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Environmental and socioeconomic factors influencing the use of urban green spaces in Coimbra (Portugal)

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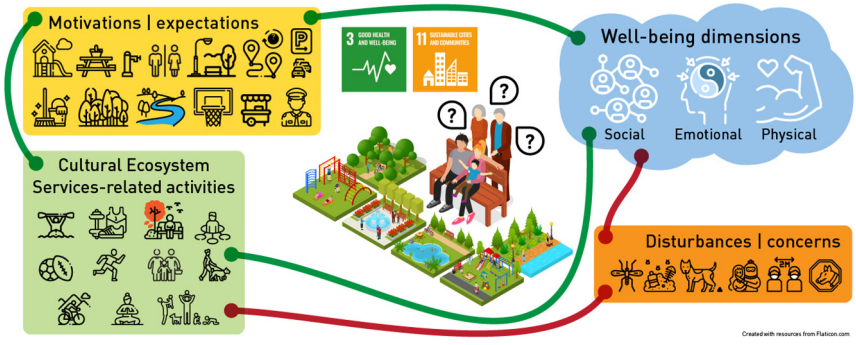
HIGHLIGHTS

- Accessibility to Urban Green Spaces (UGS) is a key aspect considered by users.
- The UGS multifunctionality influences the selection of spaces.
- Physical and emotional wellbeing are highly rated by users in all UGS.
- Tranquillity and landscape beauty are major motivations in UGS choice.
- Ecosystem disservices are not considered a threat in the parks studied.

GRAPHICAL ABSTRACT



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ABSTRACT

Urban green spaces (UGS) deliver a wide range of regulating, provisioning and cultural ecosystem services (CES), relevant to support the achievement of some United Nations Sustainable Development Goals (e.g., Goal 11: sustainable cities and communities, and Goal 3: good health and well-being). However, knowledge of preferences and uses of UGS by urban dwellers is still lacking. This study assesses the CES perceived by different users in five distinct urban parks located in Coimbra, Portugal: Manuel Braga (secular park), Botanical garden, Choupal national forest, Mondego green park (large area placed next to the river), and Vale das Flores (linear park located in a residential area). A questionnaire survey was performed in each park to investigate the activities performed and their relevance for the users, users' motivations to develop the activities on that specific UGS, the perceived benefits regarding physical and emotional well-being and social interactions, and users' perception about disservices. The results showed that walking, meeting people, practicing and doing activities with children are the activities performed by most users and are perceived as beneficial for physical and emotional well-being. Multifunctionality is a characteristic of all parks and highly appreciated by the users. Significant differences in socio-demographic characteristics of the users and motivations are recorded between parks. The tranquillity of space and landscape beauty are the main motivations to use Manuel Braga Park and the Botanical garden. Distance to the park and transportation means are particularly important for Botanical garden and Vale das Flores park users. Age group and average monthly income were associated in both Choupal national forest, Mondego green park and Vale das Flores park, denoting that older and wealthier users are more able to enjoy these parks. Users' problems or ecosystem disservices were not identified, although plagues (e.g., mosquitoes) and dangerous animals recorded average concerns in the Choupal national forest and in the Vale das Flores and

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Mondego green parks. This work's findings can help decision-makers better understand users' needs and expectations, thus improving UGS design and management to attract more citizens.

1. Introduction

Half of humanity lives in cities (3.5 billion people), and it is projected to rise to 5 billion people by 2030 (UN.DESA, 2019). Cities are facing urbanization pressure and climate change-related challenges such as increasing temperature extreme events, e.g., heatwaves and flooding (Klemm et al., 2016; Pereira et al., 2019). Urban green spaces (UGS), are defined as all urban land covered by vegetation (e.g., urban parks, street trees, residential lawns, roof gardens, and private gardens) (Breuste et al., 2013; WHO.ROE, 2017). Among several UGS types, urban parks are considered key components (Haase et al., 2014). Fagerholm et al. (2012) consider urban parks as the places to collect knowledge about the relationship between urban ecosystems and humans. UGS supply different provisioning, regulating and cultural ecosystem services (CES) (Özgüner, 2011; Zhang et al., 2013; Leitão et al., 2019). UGS can provide ways to enhance urban resilience to climate change, especially through regulating services (Buchel and Frantzeskaki, 2015; Kalantari et al., 2019) and places for recreation (Andersson et al., 2015; EC, 2020). UGS supply many CES appreciated by people (Schaich et al., 2010; Daniel et al., 2012) and considered fundamental for emotional and psychological well-being (Sacker and Cable, 2006; Keniger et al., 2013; Lin et al., 2014). These benefits reduce health costs (Thompson, 2002).

UGS are vital to the achievement of United Nations Sustainable Development Goals (SDGs) by 2030, namely SDG11 (Sustainable cities and communities), and mainly the target 11.7 aiming to "*provide universal access to safe, inclusive and accessible, green and public spaces, particularly for women and children, older persons and persons with disabilities*" (UN, 2015). Additionally, UGS are linked to SDG3 (Good health and well-being), namely, target 3.4, aiming to "*reduce by one-third pre-mature mortality from non-communicable diseases (NCDs) through prevention and treatment, and promote mental health and well-being*" (UN, 2015). The European Commission (EC) also recognizes that "*we need nature in our lives*" in its Biodiversity Strategy for 2030 (EC, 2020).

UGS visitors often use more than one ES during a visit as they can engage in similar activities, both of different or similar nature, with many activities and uses of ES being interrelated (Plieninger et al., 2013). Assessing and measuring CES can thus be a complex task (Chan et al., 2012), particularly in urban environments (Gómez-Baggethun and Barton, 2012). Nature, however, can also have adverse effects for humans, such as diseases, allergens, or poisonous plants and animals, which are called ecosystem disservices (EDS) (von Döhren and Haase, 2015).

Due to an ever-increasing demand for better life quality in urban areas, clearly expressed in the UN New Urban Agenda (UN, 2017), policymakers need to understand how access to public green space varies across societies and if its distribution is socially equitable. However, understanding the level of access to green spaces is not enough (Barbosa et al., 2007). Indicators such as the percentage of people living closer than 300 m of a large UGS are seldom enough to discern those differences. According to the World Health Organization (WHO.ROE, 2016) and the EC, a 'large UGS' is considered to have a minimum area of 1 ha (Berrini et al., 2003), whereas English nature considers a minimum area of 2 ha (English Nature, 2005). Several authors highlight the fundamental need to understand drivers of interactions between urban inhabitants and the surrounding UGS (e.g., Lin et al., 2014). Given the complexity of UGS management (Plieninger et al., 2013), municipalities are looking for more detailed data-driven methods regarding UGS use and perceptions (Stone, 2016), which they often lack due to limitations in both human and economic resources.

Several studies were developed at city scale (Jim and Chen, 2006; Bertram and Rehdanz, 2015), but most of them investigate the actual use in a specific UGS (Chiesura, 2004; Özgüner, 2011; Scopelliti et al., 2012; Tyrväinen et al., 2007), and often limited to one single site and not within an explicit framework of ES. Others are focused on collecting just the primary ES in use (Beichler, 2015; Palliwoda et al., 2020; Priess et al., 2021), leading to the underrepresentation of other ES (Plieninger et al., 2013).

This manuscript aims to assess the environmental and socio-demographic factors that influence CES's use, identify multiple CES-related activities in use in different UGS, and understand the EDS perception. The specific objectives are to address the following questions: (i) which environmental and socio-demographic characteristics influence UGS use? (ii) what type of uses are performed in different UGS? (iii) What are the main perceived benefits from UGS use? (iv) which are the primary motivations for UGS visit? (v) which UGS users most feel disservices, and what is their level of concern? This study provides a comprehensive qualitative analysis of potential groups of factors influencing CES use in different UGS, assessing their multifunctional character. The outputs of this study can provide valuable information to address the previously mentioned issues, regarding the lack of detailed data on UGS usage, on their multifunctional character, and on the underrepresentation of some ES, and provide valuable information towards the implementation of UN Agenda 2030 strategies at the municipal level.

2. Methods

2.1. Study area

The study area is located in Coimbra, the largest city in the Portuguese Center region (Fig. 1a). The city has an area of 51 km^2 and hosts 91,775 inhabitants (INE, 2020). The consolidated urban area (designated as city core and considering stabilized urban soils and infrastructures under the Regulating Decree 9/2009) covers 25% of the city (Fig. 1b) and settles 31% of its population (INE, 2011). Coimbra has a Mediterranean hot summer climate (Csa, according to Köppen-Geiger classification), and mild winters, with typically short but intense precipitations, registering an annual average temperature of 15.5 °C and annual average precipitation of 905.1 mm (IPMA, 2011). Coimbra is crossed by the Mondego River, a major natural and cultural landmark of the city and its surrounding area. Coimbra municipality has invested in greening the city in the last two decades and established several UGS, ranging from small green spaces to large urban parks. However, the city still lacks a wide coverage of UGS (Gómez et al., 2014), especially regarding multifunctional areas.

The study focuses on five UGS within the city of Coimbra (Fig. 1c). The selected UGS are Manuel Braga park, Botanical garden, Choupal national forest, Mondego green park and Vale das Flores park (Fig. 1c). The main characteristics of the UGS are summarized in Table 1. All UGS differ in terms of the construction period and, thus, in design, extent, land cover, and facilities. The investigated UGS area range from 3 ha (Manuel Braga park) to almost 72 ha (Choupal national forest). Three of the parks are located on the margins of the Mondego river (Manuel Braga park, Choupal national forest and Mondego green park), although only two provide direct access to the river, allowing both formal (Mondego green park) and informal (Choupal national forest) use (e.g. swimming, kayaking, canoeing or sailing).

