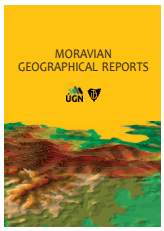

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COVID-19 pandemic and urban green spaces: Shifting usage behaviours and perceptions in Leipzig (Germany)?

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Abstract

Crises such as the COVID-19 pandemic challenge some established human-landscape interactions notably. In this article, we analyse whether the pandemic had an impact on the perception of urban green spaces (UGS) and usage behaviours in Leipzig, Germany. We use a quantitative survey to understand people's attitudes. Our study is novel in that it firstly explores the relationship between UGS and visitors during the final phase of the COVID-19 pandemic (winter 2022/2023), contrary to the vast majority of already existing studies that relied on digitally distributed surveys due to the lockdown protocols. Secondly our study does not apply exclusively online methods to reach out to the participants. The survey results show that about 40% (of the 115 participants) use parks more frequently during the final phase of the COVID-19 pandemic compared to before 2020. Characteristics such as proximity to home, naturalness and cleanliness have become the most relevant. We see a notable increase in the demand for secure public green spaces, particularly among female visitors. Every second respondent confirmed experiencing considerable difficulties when accessing UGS, revealing the existing (spatial) deficits in environmental justice. These results should be considered by urban planners to adapt UGS to the changing demands of the citizens.

Keywords: *Urban green spaces (UGS), COVID-19, usage behaviour, ecosystem services, environmental justice, Leipzig, Germany*

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1. Introduction

In March 2020, the World Health Organization declared COVID-19 a global health emergency (WHO, 2020). Consequently, governments around the globe imposed social and mobility restrictions. To stop the spread of COVID-19, the population was called upon to stay at home and to avoid social encounters for several weeks, such as for example during the lockdown protocols in Germany (German federal government, 2020).

The pandemic, but also the imposed restrictions, had a strong impact on various aspects of our everyday life. The use and perception of urban green spaces (UGS) is one of these aspects, where notable changes due to the pandemic are discussed. Several studies identified the regular usage of UGS as an effective strategy to cope with the challenges imposed by the pandemic. For example, lockdown protocols and other restrictions provoked psychological distress among people, particularly in densely populated urban areas (Xiong et al., 2020; Passavanti et al., 2021). The closure of UGS mainly affected low-income citizens because they often live in quarters with the least green space (Astell-Burt et al., 2014) and were not able to compensate with private green spaces (Geary et al., 2021). Hence, it is not surprising that even at an early stage of the pandemic, researchers started to discuss the changing relationship between society and (public green) space (Honey-Rosés et al., 2020; Yamazaki et al., 2021).

One of the main questions now is how this changing relationship is manifesting itself and to what extent it represents a reconfiguration of established habits. According to Schot (2020), COVID-19 has indeed a certain potential to induce profound changes, referred to as "deep transition". Such profound changes are becoming visible in the shift in everyday practices, e.g. new and different user behaviours in UGS, which have been documented in different case studies (Grima et al., 2020; Yap et al., 2022). The question remains, however, as to whether this change will also persist in the final phase of the pandemic.

2. Theoretical background

2.1 Urban green spaces and (cultural) ecosystem services

Analysing (the changing) patterns of green space usage has been the subject of research prior to COVID-19. Since the 1990s, the discussion was fuelled by establishing ecosystem services as a new concept that describes services provided by nature and

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used by humans (in an active or passive way; Mager et al., 2021). This concept allows for ecological aspects and their values to be considered in society during planning processes (Spyra et al., 2019). Hence, the transparent assessment of such services, and the communication with citizens and stakeholders about it, is regarded as a basis for a more participative planning approach (Mager et al., 2021, p. 41).

There are different types of ecosystem services, such as providing food and water or regulating natural systems (Huerta, 2022). In this study, we will focus on non-material benefits, labelled as cultural ecosystem services (CES). CES provide space for recreational activities and enhancement of well-being (MEA, 2005), both physical and mental (Ihlebæk et al., 2018). These services are difficult to quantify, and comparatively less studied, such as the differences in the usage of UGS around the world, which depend on cultural background and environmental influences (Fish et al., 2016). In addition, "CES are outcomes of the dynamic, complex, physical or spiritual relationships between ecosystems and humans, across landscapes, and often over long time periods" (Hirons et al., 2016).

