3(2):405–417. doi: 10.1002/pan3.10181.

OpenStreetMap contributors. 2015. Planet dump. https://planet.openstreetmap.org/.

Palliwoda J, Haase A, Suppee C, Rink D, Priess JA. 2022. Visions for development and management of urban green and blue infrastructure: a citizen's perspective. Ecol And Soc. 27(2). doi: 10.5751/ES-13129-270208.

Palliwoda J, Priess JA. 2021. What do people value in urban green? Linking characteristics of urban green spaces to users' perceptions of nature benefits, disturbances, and disservices. Ecol Soc. 26(1). doi: 10.5751/ES-12204-260128.

Pascual U, Adams WM, Díaz S, Lele S, Mace GM, Turnhout E. 2021. Biodiversity and the challenge of

pluralism. Nat Sustain. 4(7):567–572. doi: 10.1038/s41893-021-00694-7.

Pauleit S, Ambrose-Oji B, Andersson E, Anton B, Buijs A, Haase D, Elands B, Hansen R, Kowarik I, Kronenberg J, et al. 2019. Advancing urban green infrastructure in Europe: outcomes and reflections from the GREEN SURGE project. Urban Forestry & Urban Greening. 40:4–16. doi: 10.1016/j.ufug.2018.10.006.

Peters K, Elands B, Buijs A. 2010. Social interactions in urban parks: stimulating social cohesion? Urban Forestry & Urban Greening. 9(2):93–100. doi: 10.1016/j.ufug.2009.11.003.

Phillips A, Canters F, Khan AZ. 2022. Analyzing spatial inequalities in use and experience of urban green spaces. Urban Forestry & Urban Greening. 74:127674. doi: 10.1016/j.ufug.2022.127674.

Pinto L, Ferreira CSS, Pereira P. 2021. Environmental and socioeconomic factors influencing the use of urban green spaces in Coimbra (Portugal). Sci Total Environ. 792:148293. doi: 10.1016/j.scitotenv.2021.148293.

Rall E, Bieling C, Zytynska S, Haase D. 2017. Exploring city-wide patterns of cultural ecosystem service perceptions and use. Ecol Indic. 77:80–95. doi: 10.1016/j.ecolind.2017.02.001.

Rasmussen LV, Christensen AE, Danielsen F, Dawson N, Martin A, Mertz O, Sikor T, Thongmanivong S, Xaydongvanh P. 2017. From food to pest: conversion factors determine switches between ecosystem services and disservices. Ambio. 46(2):173–183. doi: 10.1007/s13280-016-0813-6.

Raymond CM, Gottwald S, Kuoppa J, Kyttä M. 2016. Integrating multiple elements of environmental justice into urban blue space planning using public participation geographic information systems. Landscape And Urban Plann. 153:198–208. doi: 10.1016/j.landurbplan.2016.05.005.

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

Rodgman MK, Anguelovski I, Pérez-Del-Pulgar C, Shokry G, Garcia-Lamarca M, Connolly JJT, Baró F, Triguero-Mas M. 2024. Perceived urban ecosystem services and disservices in gentrifying neighborhoods: contrasting views between community members and state informants. Ecosystem Serv. 65:101571. doi: 10.1016/j.ecoser.2023.101571.

Röing S, Gottwald S, Hermes J, Schmidt S, Albert C. 2021. Spatially assessing unpleasant places with hard- and soft-gis methods: a river landscape application. Ecosystems And People. 17(1):358–369. doi: 10.1080/26395916.2021.1944912.

Samuelsson K, Barthel S, Giusti M, Hartig T. 2021. Visiting nearby natural settings supported wellbeing during Sweden's "soft-touch" pandemic restrictions. Landscape And Urban Plann. 214:104176. doi: 10.1016/j.landurbplan.2021.104176.

Schindler M, Le Texier M, Caruso G. 2022. How far do people travel to use urban green space? A comparison of three European cities. Appl Geogr. 141:102673. doi: 10.1016/j.apgeog.2022.102673.

Schipperijn J, Stigsdotter UK, Randrup TB, Troelsen J. 2010. Influences on the use of urban green space – a case study in Odense, Denmark. Urban Forestry & Urban Greening. 9(1):25–32. doi: 10.1016/j.ufug.2009.09.002.

Schmitt T, Gausmann P. 2020. Die "grüne" Natur. In: H. Zepp, T. Schmitt K.-H. Otto, editors. Siedlung und Landschaft in Westfalen Vol. 42 *Ökologische und klimatische Perspektiven auf die Stadtlandschaft Bochums* (pp. Münster: Aschendorff Verlag; p. 29–43).

Silverman BW. 1986. Density estimation for statistics and data analysis estimation density. London: Kluwer Academic Publishers.

Soga M, Gaston KJ. 2022. The dark side of nature experience: typology, dynamics and implications of negative sensory interactions with nature. People And Nat. 4(5):1126–1140. doi: 10.1002/pan3.10383.

Sousa Silva CD, Viegas I, Panagopoulos T, Bell S. 2018. Environmental justice in accessibility to green infrastructure in two European cities. Land. 7(4):134. doi: 10.3390/land7040134.

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. doi: 10.1016/j.ecolind.2014.12.027.

Walker WR, Skowronski JJ, Thompson CP. 2003. Life is pleasant—and memory helps to keep it that Way! Rev Gener Phychol. 7(2):203–210. doi: 10.1037/1089-2680.7.2.203.

Wolff M, Mascarenhas A, Haase A, Haase D, Andersson E, Borgström ST, Kronenberg J, Łaszkiewicz E, Biernacka M. 2022. Conceptualizing multidimensional barriers: a framework for assessing constraints in realizing recreational benefits of urban green spaces. Ecol And Soc. 27(2):17. doi: 10.5751/ES-13180-270217.

Zaman S, Korpilo S, Horcea-Milcu A-I, Raymond C. 2022. Associations between landscape values, self-reported knowledge, and land-use: a public participation GIS assessment. Ecosystems And People. 18(1):212–225. doi: 10.1080/26395916.2022.2052749.