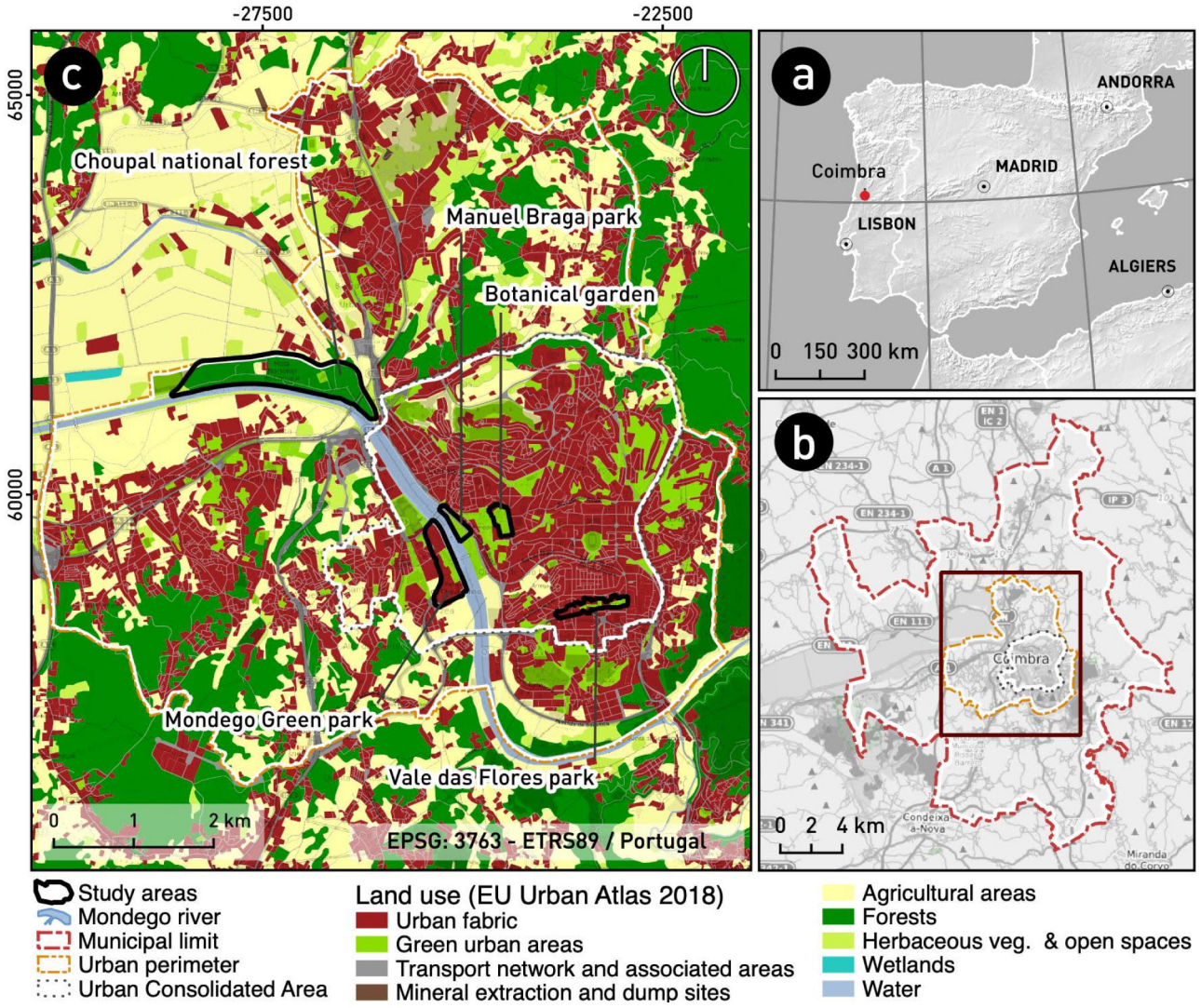

Fig. 1. a) Location of Coimbra in Portugal, b) extent of the consolidated urban area in relation to municipal boundaries, and c) location of the five urban parks investigated. Land use from Urban Atlas (https://land.copernicus.eu/local/urban-atlas).

3. Data collection

3.1. Survey

An on-site semi-quantitative survey was developed, based on questionnaires organized in 6 sections (see Table S1 in Supplementary materials). The first section focused on the respondent's socio-demographic information, including gender, age group, distance from home to the visited park (based on postal code or street name information collected), means of transportation to the UGS, education level, and visitors' frequency to the investigated UGS. The second section collected information about the three most frequent activities the user engages in when visiting that particular UGS and their importance to the most frequent activity. The list of activities provided to the participants (see CES section in Table S1 in the supplementary material) is adapted from the European initiative Mapping and Assessment of Ecosystems and their Services (EC.JRC, 2020) and the Common International Classification of Ecosystem Services (CICES) version 5.1. (https://cices.eu/). The adaptation is based on grouping and renaming some classes for better clarity to the respondents, following similar adaptations by other authors (e.g., Plieninger et al., 2013; Pueffel et al., 2018; Palliwoda et al., 2020; Rall et al., 2017; Haines-Young and Potschin, 2013). The list includes 17 activities possible to be performed in the study areas (e.g. hunting is not included because it is forbidden in all parks) and includes one option for "Doing other activities in nature" to ensure other relevant uses not included in the established list. Section 3 of the questionnaire was devoted to user' perception regarding benefits associated with the main activity identified, focusing on physical well-being, emotional well-being and social interactions. The fourth section was dedicated to the identification of motivations influencing the visits by selecting different possible responses. The fifth section was focused on user' perceptions about possible ESD that may be experienced when visiting the UGS. The importance of the most frequent CES performed, benefits, motivations and ESD perception (Sections 2 to 5) were based on a 5-level Likert scale. An additional socio-demographic question (sixth section) regarding the average monthly income was kept to the end of the survey to mitigate possible rejections from the respondents to participate in the survey.

A mobile app was developed with the AppSheet service to establish the field survey (www.appsheet.com). This tool enabled data collection with smartphones' help, using both Android and iOS devices. The implemented app design ensured that no information was missing in any record. As no official numbers are available regarding Coimbra UGS visitors, we applied 200 surveys in each of the urban parks. Only

Table 1
Summary of the main biophysical characteristics of the five urban parks investigated in Coimbra city.

	Manuel Braga Park	Botanical garden	Choupal national forest	Mondego green Park	Vale das Flores Park
Area (ha)	2.9	4.0	71.9	18.1	3.2
Year of construction	1927	1772	1850	2007	2001
Type of property	Public (local)	Private (university)	Public (national)	Public (local)	Public (local)
Landscape components	Trees, shrubs, water elements, flower beds, gardens	Trees, shrubs, water elements, flower beds, gardens	Grassland, trees, shrubs, water elements, ruderal grassland	Grassland, trees, shrubs, water elements	Grassland, trees, shrubs, water elements
Proximity to water body	Yes (no physical access to the water, just as landscape element, for visual enjoyment)	No	Yes (access to water is granted, but informal use only; no dedicated equipment or facilities)	Yes (formal use available, associated to water sport facilities)	No
Tree coverage[a]	53.4% (medium)	49.0% (medium)	85.3% (high)	20.8% (low)	20.9% (low)
Panoramic views	Yes	Yes	No	Yes	No
Sports equipment	None	None	Tennis field, basketball field, fitness/gymnastics, other sports	Fitness/gymnastics, skate park, water sports	Basketball field[b], football field[b], skate park
Other equipment	Benches, garbage bins, water points (not working)	Benches, garbage bins, water points, picnic tables, WC	Benches, garbage bins, water points, picnic tables, WC, bar[c]	Children playground, benches, garbage bins, water points, picnic tables, WC, bar[d]	Children playground, benches, garbage bins, water points (not working)

[a] Tree coverage classes: low: up to 33% coverage; medium: 33% to 66%; high: over 66%.
[b] Illumination of the sport fields turned off at 22h00.
[c] Bar and facilities closed from 18h00 to 10h00.
[d] Bar and facilities closed from 18h00 to 9h00.

Coimbra inhabitants were considered. The survey was developed in 2020, from July 27th to August 21st, through in situ face-to-face interviews. The survey was carried out in the different parks and periods of the day (Monday to Sunday, from 7h30 to 22h00). The interviewers walked along the parks to cover their different areas and available equipment, trying to ensure diversity of both users and activities. During the survey, the interviewers approach random visitors on a random selection. Interview time ranged from 5 to 30 min.

3.2. Data analysis

The analysis of the results was performed considering four main groups of variables: socio-demographic, benefits, motivations, and perceptions about disservices. A non-parametric Kruskal-Wallis test was performed to test whether there were significant differences between the parks for each variable ($p < 0.05$). A posthoc Tukey HSD test was applied to identify statistical differences within the parks ($p < 0.05$). An exploratory Factor Analysis (FA) was conducted to identify associations between the different variables for each park, based on Murphy (2020). The FA was carried out based on the correlation matrix. A varimax rotation was applied to minimize smaller loading values, contributing to a clearer view of the model factors. Loadings ≥ +0.5 and ≤−0.5 were retained as explicative of each factor as carried out in previous works (e.g., Maskey et al., 2018; Arifin and Yusoff, 2016). In this work we used a large number of variables. Therefore, even after the varimax rotation, not all the variables were strongly associated with a factor.