Crises can reshape or renegotiate such long-established relationships, making CES a compelling object of study in crisis contexts. For example, ecosystem services in general have been shown to contribute to overall well-being by promoting mental health and reducing stress levels (Kabisch & van den Bosch, 2017, p. 208 f.; Bratman et al., 2019; Samuelsson et al., 2020). With growing spatial polarisation due to gentrification (Pearsall & Eller, 2020), however, or short-term rental induced touristification (Hübscher & Kallert, 2022), access to such services is not distributed equally throughout urban spaces. On the contrary, UGS have become a decisive factor in revaluation and speculation in local housing markets and often lead to rising prices (Schwarz et al., 2021, p. 10).

From an environmental justice perspective, this raises the question of how the COVID-19 pandemic affected everyday practices of the city's residents with regard to CES in urban green spaces. On the one hand, the importance of UGS during the lockdown protocols is undoubted, as they "allowed residents to perform physical activities, enjoy natural landscapes, and relax while socially distancing, thus making them a highly effective public health tool" (Huerta, 2022). On the other hand, Huerta (2022) rightly observes that there is a growing number of studies that reveal how low-income neighbourhoods are usually disadvantaged when it comes to the distribution of and access to UGS in cities. This is particularly relevant, as we know from previous studies that socially disadvantaged neighbourhoods have higher health burdens and were more vulnerable during the pandemic (Wade, 2020; Sharifi et al., 2021). Using environmental justice as a lens helps to unravel such (spatial) inequalities.

2.2 Research gap and objectives

There are different observations regarding the use of UGS during COVID-19. Some studies report an increase, others a decrease, depending on the geographical region and the time period (Jay et al., 2022). The same applies to attitudes towards environmental issues in general, where rather divergent results are observed (Marais-Potgieter & Thatcher, 2022). What is beyond any doubt is that pandemics are seen as critical moments where lifestyles change, and thus how UGS are being used and by whom (Yamazaki et al., 2021). On that basis, we identify two main research gaps in the relationship between UGS and citizens.

Firstly, most of the existing studies have focused on the immediate effects of the pandemic, comparing a shift in perceptions and behaviours with pre-COVID-19 settings. Accordingly, the question if this shift is persistent, even during the final phase of the pandemic, remains unanswered.

Secondly, during the pandemic, most of the researchers relied exclusively on online methods to reach out to their participants. For example, Cheng et al. (2021) analysed posts on social media platforms to assess the use and perception of UGS. Others make use of online surveys distributed on the internet (Lopez et al., 2021; Poortinga et al., 2021; Noszczyk et al., 2022). Online tools were certainly a valuable approach, particularly in times of restrictions due to the pandemic. At the same time, such methods exclude certain social groups from participating, for example those who are less media-savvy or less present on social media platforms.

In our study, we address both of the aforementioned gaps. Firstly, our study is novel, as it takes place during the final phase of the pandemic. With large parts of the (German) population vaccinated and a decreasing number of infections during winter 2022/2023, a "top German virologist says COVID-19 pandemic is over" (Deutsche Welle, 2022). Hence, the aim of this paper is to find out whether COVID-19 has changed the reasons for visiting UGS, compared to before the pandemic. We also want to find out to what extend this change is becoming permanent (Honey-Rosés et al., 2020), and we seek to understand which characteristics of urban green spaces and CES are important to meet the needs of their users and ensure environmental justice.

Secondly, our objective is to address a broad audience. Here, we will combine both online and offline approaches. This will help us to reach out to our potential participants, even during the winter season, but also to include a wide variety of people.

We choose Leipzig, Germany, as a case to study for several reasons. With 25 public parks and one city forest, Leipzig has the sixth highest green space density among large German cities, which amounts to approximately 17.15 m^2 per resident, or a total of 9.98 km^2 (Stadt Leipzig, 2023a; Keller, 2023). There is a diversity of UGS in Leipzig that encompasses both designed green spaces, but also an inner-city floodplain forest, which is the second largest of its kind in Germany (Kasperidus & Scholz, 2011). Unlike other cities (Huerta, 2022), the city administration in Leipzig provides public data about the distribution, characteristics, and area of UGS (Stadt Leipzig, 2023a), which makes it easier to conduct research about this topic.