Regarding the activities identified by the users in the different UGS, we considered only the first activity for the FA, as benefits and motivations identified by users are exclusively related to the first activity. The results from the second and third activities registered were used as a proxy to each UGS's multifunctionality. For analysis purposes, the different CES were grouped under three distinctive groups related to the UGS interactions: Physical activities, Experiential and aesthetical activities, and Social activities. Differences in the number of selected activities and the diversity of the CES groups associated with those activities per park were tested with a non-parametric Kruskal-Wallis test, and significant differences within parks were checked with a posthoc Tukey HSD ($p < 0.05$).

A spatial analysis of the results was performed based on the respondents' address by geocoding the collected postal codes/street names to calculate the travel distance between the interviewee residence and the UGS. Isochrone distance maps were calculated for each park based on the road network, using the QNEAT plugin in QGIS. The road network used was the OSM data from Geofabrik (www.geofabrik. de). Kernel density estimation heatmaps (quartic kernel shape, 500 m radius) were created for each park based on respondents' residence and included Standard Deviation ellipses (CrimeStat method, 500 m radius) and mean distance points calculated for each UGS. SD ellipses are centred on their mean distance points and represent the geographical distribution trend, summarizing both dispersion and orientation of users' residence. All statistical analysis were done in R software (macOS version 1.3.1093) using packages Dplyr (Wickham et al., 2020), Writexl (Ooms, 2020), Rstatix (Kassambara, 2020a), DescTools (Signorell et al., 2020), Rcompanion (Mangiafico, 2020), Ggrepel (Slowikowski, 2020), Tibble (Müller and Wickham, 2020), and Data. Table (Dowle and Srinivasan, 2019). The plots were produced with ggplot2 (Wickham, 2016), Ggpubr (Kassambara, 2020b) and RColorBrewer (Neuwirth, 2014). Spatial analysis was performed in QGIS (v3.16).

4. Results

4.1. Descriptive statistics

4.1.1. Visitors characteristics

All socio-demographic variables showed significant differences ($p < 0.05$) between parks (Table 2 and Table S2 in supplementary materials). Choupal national forest is mainly frequented by older people (41.5% of visitors were above 45 years old) comparing with users from the other four parks (average of 25.8% for the same age group; $p < 0.05$). The users of Choupal national forest and Mondego green park are gender-balanced, but in the Botanical garden female users dominate (64.5%; $p < 0.05$), while in the Manuel Braga and Vale das Flores parks, male users were dominant (54.5% and 59.0% respectively; $p < 0.05$). Concerning the education level, the Botanical garden records the highest share of users with the highest education level (74.5% with college or higher; $p < 0.05$), opposing to the Manuel Braga and Vale das Flores park with a high number of users with lower education levels (respectively 49.5% and 51.5% with 1st grade or high school; $p < 0.05$). The Choupal national forest and the Mondego green park

Table 2
Socio-demographic characteristics of the interviewed in the five UGS investigated in Coimbra. The values in the table indicate median (1st quantile, 3rd quantile) responses. Different letters represent significant differences within parks ($p < 0.05$).

	Manuel Braga park	Botanical garden	Choupal national forest	Mondego green park	Vale das Flores park
Age group[a]	3(2,3)	3(2,3)	3(3,4)	3(2,3)	3(2,3)
	b	b	a	b	b
Gender[b]	2 (1,2)	1 (1,2)	2(1,2)	1(1,2)	2(1,2)
	a	b	ab	ab	a
Education level[c]	3(2,4)	4(3,4)	4(2,4)	4(2,4)	2(2,4)
	c	a	ab	ac	c
Average monthly Income[d]	2(1,3)	2(1,3)	3(2,3)	2(1,3)	2(1,4)
	a	a	b	a	a
Transport type to UGS[e]	1(1,4)	4(1,6)	6(6,6)	6(1,6)	1(1,6)
	c	b	a	b	c
Distance between residence and UGS (m)	2058(1171,3324)	1496(928,2549)	3603(2563,4973)	2451(1527,3913)	630(193,2710)
	bc	c	a	b	d
Frequency of visit[f]	3(2,3)	2(1,3)	3(2,3)	3(3,3)	3(3,4)
	b	c	b	b	a
CES group[g]	1(1,2)	2(1,2)	1(1,1)	1(1,2)	1(1,2.25)
	ac	c	ab	ab	b

[a] 1: <18, 2: 18–25, 3: 26–45, 4: 46–65, 5: >65 years old.
[b] 1: male, 2: female.
[c] 1: first grade, 2: high school, 3: vocational education, 4: college or higher.
[d] 1: no income, 2: ≤750€, 3: 750–1.500€, 3: 1.500–3000€, 4: >3000€, 5: don't know/don't want to answer.
[e] 1: by foot, 2: bike, 3: other individual soft transports, 4: public transport, 5: scooter/motorbike; 6: car.
[f] 1: annually, 2: monthly, 3: weekly, 4: daily.
[g] 1: physical interactions, 2: experiential and aesthetical interaction, 3: social interactions.

record a more even distribution and education level groups. Users from Choupal national forest also display a higher average monthly income (41.0% in the range between 750€ to 1.500€ group; $p < 0.05$) than the users from the other four parks (27.4% had an average income of ≤750 €). Regarding the transport type used to the UGS, most users of Choupal national forest arrive by car (79.0%; $p < 0.05$), whereas most users of Manuel Braga and Vale das Flores parks arrive by foot (53.5% and 64.0% respectively; $p < 0.05$). Both Botanical and Mondego green parks have ~50% of users arriving by car, with other users arriving either by foot or by bus. Users of Vale das Flores Park, Botanical garden, Manuel Braga and Mondego green park showed increasing distances to their residence (from 630 m for Vale das Flores park to 2451 m for Mondego green park), with users of the Choupal national forest registering the highest average distance (3603 m; $p < 0.05$). The frequency of visit records significant differences between Vale das Flores park, which has the highest frequency of visit, between daily (37.5%) to weekly (46.0%), and the Botanical garden registering the lowest frequency of visit, mainly monthly (37.0%) to annual (30.0%).

Table 3
Cultural Ecosystem Services (CES) related activities identified as the first activity performed by visitors in the five parks during the survey, with percentage of responses by CES group and CES-related activity per park, and total number of CES by park.

CES Groups	Cultural Ecosystem Services related activities	Responses (%)					
		Manuel Braga park	Botanical garden	Choupal national forest	Mondego green park	Vale das Flores park	Average
Physical activities	Walking the dog	6.5	1.5	4.0	5.0	15.0	6.4
	Walking, strolling, hiking	43.0	35.5	44.5	32.5	23.0	35.7
	Jogging, running	5.0	2.5	12.5	3.5	4.0	5.5
	Fitness	1.0	0.5	2.5	0.5	1.0	1.1
	Sports	0.5	–	9.0	2.5	25.5	7.5
	Biking	3.5	0.5	9.5	1.0	1.5	3.2
	Skating	–	–	0.5	2.0	2.0	0.9
	Boating, canoeing	–	–	–	11.0	–	2.2
	Swimming, snorkeling, diving	–	–	0.5	5.0	–	1.1
Total physical activities (%)		59.5	40.5	83.0	63.0	72.0	63.6
Experiential & Aesthetical activities	Making use of shade & shelter	13.5	5.5	0.5	4.0	1.5	5.0
	Reading	1.5	3.0	1.0	1.0	1.0	1.5
	Watching animals or plants	–	3.5	1.5	1.0	–	1.2
	Enjoy landscape beauty	2.5	17.0	0.5	2.5	0.5	4.6
	Being inspired by nature	1.5	2.5	–	1.0	–	1.0
	Experience cult. heritage, sense of place	–	1.0	–	–	–	0.2
	Other experiential & aesthetical activities[a]	1.0	5.0	–	4.0	–	2.0
Total experiential & aesthetical activities (%)		20.0	37.5	3.5	13.5	3.0	15.5
Social activities	Meeting people	16.5	6.5	3.0	16.5	6.5	9.8
	Picnicking, barbequing	1.0	4.5	2.5	2.5	–	2.1
	Activities with children	1.0	8.0	6.5	4.5	17.5	7.5
	Doing research, environmental educ.	0.5	1.5	1.5	–	0.5	0.8
	Other social activities[a]	1.5	1.5	–	–	0.5	0.7
Total social activities (%)		20.5	22.0	13.5	23.5	25.0	20.9
Different CES-related activities per park (1st ES choices)		16	18	16	18	14	21

[a] A detailed list of other activities is provided in Table S3 of the supplementary material.

4.1.2. Cultural ecosystem services used in the UGS

In terms of activities developed in each park (Table 3), all parks record mostly physical activities in nature (63.6% on average engage, e.g., in walking or sports), although with values ranging from 40.5% in the Botanical garden to 83.0% in the Choupal national forest. Regarding social activities, Vale das Flores park records a higher share of users, with 25.0% engaging in activities such as activities with children or meeting people, whereas in the other parks recorded an average of 20.9%. The Botanical garden has the highest share of users engaging in experiential and aesthetical activities, with 37.5% of its users engaging on, e.g., enjoying landscape beauty, against an average of 15.5% for the other parks.

Park users identified a total of 21 different CES-related activities (see Table 3 and Table S3 in supplementary materials), with the Botanical garden and Mondego Green park recording a larger number of activities (18), followed by Manuel Braga Park and Choupal national forest (16 activities), and Vale das Flores park (14 activities). Activities such as 'Fitness', 'Sports' and 'Activities with children', were added to the main list of CES-related activities for analysis due to their relevance in terms of users' engagement (see Table S3 in supplementary materials).

Physical activities, such as walking, running, or group sports, were dominant in all parks, although the Botanical garden records the lowest percentage of users engaging in physical activities (40.5%) compared to the other four parks (59.5%–83.0%). Walking, strolling, or hiking was the dominant activity in all parks, except in the Vale das Flores park, where group sports were the dominant activity (25.5%). The Mondego green park recorded the highest diversity of physical activities, with all 9 physical activities listed in the questionnaire being identified by users.

Experiential and aesthetical activities, such as enjoying landscape beauty or making use of shade, were more relevant in the Botanical garden (37.5% of all CES groups), the Manuel Braga park (20.0%), and the Mondego green park (13.5%). In the Choupal national forest (3.5%) and the Vale das Flores park (3.0%), they were almost absent. Enjoying landscape beauty was relevant mainly in the Botanical garden (17.0%), and making use of shade and shelter was most relevant in Manuel Braga park (13.5%). Botanical garden recorded the highest diversity of experiential and aesthetical activities (7 activities, including photography under "other activities") among the five parks.

Regarding social activities, such as meeting people or activities with children, this group of CES-related activities showed a higher number of users than the experiential and aesthetical activities, with 20.5%–25.0% users engaging in this type of activities in all parks, except Choupal national forest (13.5%). Meeting people was most relevant in the Manuel Braga and Mondego green parks (16.5% of users in both parks). Activities with children were most relevant in the Vale das Flores park (17.5%), followed by the Botanical garden (8.0%), Choupal national forest (6.5%) and Mondego green park (4.5%). The Botanical garden and the Manuel Braga park recorded the highest diversity of social activities (both registered 6 activities, 2 of which under "other activities").

The number of activities in which users engage is significantly different between the parks ($p < 0.05$; see Tables S4 and S5 in supplementary material). Most Botanical garden users (87.0%) identified 3 different activities usually practised when visiting the site. The Vale das Flores park recorded the highest share of users, indicating either only one activity (20.0%) or two activities at the most (30.5%), similar to the activities reported in Choupal national forest (37.5% of the users developing one or two activities). Overall, almost 90% of the park users reported at least two activities, with over two thirds (68.7%) registering three activities.

As for the diversity of multiple uses concerning the three groups of CES-related activities, significant differences ($p < 0.05$) were also found between parks (see Tables S5 and S6, in supplementary materials). Manuel Braga Park and the Botanical garden registered an average to high diversity in terms of ES groups in use (shares of 83.0% and 85.0%, respectively). In contrast, the Vale das Flores park and the Choupal national forest registered the lowest diversity, with circa one-third of their users reporting activities from a single ES group (37.5% and 32.5%, respectively). Overall, over 75% of the park users registered activities from at least two different ES groups.

4.1.3. Perceived benefits, motivations and identified disservices

Regarding perceived benefits, physical well-being was considered highly relevant by most of the users from all parks (Table 4 and Table S8 in supplementary materials). However, it was identified as more relevant ($p < 0.05$) in the Choupal national forest (70.0%) than in Manuel Braga park (52.0%) and the Botanical garden (53.5%). On the other hand, emotional well-being was considered highly relevant by most users (58.0%–65.5%) in the 5 parks ($p > 0.05$). Social interactions were not so well perceived as physical and emotional well-being. However, visitors from different parks revealed different perceptions, with users from Vale das Flores park giving higher relevance ($p < 0.05$) to social interactions (52.5% considered it highly relevant) than users from the Botanical garden (21.5%).

The motivations identified by users to visit the study sites are different between the five parks ($p < 0.05$) (Table 5; see also Table S9 in supplementary material). In general, landscape beauty, the tranquillity of space, the presence of water and accessibility are the most fundamental variables in the selection of the park to visit. Although accessibility was identified as a relevant motivation in the choice of all five parks, it was more important for users of Vale das Flores and Manuel Braga parks (67.0% of the visitors considered it fundamental) than for those in the Botanical garden (59.0% considered it to be somehow influential) ($p < 0.05$). The proximity to home was also considered fundamental in Vale das Flores park (60.0%), while in Manuel Braga park, it was identified as just somehow influential (27.0%; $p < 0.05$).

Public transport availability has almost no influence or no influence at all in the motivation of users to visit the parks (75.7% on average), except in Manuel Braga park, where 41.5% of the users identified this variable as influential or fundamental. On the other hand, the tranquillity of space was mainly classified as essential in all parks (59.8% on average), except in the Vale das Flores park where, although considered influential, it received a slightly lower valuation than in the other parks (44.0%). Similarly, landscape beauty was classified as fundamental in visiting all parks (53.8% on average), except in Vale das Flores park, where few users considered it as fundamental as in the other parks (30.5%). The presence of a water element was deemed to be essential by most users in the Manuel Braga and Mondego green parks (62.5% and 80.5%, respectively) and clearly influential in both the Botanical

Table 4
Physical and emotional well-being and social interaction benefits perceived by the visitors of each study area. Median (1st quantile, 3rd quantile) values reported in a Likert scale from 1 (not relevant) to 5 (highly relevant). Different letters represent significant differences within parks ($p < 0.05$).

Benefits	Manuel Braga park	Botanical garden	Choupal national forest	Mondego green park	Vale das Flores park
Physical well-being	5(4, 5)	5(4, 5)	5(4, 5)	5(4, 5)	5(4, 5)
	b	b	a	ab	ab
Emotional well-being	5(4, 5)	5(4, 5)	5(4, 5)	5(4, 5)	5(4, 5)
	a	a	a	a	a
Social interactions	4(3, 5)	4(3, 4)	4(3, 5)	4(3, 5)	5(3, 5)
	b	c	b	ba	a

Table 5
Evaluation of possible motivations to visit each of the five UGS. Median (1st quantile, 3rd quantile) values in a Likert scale from 1 (no influence at all) to 5 (fundamental in my choice). Different letters represent significant differences within parks ($p < 0.05$).

Motivations variables	Manuel Braga park	Botanical garden	Choupal national forest	Mondego green park	Vale das Flores park
Accessibility	5(4, 5)	4(3, 5)	4(3.75, 5)	4(4, 5)	5(4, 5)
	ab	c	cd	bd	a
Proximity to home	3(3, 4)	4(2, 5)	4(2, 4)	4(3, 5)	5(4, 5)
	c	bc	c	b	a
Proximity to work	1(1, 4)	1(1, 4)	1(1, 1)	1(1, 4)	1(1, 3)
	a	a	b	a	a
Public transport availability	3(1, 4)	1(1, 1)	1(1, 1)	1(1, 3)	1(1, 1.25)
	a	b	c	b	b
Tranquillity of the space	5(4, 5)	5(5, 5)	5(4, 5)	5(4, 5)	4(4, 5)
	bc	a	ab	c	c
Landscape beauty and diversity	5(4, 5)	5(4.75, 5)	5(4, 5)	4.5(4, 5)	4(3, 5)
	b	a	ab	b	c
Presence of a water element	5(4, 5)	4(3, 5)	4(3, 5)	5(5, 5)	[a]
	a	b	b	a	
Dimension of the park	4(3, 5)	4(3, 5)	4(4, 5)	4(3, 5)	4(3, 5)
	bc	bc	a	ab	c
Urban equipment available	3(3, 4)	3(3, 4)	3(2, 4)	3(2, 4)	4(3, 4)
	a	a	ab	b	a
Sports facilities available	1(1, 3)	1(1, 2)	4(2, 5)	4(2, 5)	4(2, 5)
	b	c	a	a	a
Social interaction opportunities	4(3, 4)	3(2, 4)	4(2, 4)	4(3, 5)	4(4, 5)
	bc	c	bc	ab	a

[a] No water element was present.

garden (32.5%) and the Choupal national forest (27.5%). The Vale das Flores park does not include any water element (Table 1).

The park's dimension was considered as clearly influential to fundamental in the decision of most visitors to go to all the parks (69.7% on average). The Choupal national forest registered the most differentiated share of users classifying it as clearly influential to fundamental (86.0%), while the other four parks ranged from somehow influential to fundamental, with Vale das Flores park recording the highest share of users saying that park size had no influence (18.0%). Regarding the availability of urban equipment (e.g., benches, water fountains, picnic tables), all parks received a somehow influential (average of 28.0%) to clearly influential (average of 29.8%) evaluation, except for the Vale das Flores park, which recorded a high percentage of users (53.0% against an average of 45.6%). Both the Choupal national forest and the Mondego green park registered a higher share of users who considered the availability of such equipment as almost no influence (12.5% and 13.5%, respectively, against an average of 9.4%).

As for the availability of sports facilities, significant differences were recorded between parks ($p < 0.05$), with Vale das Flores park, Choupal national forest, and Mondego green park registering a high influence (64.0%, 56.5%, and 53.0%, respectively), opposing to Manuel Braga park and the Botanical garden whose users stating no influence at all from this variable (59.0% and 73.5%, respectively).

The social interaction opportunities are identified as clearly influential and fundamental in the motivation of Vale das Flores users (75.0%, against an average of 57.3% for all parks) and the users of Mondego green park (61.5%). In the other three parks, the Botanical garden was the one differentiating the most, with most users stating that this variable was, at most, somehow influential in their visit (58.0%, against an average of 42.7% for all parks).