With currently 616,000 residents, Leipzig has been Germany's fastest growing city over the last decade and has grown by about 100,000 residents since 2010 (Stadt Leipzig, 2023b). This strong growth has changed the framework of urban development in the city completely. The vacancy rate on the housing market dropped from 9.7% in 2010 to only 2.5% in 2021 (Statista, 2022). Simultaneously, displacement pressure is becoming stronger due to inner-city suburbanisation (Koumparelou et al., 2023), green gentrification (Ali et al., 2020) and commercial gentrification (Hübscher et al., 2020). Exploring the changing use of UGS in this setting is particularly compelling. Considering the abovementioned data, we presuppose an increasing pressure on UGS in Leipzig due to the sheer growth of 100,000 potential new users within the last 10 years.

We also see Leipzig as an interesting case to study with regard to the COVID-19 restrictions and their impacts. Germany faced several (strict) lockdown phases that included different measures, e.g. closed schools, limitation of social contacts in public space, and even a curfew (for an overview see Federal Ministry of Health, 2023). Compared to other countries, Germany's restrictions were rather moderate (Hale et al., 2021). Within Germany, Saxony (which is the German federal state or Bundesland where Leipzig is located), saw the second highest lethality rate, indicating the relationship between the number of deaths and the number of infections (Siekmann & RKI, 2023). This means that Leipzig is a city where the pandemic was particularly visible, within the German context.

On this basis, we structured our paper as follows: Section three describes the methods and data collection. In section four, we present the results. Section five discusses the findings and puts them into context with the current state of research. Section six draws a conclusion.

3. Methods

3.1 Study design

We conducted an online survey using a quantitative questionnaire (see supplemental material). Our aim was to explore the changes in behaviour and perception of people using UGS in Leipzig. Due to the high degree of standardisation, we were able to directly compare responses and draw conclusions (Mayer, 2013; Kromrey et al., 2016).

We decided to carry out the survey online via the LimeSurvey platform and created a link and a QR code which we distributed among UGS visitors on site in December 2022 and January 2023. This decision was influenced by the cold and wet weather conditions during these winter months in Germany. Conducting the survey online was one way to ensure a high level of participation, because it allows participants to complete the questionnaire from their homes and without the influence of the instructors (Mayer, 2013). By distributing the QR codes in the UGS, we ensured that we were reaching out to current park users. By means of a pre-test, we confirmed the functionality of both the process and the survey. If a person was interested in participating, but did not feel comfortable doing the survey online, we would do it together on site using an end device such as a mobile phone. We designed the questions in such a way that they offer as little scope for interpretation as possible. Additionally, all participants answered the questions in the same order and form. This guarantees a high degree of reliability and comparability of the study (Moosbrugger & Kelava, 2020).

Our survey was structured in thematic sections (Mayer, 2013; see Tab. 1). At the end, we asked some demographic questions, which we used to analyse the results of the different user groups. Between each section, we provided a short transition sentence that briefly explained the next subtopic. We used closed questions with predefined answer options, which we based on a previous field observation and categories found in other studies (e.g. Walter, 2015) in order to ensure data comparability. Participants were able to give their own answers in some cases, however, within the category "other". We also used filtering questions to sort out those aspects that were not relevant to the participants. Thus, we gave our participants the opportunity to complete the questionnaire even if they could not answer some questions (Döring & Bortz, 2016).

There are multiple techniques to operationalise CES. In accordance with the classification of methods presented by Hirons et al. (2016), we mainly apply scaling methods. Hence, the response format for some of the questions was a rating scale (e.g. "Please specify whether the following park characteristics have become more or less important to you as a result of the COVID-19 pandemic"). A rating scale is easy to tick off and provides interval-scaled data that can be analysed statistically. We decided to use an odd number of levels, namely a five-point scale that ranged from "+ 2" (more important) to "– 2" (less important). This gave participants the possibility to choose a neutral option. Apart from a descriptive statistical analysis, we also performed one and two-sample t-tests and ANOVA.

3.2 Choice of urban green spaces

In order to choose appropriate case studies (meaning the locations where to approach the participants), the first step was to identify all UGS in Leipzig, based on the town hall's online database (Stadt Leipzig, 2023a) and desktop research. On that basis, we chose four parks that were as different as possible according to criteria such as location, size, amenities, and socio-economic factors. In doing so, our aim is to reach a representative sample of UGS visitors in Leipzig, rather than comparing different parks with each other.