Considering the perceived disservices, no significant differences ($p < 0.05$) were found between parks regarding air pollution, soil erosion, allergic reactions, and dangerous animals (Table 6; see also Table S10 in supplementary material). For these variables, the major share of users either never felt the related problem (averages of 89.2%, 79.1%, 90.6% and 94.3%, respectively) or considered it as of low concern (6.0%, 7.4%, 3.3% and 2.5% respectively). From the disservices showing significant differences between parks, maintenance issues were the most relevant, with Choupal national forest recording the highest share of users reporting medium concerns (29.0%) among the five

Table 6
Evaluation of perceived disservices identified by users of the five study areas. Median (1st quantile, 3rd quantile) values in a Likert scale from 1 (never felt this problem) to 5 (highly problematic/frequent). Different letters represent significant differences within parks ($p < 0.05$).

Perceived disservices variables	Manuel Braga park	Botanical garden	Choupal national forest	Mondego green park	Vale das Flores park
Unpleasant sight or landscape	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 2)	1(1, 1)
	ab	b	ab	a	ab
Air pollution	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)
	a	a	a	a	a
Water quality issues	1(1, 2)	1(1, 2)	1(1, 1)	1(1, 2)	1(1, 1)
	a	a	a	a	b
Soil erosion	1(1, 2)	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)
Allergic reactions	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)
Plagues (e.g. mosquitoes)	1(1, 1)	1(1, 1)	2(1, 3)	1(1, 2)	1(1, 1)
	bc	c	a	b	bc
Dangerous animals	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)
Insecurity	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)	1(1, 1)
	a	b	ab	ab	ab
Maintenance issues	2(1, 3)	1(1, 2)	3(1, 3)	2(1, 3)	2(1, 3)
	a	c	a	ab	b

parks. Users from all other four parks mainly reported low concerns regarding maintenance (between 23.5% and 29.0%), with the Botanical garden being the park with almost no maintenance concerns from its users (82.5%). Regarding insecurity issues, all parks mainly recorded no user concerns (average of 87.2%, with values ranging from 76.5% in the Manuel Braga park to 93.5% in the Botanical garden). However, the Manuel Braga park registers a slightly higher share of users reporting having felt, at some point, low to medium concern when visiting the park (48.0%, against an average of 42.1%).

4.1.4. Multivariate analysis

Fig. 2 shows the exploratory FA plotted results for each park (Factor 1 vs Factor 2). The exploratory FA loadings for all parks are detailed in Tables S11–S15 in supplementary materials. Fig. 2a shows the results for Manuel Braga park. Factor 1 (Well-being) was formed by physical well-being (b1), emotional well-being (b2) and importance attributed to the activity performed (ESi), while factor 2 (Tranquillity and landscape beauty) explained both tranquillity of space (m05) and landscape beauty (m06). A first group is formed by both physical well-being (b1), emotional well-being (b2) and importance attributed to the activity performed (ESi). This group is inversely related to the age group (sd2). Two other groups are formed with motivation variables, the most detached one representing higher values attributed to both tranquillity of space (m05) and landscape beauty (m06), and the one in between representing medium to higher values attributed to accessibility (m01) and the presence of a water element (m07).

Botanical garden (Fig. 2b) Factor 1 (Well-being) is formed by physical well-being (b1), emotional well-being (b2), the importance attributed to the activity performed (ESi), tranquillity of space (m05) and landscape beauty (m06). Factor 2 (Accessibility) is formed by accessibility (m01), closer proximity to home (m02), transport type (sd5) and distance to park (sd6). Sd5 and Sd6 have an inverse relation to m01 and m02. The exploratory FA identified five groups. The most detached group is formed by higher levels of physical well-being (b1), emotional well-being (b2), the importance attributed to the activity performed (ESi), as well as higher motivations attributed to the tranquillity of space (m05) and landscape beauty (m06). This group is inversely related to dangerous animals (sd7). A third group is formed by higher levels attributed to motivations accessibility (m01) and closer proximity to home (m02), which is inversely related to the fourth group formed by socio-demographic variables including transport type (sd5) and distance to park (sd6), both reflecting accesses mainly by foot and shorter distances to home.

The results for Choupal national forest (Fig. 2c) showed that Factor 1 (Well-being) is formed by variables physical well-being (b1), emotional well-being (b2) and importance attributed to the activity performed (ESi), and factor 2 (Seniors wealth) by age (sd1) and average monthly income (sd4). Four main groups of variables were identified. The first group is formed by higher levels attributed to physical well-being (b1), emotional well-being (b2) and importance attributed to the activity performed (ESi). A second, less detached group associates average to high social activity benefits (b3) with both averages to the high frequency of visit (sd7) and tranquillity of space (m05). A third group includes the socio-demographic variables age (sd1), average monthly income (sd4) and transport type (sd5), representing older, wealthier users, arriving mainly in their car.

Results for the Mondego Green park (Fig. 2d) showed that Factor 1 (Well-being) explained the following variables: activity performed (ESi), associated physical (b1) and emotional well-being (b2), while factor 2 (Seniors wealth and accessibility) explained age (sd1), average monthly income (sd4), and proximity to home (m02). In this case, the variables have a more scattered distribution, although 5 groups can be identified. The first group of variables comprises higher importance attributed to the activity performed (ESi) and the associated physical (b1) and emotional well-being (b2), with medium to a high frequency of visit (sd7). Another group represents the association of similar levels of average relevance attributed to social activity benefits (b3), motivation driven by the tranquillity of space (m05) and sports facilities available (m10). A third group includes the variables age group (sd1), average monthly income (sd4), proximity to home (m02), and accessibility (m01), representing older and wealthier users living more distant from the UGS, but with good accessibility to the park. A fourth group is formed by the variable unpleasant sight or landscape (d1), which is somehow inversely related to the first group.

In Vale das Flores park (Fig. 2e) the results show that factor 1 (Accessibility and frequency) explained the mean of transportation (sd5), distance to UGS (sd6), frequency of visit (sd7) and proximity to home (m02). Factor 2 (Seniors wealth) is formed by the socio-demographic variables age group (sd1) and average monthly income (sd4). We identified a strong aggregation of variables in the centre of the axes, with four independent groups. The first group includes the socio-demographic variables such as the mean of transportation (sd5) and distance to UGS (sd6), with distinctive negative values. This group is negatively related to the second group, formed by frequency of visit (sd7), proximity to home (m02) and accessibility (m01). The third group is formed by the socio-demographic variables age group (sd1) and average monthly income (sd4), including older users with higher income levels. This group is inversely related to the motivation variables of proximity to work/study place (m03) and sports facilities available (m10), reflecting younger users closer to study places and to use sports equipment.

4.1.5. Spatial analysis

Fig. 3 shows the heatmaps, with mean and standard deviation (SD) ellipses regarding the user's residence's distance to each study park. Vale das Flores park shows the smallest SD ellipse (Fig. 3e), covering an area of 19.7 km^2, showing a clear concentration of users in the park's vicinity. The Botanical garden (Fig. 3b) has the second smallest influence area (26.94 km^2). Manuel Braga park (Fig. 3a) shows an SD ellipse extending over an area of 31.53 km^2, with an elongated form, dispersed along an NNW-SSE axis, associated with its users' distribution. The Mondego Green park SD ellipse (Fig. 3d) is the second largest after Choupal national forest, covering 35.46 km^2. The Choupal national forest (Fig. 3c), the most far from the city centre (Fig. 1), shows the largest SD ellipse, with 47.29 km^2.

5. Discussion

5.1. UGS visitors and their use of Cultural Ecosystem Services

CES use is linked to socio-demographic variables. Age group, average monthly income, transport type to UGS, and distance between residence and UGS were the variables showing relevant groupings in the different UGS. Seniors wealth is one of the main factors in three of the five parks, with age group and average monthly income forming separate groups in the Choupal national forest, Mondego Green park, and Vale das Flores park, denoting that wealthier older users are more able to enjoy these parks. These results are similar to other studies' findings (Neuvonen et al., 2010; Lo and Jim, 2012; Rossi et al., 2015; Riechers et al., 2018; Sun et al., 2019; Wen et al., 2020). Taking these variables into consideration in park planning should be weighted, especially concerning social equity in park availability and accessibility.

Physical activities (e.g., walking, practising group sports, running, or walking the dog) are the most dominant CES-related activities, being identified as the main activities performed by the visitors in all parks (Table 3), similar to findings in elsewhere UGS, e.g., in Austria, Denmark, Germany, the Netherlands, and Sweden (Bertram and Rehdanz, 2015; Bijker and Sijtsma, 2017; Rall et al., 2017; Palliwoda et al., 2020). Physical activities are followed by social activities identified as the first activity performed by users, including meeting people and doing activities with children. Social activities have been considered a group of ES that has a universal appeal across different cultures

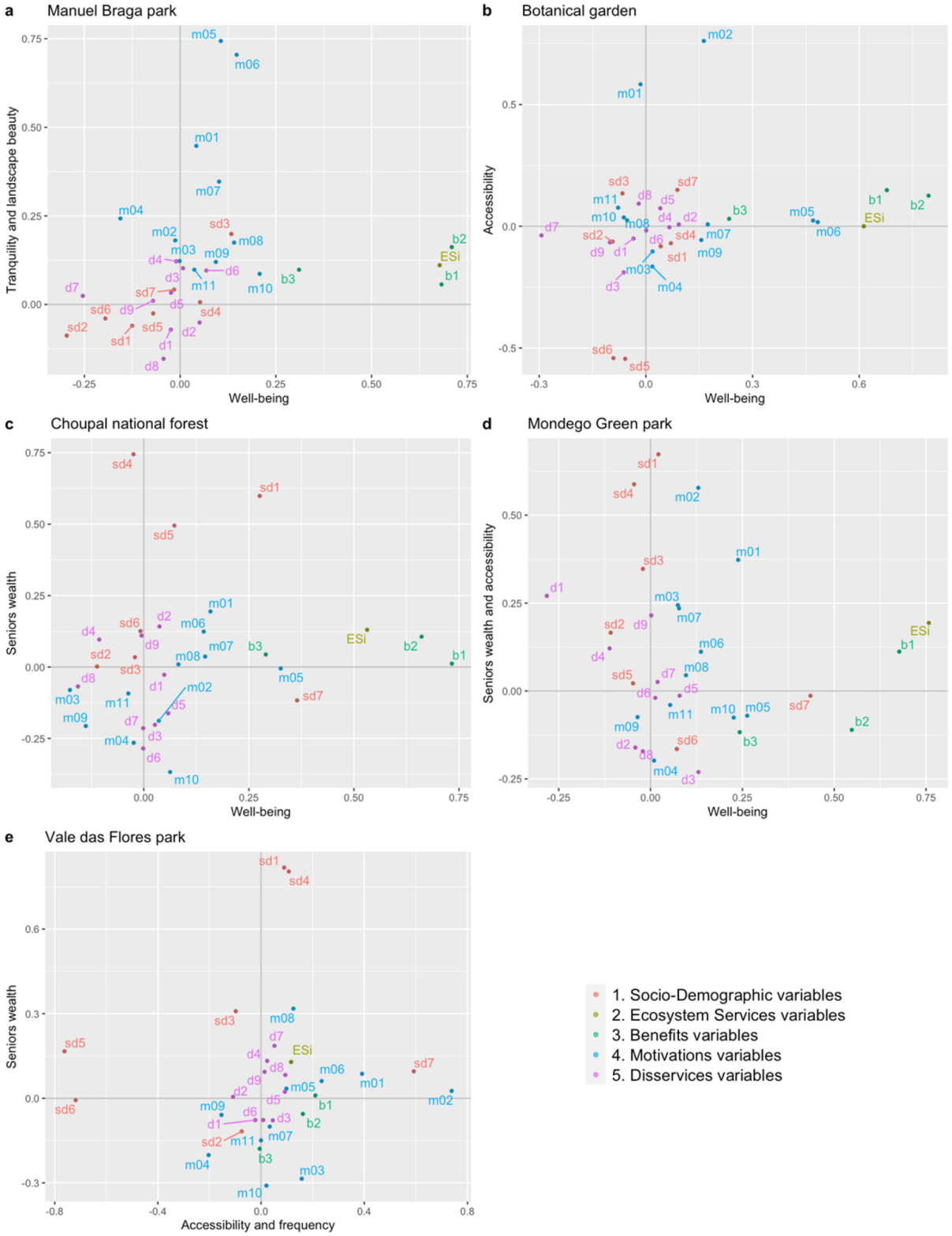

Fig. 2. Relation of PCA factors 1 and 2 for the parks studied. Different colors represent the variables aggregated into 6 groups: *Socio-demographic variables* (sd1: age group; sd2: gender; sd3: education level; sd4: average monthly income; sd5: transport type to UGS; sd6: distance to UGS; sd7: frequency of visit to UGS); *Ecosystem services variables* (ESi: importance attributed to the activity performed); *Benefits variables* (b1: physical wellbeing; b2: emotional wellbeing; b3: social interactions); *Motivations variables* (m01: accessibility; m02: proximity to home; m03: proximity to work place; m04: availability of public transport; m05: tranquillity of space; m06: landscape beauty; m07: presence of a water element; m08: dimension of park; m09: available equipment; m10: sports facilities available; m11: social interactions); *Disservices variables* (d1: unpleasant sight or landscape; d2: air quality problems; d3: water quality problems; d4: soil erosion or landslides; d5: allergic reaction to plants or animals; d6: plagues (e.g., mosquitoes); d7: dangerous animals; d8: insecurity issues; d9: maintenance issues).

(Jim and Chen, 2006). Using shade and shelter and enjoying landscape beauty are the most relevant activities regarding experiential and aesthetical activities identified by the users of the study sites. In general, visitors' preferences can be based on (1) UGS activities supported by available infrastructure (CES supply) (e.g., badminton players can install their badminton nets in Choupal national forest and thus practice this

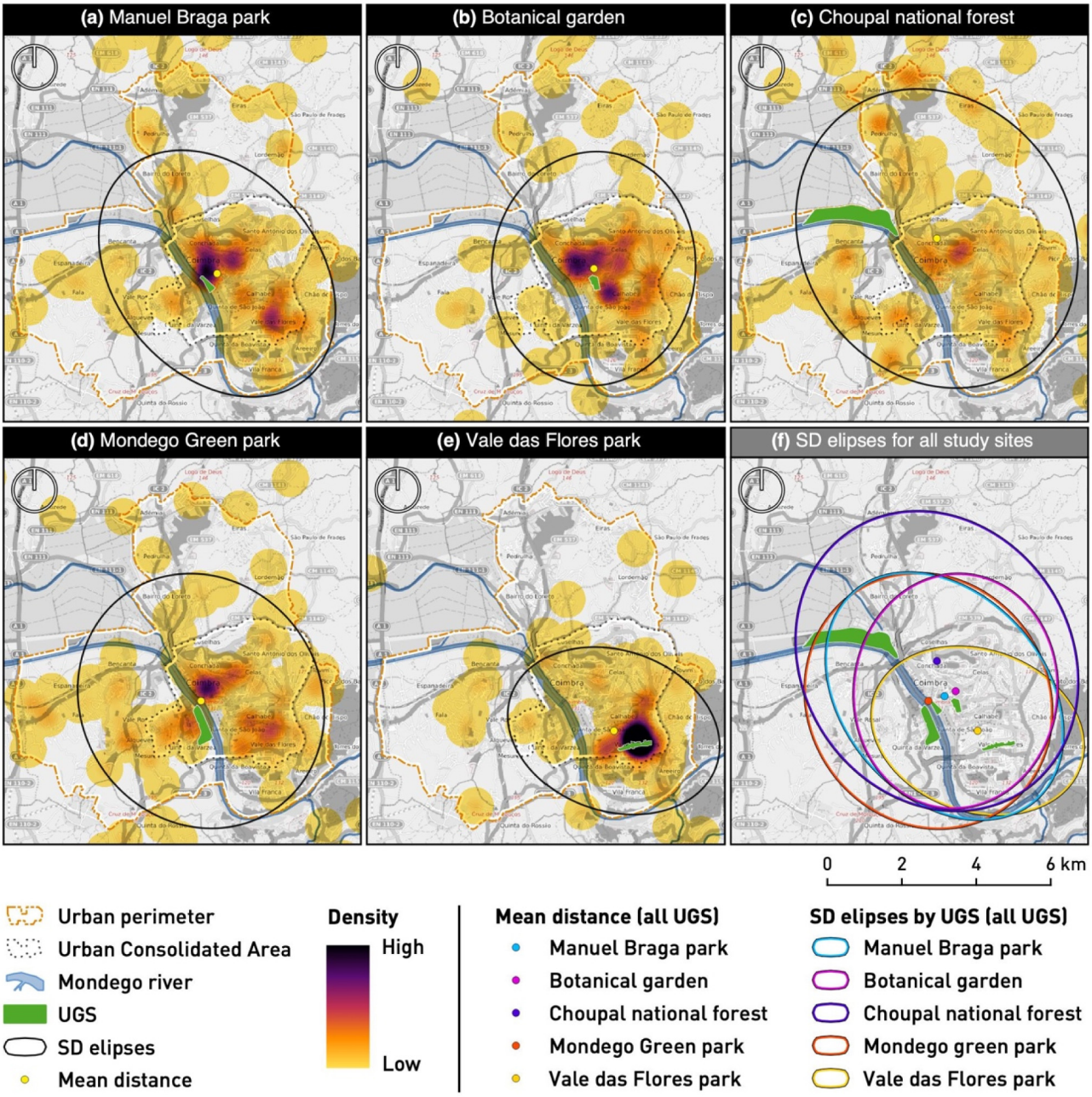

Fig. 3. Mean distance between visitors' residence heatmaps and UGS, including standard deviation (SD) ellipses and mean distance points for each UGS.

sport); and (2) UGS biophysical characteristics such as accessibility and proximity, identified as main motivations by the users (Table 5). This can be particularly relevant in Vale das Flores park (Table 5 and Fig. 3), where, for example, outdoor classes from a nearby gym have been performed during the COVID-19 pandemic. The use of CES is both influenced by the users' characteristics and preferences (demand of CES), and UGS' characteristics (supply capacity), as mentioned by Hegetschweiler et al. (2017).