We have chosen Robert-Koch-Park, Lene-Voigt-Park, Rosental and Lennéanlage (see Tab. 2 and Fig. 1) as case studies, because these spaces display a certain diversity within the city of Leipzig (larger and smaller parks; central and peripheral locations, different degrees of naturalness). Embedded within a highly dynamic urban context, these UGS have been shaped and designed by society to varying degrees. Due to this variety of green spaces, we apply the broad concept of urban green spaces (UGS) in this paper. UGS encompass publicly accessible spaces "with a high degree of cover by vegetation" of either natural or designed origin (Schipperijn et al., 2013, p. 110). Simultaneously, our four selected cases are also labelled as parks by Leipzig's town hall (Stadt Leipzig, 2023a), which is why in our paper we will use both terms.

Rosental is one of the largest UGS in Leipzig with extensive grass areas. We have chosen the Lene-Voigt-Park because of the numerous amenities it provides in an emerging neighbourhood with a very low average age of residents (Stadt Leipzig, 2023b). Robert-Koch-Park is situated in Grünau, a district of Leipzig with the highest unemployment rate (Stadt Leipzig, 2023c) and the lowest income (Stadt Leipzig, 2023d) in the city. In addition, we started to conduct the survey in Oberer/Unterer Park in the city centre. We decided to change the park for reasons of personal safety, however, as we were worried about the high level of crime

Part	Aspects
A/ Introduction	• Place of residence in Leipzig (neighbourhood)
	• Time living in Leipzig
B/ Current use of UGS	• Frequency
	• Purpose
C/ Change of usage	• Compare the current usage behaviour to the pre-COVID-19 context (with regard to activities, frequency, etc.)
	• Is the change (if any) persistent (probability)?
D/ Characteristics of UGS	• Assessment of the perceived characteristics of UGS, their importance and how they changed due to the pandemic
E/ Most frequently used UGS	• Designation of the personally most frequently used UGS in Leipzig and assessment whether this preference has changed due to the pandemic
	• Time taken and means of transportation to reach this UGS
F/ Demographic questions	• Age, gender, profession
	• Household income
	• Opinion about the current restrictions due to the pandemic

Tab. 1: Topics and aspects in the survey
Source: authors' elaboration

Parks	Robert-Koch-Park	Lene-Voigt-Park	Rosental	Lennéanlage	
Size (ha)	25	11	70–118	3.3	
Amenities	Playground, many trees and greenery	Many amenities (sports facilities, playground, barbecue), less green	Café, playground, extensive green spaces	Seating, several trees	
Location	Adjacent to a hospital in a peripheral neighbourhood	Located in a dynamic and emerging neighbourhood	Adjacent to the zoo, close to the city centre	City centre	
Neighbourhoods	**Grünau-Ost**	**Reudnitz-Thonberg**	**Zentrum-Nordwest**	**Zentrum**	**City of Leipzig**
Population in 2022	7,775	23,293	11,042	1,901	624,689
Recreational area [ha] per resident (in 2020)*	0.0012	0.0010	0.018	0.0026	0.0055
Population growth 2012-2022 [%]	5.9	24.4	11.7	11.6	18.2
Average age in 2022 [years]	51.5	36.5	39.5	44.2	42.2
Net income in 2021 [€ per month]	1,400	1,700	2,200	2,000	1,592
Share of foreigners in 2022 [%]	14.3	14.0	10.4	30.7	13.4
Unemployment rate in 2022 [%]	7.2	4.4	2.9	4.0	5.1

Tab. 2: Selected UGS in Leipzig and their respective neighbourhoods
*Note: *There is no public data available on the amount of green spaces per neighbourhood in Leipzig. The statistic on recreational area includes green spaces, but also entails other recreational spaces that are not regarded as green spaces.*
Source: authors' elaboration based on Stadt Leipzig (2023a–d)