5.2. UGS characteristics and multifunctional uses

The diversity of CES-related activities reported by users of the analyzed UGS supports the evidence that parks containing various features and amenities attract a wide range of users (Table S1 in supplementary material). The relevance of multifunctional aspects of UGS has been reported in other similar studies in a medium-sized city in Ontario, Canada (Kaczynski et al., 2008) and in Perth, Australia (Giles-Corti et al., 2005), and considered one of the main reasons for most visits to UGS in Coimbra itself (Gómez et al., 2014), as well as in other cities such as Madrid, Spain (Canosa et al., 2003), Amadora, Portugal (Santana et al., 2007), or Salamanca, Spain (Gómez et al., 2014). The results clearly show that multifunctionality is a reality in all the parks under analysis (Tables S4, S5 and S6). Nevertheless, there are some interesting differences between parks, with Choupal national forest and Vale das Flores park registering slightly lower levels in both the number of activities reported per user and the diversity of activities regarding different CES groups. Several factors may influence these results (Table 1). Although with contrasting areas and significantly different distances to users' residence, both parks record the highest offer in sports equipment, bringing visitors looking exclusively for a place

mainly to engage in sports activities. The concentration of sports equipment, large park size, and nature presence are some of the characteristics necessary to classify the Choupal national forest as the 'perfect park', according to Rivera et al. (2021). The more distant location and large size of Choupal national forest force most users to arrive by car, although they mainly came for physical activities such as biking or running. On the other hand, Vale das Flores Park, located in the centre of the urban area and with a strong presence of sports equipment, attracts local younger users, looking mainly to engage in group sports. This relation between distance and transport type was also reported as relevant regarding park use in other studies in Norway (Fongar et al., 2019). Furthermore, although the Choupal national forest is located in the Mondego river's margin, its users can hardly enjoy its view due to the dense tree coverage. Vale das Flores park, in turn, does not have any water element. This lack of water features restricts the number of ES-related activities available for the users and their diversity regarding the different ES groups. According to Veitch et al. (2006), landscape characteristics, particularly the presence – or lack – of a water feature, affect the experiential and aesthetical activities' potential.

Overall, our results support the idea that multifunctional UGS can provide a diversified set of CES-related activities to be offered and enjoyed, even in limited-size areas, as suggested by other authors (Gómez et al., 2014; Van Herzele and Wiedemann, 2003). However, these findings also suggest that potential multifunctional use vs. effective multifunctional use can be affected by a complex combination of UGS size, distance to the user, relation to water elements in the landscape, and sports equipment offer.

5.3. Perceived Benefits from UGS

Well-being is one of the main factors identified in the exploratory FA in all parks. Although physical well-being benefits have received higher valuations than emotional and social interactions (Table 4). However, the FA results showed that physical well-being and emotional well-being are strongly connected and separated from all the other variables in all parks, except in the Vale das Flores park. Nevertheless, the value of physical well-being is mainly related to UGS infrastructures and the different physical CES activities provided. For example, Choupal national forest records higher reported physical well-being rates (Table 4), driven by a higher offer in sports equipment (Table 1). These findings are in line with those reported in studies performed elsewhere, identifying that both facilities and sports equipment contribute to the use of UGS in, e.g., a small US city (Estabrooks et al., 2003), Melbourne, Australia (Crawford et al., 2008), and México City, Mexico (Ayala-Azcárraga et al., 2019).

Emotional well-being is transversal to all CES groups and parks, seemingly related to the use of outdoor green spaces in itself rather than specific aspects of the park since no significant difference is identified between the five UGS investigated (Table 4). These findings are also in accordance with those reported by other authors, which demonstrated that psychological well-being is associated with the perception of UGS availability (e.g., Cleary et al., 2019; Liu et al., 2019). In addition, our results also suggest that depending on park characteristics and CES offer, parks such as the Botanical garden or the Manuel Braga park attract people more interested in emotional well-being, such as experiencing tranquillity and landscape beauty (Fig. 2a and Fig. 2b).

Regarding social interactions, this study's results show highly relevant benefits associated with parks located in socio-demographic diversified urban areas and offering a wide diversity of multifunctional spaces. This diversity can involve infrastructures for both group and individual sports, for social activities, including children's playgrounds, picnic tables or a bar, and aesthetic and experiential activities, such as flowerbeds, benches, secluded areas, or provision of landscape view spots. This UGS multifunctionality role is relevant to social activities established in Vale das Flores park (Table 4), bringing together inhabitants with different socio-demographic backgrounds (Table 2 and Table S1 in supplementary materials). The relevance of UGS on promoting social interaction and cohesion has been widely reported in studies elsewhere (Kuo et al., 1998; Reeves, 2000; Green Space Scotland, 2008; Peters and Buijs, 2010; Kázmierczak, 2013; Maruthaveeran, 2017).

5.4. Main motivations to visit UGS

Regarding motivations to visit the investigated UGS, accessibility, tranquillity, and landscape beauty receive higher relevance rankings from interviewed users (Table 5). Accessibility is considered by the users a relevant factor in most parks, often associated with proximity to home, as in the Botanical garden, the Mondego Green park and the Vale das Flores park (Fig. 2b, d and e), which is in line with other studies mentioning that distance is an essential predictor of actual park use (Schipperijn et al., 2010a, 2010b). Accessibility and proximity to home are related to socio-demographic variables of transport type and distance to UGS in the Botanical garden and Vale das Flores park (Fig. 2b and e). These parks located closest to densely inhabited areas of the city (Table 1), record users from closer distances (Fig. 3b and e), accessing the UGS mainly by foot (Table S1). This is clearly shown by the small dimension of the SD ellipses, denoting the relevance of accessibility and proximity in attracting users to these parks. The SD ellipse from the Choupal national forest corresponds to a more disperse and broader distribution of users, as confirmed by the respective heatmap (Fig. 3c). Its centre is dislocated towards the city centre, reflecting its peripherical location related to the urban settlement pattern. The Mondego green park SD ellipse clearly shows a large distribution of users from all over the city area (Fig. 3d), although displaying a higher concentration of users from nearby locations, with a lower dispersion of users around the city. The dislocation of the SD ellipse's mean centre for the Vale das Flores park to the NW shows that park users originate mainly from the consolidated urban area, with the park located in the inner SE limit of this area. Vale das Flores park FA results indicate a strong dominance of users living close to the UGS and accessing it mainly by foot (Fig. 2e). Accessibility is one of the main factors identified by the exploratory FA for both Vale das Flores Park and Botanical garden.

Tranquillity is associated with UGS either having no sports equipment, such as the Botanical garden (Table 5) or being large enough for sports activities without affecting the park's entire area, such as in the extensive Choupal national forest (Table 5). Tranquillity also seems to be related to higher tree coverage, as in the Manuel Braga park, Botanical garden and Choupal national forest, which comprise medium to high tree coverage (Table 1). In these three parks, tranquillity provides significantly higher motivation levels than the other two UGS (Table 5). This is in line with elsewhere results, as in Trondheim, Norway (Bjerke et al., 2006), México City, Mexico (Ayala-Azcárraga et al., 2019), and Leipzig, Germany (Palliwoda et al., 2020). However, while Palliwoda et al. (2020) reported a negative influence of tree cover on physical interactions in urban parks and green brownfields in Leipzig, our results for Choupal national forest, with over 85% of tree cover, show the highest share of users engaging in physical activities (Table 3). In the Choupal national forest, this difference can be related to both park size and the degree of naturalness of the park (Table 1). A significantly larger park size allows for longer and diversified circuits for walking, running and biking, while the UGS also provides sports fields and separate areas for relaxing. Additionally, Germany's cold climate contrasts with the warm Mediterranean climate in Coimbra, which may explain a different perception about tree cover relevance by UGS users. Tranquillity and landscape beauty and aesthetic enjoyment have been identified as main motivations for visits to UGS elsewhere, either for UGS visitors in Beijing, China (Dou et al., 2017; Sun et al., 2019), or for tourists from both Chinese- and UK-origin (Ren, 2019).

Landscape beauty received the greatest relevance, particularly in the Botanical garden, followed by Manuel Braga park, and Choupal national forest (Table 5; see also Fig. S2, in the supplementary material),

suggesting that higher tree coverage and landscape structure (Table 1) may provide more attractive landscapes. The relevance of tree cover within the landscape was also reported in other studies, such as in Fraser's Hill resort, in Malaysia (Othman, 2015), in a mountain touristic region in Brazil (Bachi et al., 2020), or the Genheyuan region, in northeast China (Dou et al., 2020). Furthermore, the river's presence seems to provide an essential motivation for visitors, as identified in Manuel Braga park, Choupal national forest and Mondego Green park (Table 5). These findings are in line with Schirpke et al. (2013), which states that scenic beauty is positively related to complexity, diversity and structural richness of landscape.

Regarding the parks' dimension, the respondents' attributed relevance is consistent with other studies reporting that UGS dimension can change the distance and time a user is willing to invest to reach it (Van Herzele and Wiedemann, 2003; Rigolon, 2016). This seems particularly relevant for the Choupal national forest users, the most distant UGS. Although UGS multifunctionality provides particular characteristics that suit or fulfil the user's needs (see Section 4.1), they accept to travel longer distances. This is also in line with Rall et al. (2017) regarding the need for parks to provide particular characteristics according to the local community's context to offer real benefits to their users.

Urban equipment as motivation was considered somehow relevant in all parks, except in Vale das Flores park, classified as clearly influential in the reason to visit (Table 5). We believe this may be linked to the presence of families with children looking for a safe environment for their offspring's, since the park is central in the urban area, with adequate, diverse and well-maintained equipment, characteristics identified by several authors as relevant for adult's motivation for visits with children (Bedimo-Rung et al., 2005; Jansson, 2010; Jansson and Persson, 2010; Refshauge et al., 2012; Veitch et al., 2006). Based on the collected comments during the survey, users from the other four parks find the equipment to be relevant, similar to findings elsewhere, e.g., in parks in Australia (Holman et al., 1996), the United States and Denmark (Refshauge et al., 2012), although not essential to ensure their visit.

Social interaction opportunities, which are considered a positive and relevant outcome of UGS visitations (Enssle and Kabisch, 2020; Rivera et al., 2021; Veitch et al., 2006), were considered influential to visit all parks, except for the Botanical garden. Visitors from this park are less interested in the social interaction opportunities, visiting the space with friends or family (as commented by the interviewees and directly observed by the interviewers), not expecting to meet other people in the garden. On the other hand, Vale das Flores park recorded the highest share of users considering social interaction opportunities as fundamental in their choice for this park, highlighting a pattern of younger users visiting the park to interact with other users through group sports, similar to findings reported by Rivera et al. (2021).