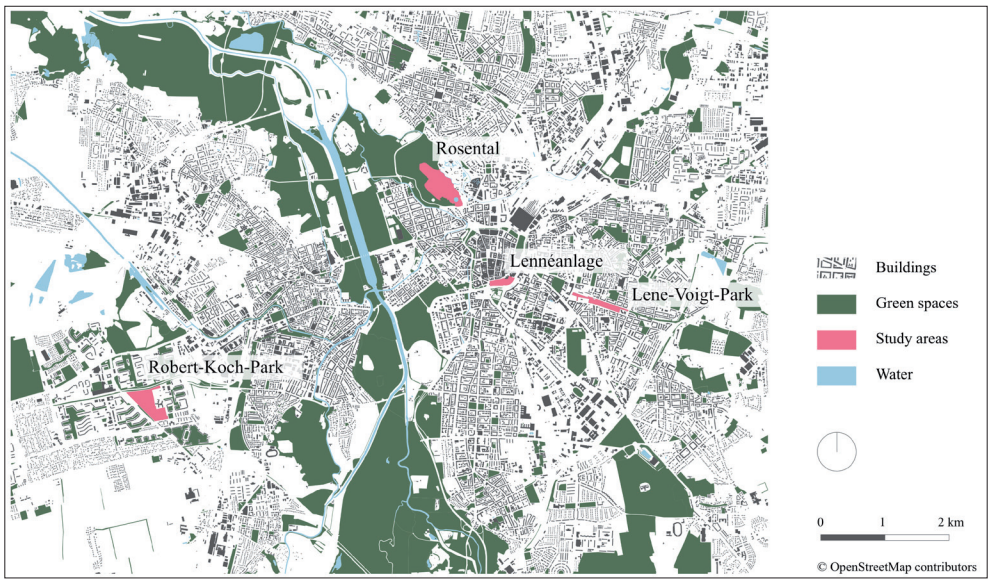

Fig. 1: Green spaces and the selected study areas in Leipzig
Source: authors' elaboration based on Open Street Map and Geofabrik GmbH (2022)

and did not feel safe during certain hours. Instead, we changed to Lennéanlage. Both parks have similar characteristics, particularly in terms of location (in the city centre) and size.

To conduct our online survey, we decided to provide QR codes. These codes were distributed in the four selected parks during different time slots (7–9 am, 12–2 pm, 3–5 pm, 6–8 pm), on several weekdays and weekends. In addition, the survey was carried out in common areas of each park, such as the entrances, and every third person or group of people was approached. This ensured the objectivity of the study and guaranteed that the sample was not biased towards a particular type of user (Moosbrugger & Kelava, 2020, p. 18). Within one month (14th of December 2022 to 14th of January 2023) we covered all time slots in each UGS.

3.3 Statistical Analysis

We distributed 439 QR codes in the chosen parks in Leipzig. In total, 142 individuals commenced the survey, and 115 completed it (response rate: 26.2%, completion rate: 81.0%). To analyse the sample, we started with a descriptive analysis of each question. We were particularly interested in the questions about changes in usage behaviour which were Likert-scaled. For better interpretations in further steps, we conducted a one-sample t-test to check if the mean differs significantly from the midpoint (0) of the scale (Bortz & Schuster, 2011).

In addition, we used an independent sample t-test for one and two groups and analysis of variance (ANOVA) for more than two groups (Völkle & Erdfelder, 2010, p. 456) to analyse mean differences between groups (e.g. students, non-students, etc.) for certain factors (categories such as well-being and social interaction). Several textbooks mention that a normal distribution is required in order to use these tests. As a result, we examined the distribution visually and decided to use the t-test because we did not identify severe deviations from a normal distribution. Some more recent publications argue that t-tests are robust to violations of the normal distribution with sample sizes greater than 30 anyway (Herzog et al., 2019; Rasch et al., 2011; Pagano, 2011). This is also the reason why we decided to not dig deeper into this analysis.

One major objective was to compare income groups, different occupations and age groups with each other for certain factors simultaneously using an ANOVA. The ANOVA did not yield significant results, however, as the group sizes were too small (Bortz & Schuster, 2011, p. 481). Instead, we only identified

some tendencies in the results (Section 4). We are also not able to make significant statements about groups such as pensioners, unemployed persons or people identifying themselves as non-binary, due to small group sizes. Using independent t-tests, however, allowed us to identify some significant differences between groups, which we present in the results.

4. Results

4.1 Participants

We expected that the winter months and the associated weather conditions would make it more difficult to find participants in the parks. Still, we received 115 fully completed questionnaires for analysis. According to Slovin's 1960 formula (Tejada & Punzalan, 2012), this is enough participants to have an alpha error tolerance of less than 10%, meaning that we are willing to accept a 10% chance of false rejection of our H_0 hypothesis when it is actually true. Still during the summertime, people use UGS more often and for different activities than in the winter. That is why we asked for activities and behaviours during summer months or days with good weather conditions, rather than winter months.

By conducting an online survey and distributing QR codes in the chosen parks, our aim was to address a broad variety of park users, which previous studies had difficulties with based on the lockdown protocols. Indeed, we reached a slightly higher proportion of participants aged 66 or older (4.3%) compared to other studies (3.5%; Noszczyk et al., 2022). The majority of codes were circulated in Lene-Voigt-Park (43.3%), followed by Lennéanlage (25.9%) and Rosental (23.2%). The fewest codes were distributed in Robert-Koch-Park (7.5%). Approximately one fifth of the participants live in Reudnitz-Thonberg, which is the neighbourhood surrounding Lene-Voigt-Park, and this also reflects the QR code distribution named above. With the exception of Reudnitz-Thonberg, the distribution of participants throughout the city was relatively even. People from 38 out of 63 neighbourhoods in Leipzig participated. Table 3 shows some demographic and socio-economic characteristics of the participants.

4.2 General park usage behaviour

The results show that the vast majority of participants indicated feeling generally little affected or not affected at all by COVID-19 (94.1%, in winter 2022/23). Three quarters of all participants confirmed that they used UGS in the summer or on days with good weather at least once a week. To analyse this in more detail, we asked the participants about their activities in UGS. Based on "physical and intellectual interactions" provided by CES (Hirons et al., 2016, p. 549), we predefined the following six categories, which we based on a previous field observation and categories found in other studies (Walter, 2015) (transit, walking the dog, well-being, social interaction, sports, and education). The most frequent use of parks by participants was for transit routes (Fig. 2). Two thirds pointed out that they used parks for personal well-being on a weekly basis. The categories of walking the dog and education were the two least frequent usage categories.

Gender	Frequency	%	Age group	Frequency	%
Female	56	48.7	18–24	37	32.2
Male	58	50.4	25–40	55	47.8
Non-binary	1	0.9	41–65	18	15.7
			66+	5	4.3
Total	**115**	**100.0**	**Total**	**115**	**100.0**
Occupation	**Frequency**	**%**	**Household income (€)**	**Frequency**	**%**
Pupil	2	1.7	1,249 or lower	47	40.9
University student	45	39.1	1,250–1,749	13	11.3
Employee	50	43.5	1,750–2,499	19	16.5
Self-employed	8	7.0	2,500–3,499	13	11.3
Unemployed	2	1.7	3,500–4,999	10	8.7
Retired	5	4.3	5,000 or higher	13	11.3
Others	3	2.6			
Total	**115**	**100.0**	**Total**	**115**	**100.0**

Tab. 3: Demographic and socioeconomic characteristics of the sample
Source: authors' elaboration