5.5. Perceived ecosystem disservices associated with UGS

EDS are not seen as a relevant problem in most UGS investigated, with most visitors declaring to have never felt any problem (Table 5), similar to findings from Rall et al. (2017). Nevertheless, some visitors have reported few problems related to plagues (e.g., mosquitoes) in Choupal national forest and Mondego Green park, possibly favoured by the proximity to the Mondego river. Maintenance issues were identified by some visitors in all UGS (Table 5), but mostly in (i) the Choupal national forest due to degraded vegetation in some areas of the extensive UGS, and (ii) the Manuel Braga and Mondego Green parks, associated to water quality problems driven by both litter and debris transported by the river during flood episodes (Table S1), mentioned by the users during the interviews. These water quality issues are in line with findings in Helsinki (Finland) by both Marttila (2007) and Lodenius (2004). Although most visitors never felt insecurity problems, a few interviewed reported them as very low relevance or frequency, particularly in Manuel Braga park (Table 6 and Table S10), with people avoiding visiting it mainly during late evening and night. This is similar to findings in Berlin, Germany, by Rall et al. (2017). In Coimbra, most park users (90%) also do not report problems with dangerous animals, and the few visitors identifying the problem consider it of low magnitude and driven by the presence of dogs without a leash, according to interview clarifications during the field survey (Table S10). This agrees with findings from studies such as the one by Andrews and Gatersleben (2010), focused on the perceptions of danger and fear, or the one by Lis et al. (2019), on the perceived danger by women of walking paths, in Poland, Latvia and China.

5.6. Limitations of the study

Field survey based on face-to-face random interviews has limitations regarding sports practitioners (e.g., bikers, water sports), given the difficulty of interrupting and questioning them. The survey was implemented in a single period – summer – and it cannot be considered representative for the average annual use of the study areas. Nevertheless, UGS are largely frequented during the summer. Another limiting aspect was the survey's timing, developed during the COVID-19 pandemic, with the country partially in lockdown. It was challenging to address seniors since they belong to a risk group, and thus they might have been underrepresented in this study. Changes in social and economic aspects of the society raised by the pandemic situation may have led to visitors' changes and their perception of UGS. For example, several fitness activities moved out from indoor spaces to the UGS, usually on shaded areas. Furthermore, from the interactions with several interviewees, it was perceptible that while more people have more time to use UGS, they face socioeconomic struggles. Thus, visiting a UGS is a way of coping with emotional stress and well-being issues, as reported by several authors (e.g., Croucher et al., 2008; Soga et al., 2020).

5.7. Implications for UGS management

Globally, increasing attention is expected to be provided to UGS in the future, given both the United Nations SDGs and the EC Biodiversity Strategy for 2030. The latter is expected to set up an EU Urban Greening Platform to support Urban Greening Plans' development by the end of 2021 (EC, 2020). This can be good timing for Coimbra municipality (and other municipalities across Europe) to consider developing plans for a network of connected and multifunctional UGS, which can foster CES, human well-being and social justice.

To achieve effective planning and management of UGS, it is crucial to consider both the inhabitants' perceptions and preferences for CES, and the city-specific context regarding park availability (Bertram and Rehdanz, 2015; Almeida et al., 2018). UGS design can positively or negatively influence UGS use (e.g., Rigolon, 2016; Ayala-Azcárraga et al., 2019) while influencing residents' attachment to places (von Wirth et al., 2016). The lack of public involvement in some UGS design has led to some projects' failure, as reported by Jim and Chen (2006). Concerns about conflicting demands due to socioeconomic or cultural heterogeneity in UGS-scarce areas (e.g., preference for quiet or passive recreation vs. social or active activities) should be carefully addressed at the UGS planning and design stages (Riechers et al., 2018). Multifunctional spaces, however, raise challenges to management (Cowie et al., 2007; Plieninger et al., 2012).

Although there is no relevant tradition of public participation in UGS design in Coimbra, the involvement of citizens and the integration of their preferences and expectations could lead to the increasing use of UGS and a greater degree of social cohesion by promoting attachment to those places and a sense of ownership, as observed by Fors et al. (2015). This can result in a better and more effective green space administration and in additional benefits to more people (Dunnett et al., 2002; Marcus and Francis, 1998).

This study shows that accessibility, proximity to home and transport type are key factors influencing most UGS visits. However, although

most users identified accessibility to a UGS as an important factor affecting their use, over 90% of the interviewees live closer to another green space (≥0.5 ha) than the one they were interviewed. Thus, distance can be a secondary motivation compared to other factors such as multifunctionality (broad CES-related activities offer), perceived physical, emotional and social benefits, or even aesthetic enjoyment, as in the case of Botanical garden.

The well-being factor, involving both physical and emotional well-being benefits resulting from the activities performed were identified as a fundamental factor in 4 out of the 5 parks. On the other hand, in some cases (e.g., Mondego Green park), age group and average monthly income are strongly and inversely related to sports facilities. The tranquillity of space and landscape beauty is strongly linked and is relevant for UGS visit, being identified as an influential visitation factor in Manuel Braga park. Although accessibility and proximity are relevant to most users, these look for UGS fulfilling their CES demands, with multifunctional spaces providing high physical and emotional well-being levels. Furthermore, users are willing to travel longer distances rather than visit the closest UGS. Our results suggest that potential multifunctional use can be affected by UGS size, distance to the user, water elements in the landscape, and sports equipment offer. These conditions pose further challenges to municipalities concerning the management of multifunctional green spaces.

We discussed the relevance of the low availability of trees and shadows in the Mondego Green park and Vale das Flores park during our field survey. Both parks share the lowest tree coverage (<21%) and a ratio that is well under the "40% sun, 20% half shade and 40% shade" proportion recommended by Klemm et al. (2016). This aspect is relevant not only because the demand for shaded areas is increasing (Lo and Jim, 2012; Riechers et al., 2018) but also because the use of shading in UGS may become increasingly important due to the projected warming for the Iberian Peninsula (Pereira et al., 2017).

Based on our survey, the UGS design process in Coimbra – potentially adaptable to other locations – should include, among other considerations: (1) multifunctionality based on CES demand according to socio-demographic characteristics; (2) adequate spatial distribution of equipment inside the UGS itself, to ensure a successful coexistence of the diverse and potentially conflicting social, ecological and practical functions (Jim and Chen, 2006); and (3) careful consideration of new UGS locations within the city, based on accessibility to current UGS and equal access to all citizens.

6. Conclusions

The results from this study show a complex web of factors influencing CES use in differentiated UGS in Coimbra. Socio-demographic characteristics influencing UGS use include age group, average monthly income, transport type to UGS, and distance to park. The interviewed engaged on a large set of diversified activities, grouped into physical interactions such as walking, running, or playing sports; experiential and aesthetical interactions, including mainly making use of shade and shelter, and enjoying landscape beauty; and social interactions, dominated mainly by meeting people, and activities with children. Physical interactions, including walking, strolling and hiking, the practice of sports, walking the dog, and running are among the most relevant CES-related activities in use. However, differences between parks were identified and partially driven by specific biophysical characteristics of the UGS.

Characteristics such as UGS size, the distance between UGS and users' residence, water elements in the landscape, and available sports equipment affect the UGS multifunctional use. Although presenting additional management challenges, multifunctional UGS can provide a diversified set of CES-related activities to be both offered and enjoyed by urban dwellers, even in limited-size areas (e.g., Vale das Flores park).

A common characteristic to most UGS is the perceived high level of physical and emotional well-being benefits associated with the activities performed, with well-being showing up as the main factor influencing UGS use. Although the perceived benefits regarding physical well-being can be linked to the activities performed and thus can differ between UGS, the perception of benefits regarding emotional well-being is common to all outdoor activities, independent of the chosen UGS. Accessibility, landscape beauty, and tranquillity are the main motivations identified by the UGS users, receiving higher relevance rankings. Albeit accessibility is considered a fundamental factor in UGS use, results show that CES offer and UGS characteristics can influence users' choices.

Disservices, however, are generally not perceived as relevant by the users, although plagues (e.g., mosquitoes) and other possible dangerous animals recorded average concerns from a small number of users (the latter associated with dogs without a leash).

Based on users motivations and perceptions regarding the CES and disservices in UGS, as well as on demand for multifunctional UGS, the design of these areas should include (i): implementation of multifunctional spaces based on CES demand, according to the socio-demographic characteristics of the population; (ii) adequate spatial distribution of facilities inside the UGS, to ensure a successful coexistence of diverse activities (e.g. sport and relaxation) and mitigation of potential conflicts between different users; and (iii) careful assessment of new UGS location, considering effective accessibility and current UGS offer, including consideration of UGS type, size, and inclusion of facilities and equipment. Findings can support UGS managers to better understand users' needs and expectations, potentially positive implications for UGS design and management, aiming to maximize human well-being.

CRediT authorship contribution statement

Luís V. Pinto: Conceptualization, Methodology, Visualization, Software, Statistical analysis, Writing- Original draft preparation. **Carla S. S. Ferreira:** Conceptualization, Methodology, Supervision, Writing-Reviewing and Editing. **Paulo Pereira:** Conceptualization, Methodology, Statistical analysis, Supervision, Writing- Reviewing and 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.

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Appendix A. Supplementary data

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