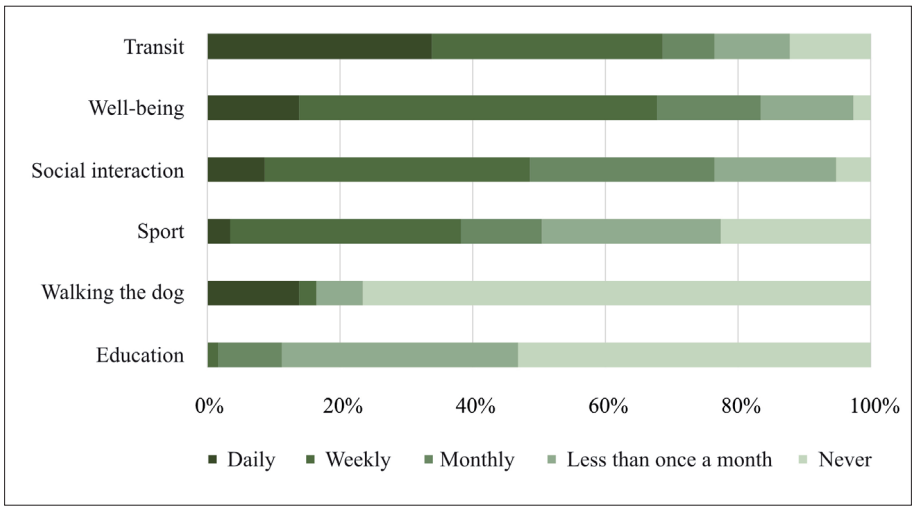

Fig. 2: Frequency and purpose of UGS usage
Source: authors' elaboration

In the survey we asked, "Do you currently use parks more often compared to the winter months before the COVID-19 pandemic?", which was confirmed by nearly 40% of the participants. In addition, 26.9% reported a change in their usage behaviour in terms of what they did in parks and their use of parks for new activities. We analysed this result to see if students showed a different behaviour compared to other groups, such as employees. Here we compared the mean values of both groups with a two-sample t-test, to identify significant differences between the groups. For this t-test the H_0 hypothesis was that students do not use parks significantly more often for new activities than employees. The analysis showed that we can reject this hypothesis with a 5% probability of error and therefore argue that the students tried more new activities than the other groups.

The results of the survey also show that more than half of those who use parks for new activities since the start of the pandemic use them for social interactions and personal well-being. Sports also play an important role in this regard. Looking at the general change in usage behaviour, rather than only new activities, the descriptive statistics show that the mean of all categories is above "0". The question arises if this is a significant effect. The one-sample t-test indicates a significant difference from "0" in park usage with respect to well-being, social interaction, transit, and sports as demonstrated in Table 4. Their means are positive which indicates an increase in usage for these four categories.

On a rating scale, we asked the participants if they practised a certain use with higher (+ 2) or with lower frequency (− 2) compared to before the pandemic. 0 meant there was no change, so an average higher than 0 would indicate an increase in usage. Here, "well-being" reached the highest average score (0.74), while "social interaction" came second (0.57; Fig. 3). Also, the uses "transit" and "sports" reached higher frequencies. Contrary to that, "walking the dog" and "education" scored only 0.07 and 0.05 respectively, which were the only categories without a significant increase ($p > 0.05$). Still, the statistical tests have shown significant differences between the categories, with the social and personal functions of the UGS being those uses that increased most during the pandemic.

Compared to their pre-COVID-19 usage behaviour, 59.1% of the participants said they did not use parks more often at the time they were asked. In contrast, the distribution by category gives a different picture (Fig. 3). According to this distribution, at least 45% of them use the parks more frequently. In addition, almost 85% of participants stated that their changing usage behaviour is more likely or very likely to be permanent, even in a post-COVID-19 setting.

4.3 Characteristics of parks

The importance of characteristics of UGS depends on the needs of their visitors. In this questionnaire, we asked for the changing importance of several characteristics since the beginning of the COVID-19 pandemic (size, proximity to home, naturalness, sports grounds, playgrounds, security, infection protection, places to sit and cleanliness of a park).

Figure 4 illustrates that all these characteristics are, on average, more important to participants today compared to before the pandemic. Again, a one-sample t-test was used to test whether the means of these characteristics differed from the scale midpoint (0, no change). The test revealed a significant difference to the scale midpoint ($p < 0.05$) for all characteristics, except for playgrounds. The characteristic with the highest growth in importance for the participants since the beginning of COVID-19 is the location

	Mean*	Standard deviation	T	Df**	One-tailed p	Two-tailed p
Well-being	.74	.839	9.452	114	< .000	< .000
Social interaction	.57	.928	6.634	114	< .000	< .000
Sports	.29	.710	4.332	114	< .000	< .000
Transit	.27	.717	4.030	114	< .000	< .000
Education	.06	.566	1.152	114	.126	.252
Walking the dog	.05	.510	1.096	114	.138	.275

Tab. 4: T-test of changes in usage behaviour
*Notes: *All items used a response scale of − 2 (less use) to + 2 (more use). One-sample t-tests were used to examine whether means differ from the midpoint of 0; **Degrees of freedom*
Source: authors' elaboration

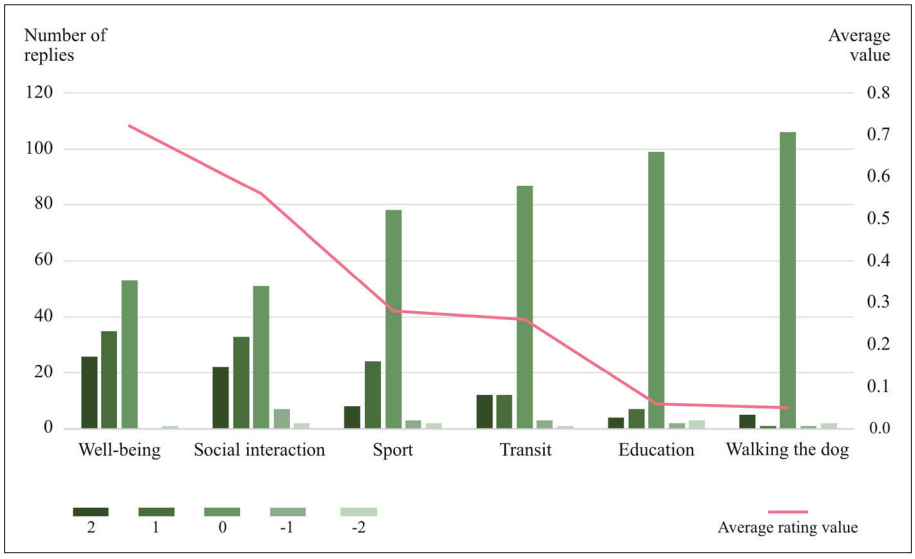

Fig. 3: Change in park usage since COVID-19 from higher frequencies (+ 2) to lower frequencies (− 2)
Source: authors' elaboration

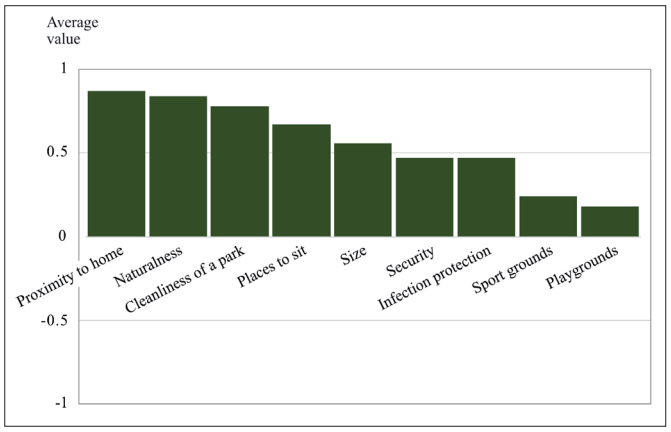

Fig. 4: Changing importance of characteristics in UGS since the beginning of the COVID-19 pandemic from strong increase (+ 2) to strong decrease (− 2) in importance
Source: authors' elaboration

relative to their homes, with an average value of 0.98 (on a scale from + 2 to − 2). The second and third highest growth in importance was for cleanliness and naturalness of the parks with average values of 0.90 and 0.87 respectively.

Furthermore, security in public green spaces seems to be a matter of gender. We analysed this aspect in more detail since we suspected that it would be more important for women than for men (Madan & Nalla, 2016). The one-sided t-test shows that the importance of security in UGS is significantly higher ($p < 0.05$) for women than for men with values of 0.78 for women and 0.28 for men (on a scale from + 2 to − 2). We also analysed the survey regarding differences in income, occupation and age. For that we can identify differences in the means, but they do not reach the required level of significance (5%). This means that we cannot make any significant statements about them but can only point to certain trends. Nevertheless, our survey shows that the importance of sports facilities seems to have increased more for people with lower incomes than for those with higher incomes. This is also observable for the attribute of places to sit and the naturalness of the park, as well as for the activities of transit, well-being and social interaction. In terms of age, our survey shows that it is mainly younger people (under 25) and people over 65 who have changed their habits and perceptions of parks the most compared to pre-COVID-19. Although explanations and conclusions may seem obvious for some of these results, we cannot provide or draw on them due to lack of significance. They suggest possibilities for further research, however, and could be further explored in a later and larger study.

We found that about 30% of the participants need more than 14 minutes to get to their most frequently used park (by walking, cycling, car or public transport). Since most of the participants prefer to have a park nearby, we also wanted to know if people changed their most frequently visited UGS because of the pandemic, which was the case with 22.6% of the participants. Only two people, however, explicitly stated that COVID-19 was the reason for this change. The participants were sensitive with regard to physical obstacles when going to their preferred UGS: Almost one in two reported traffic problems (such as busy roads without traffic lights, etc.) or even safety concerns.

5. Discussion

This study has focused on the users' perspective on UGS, referring to other researchers' calls to activate and explore local knowledge about ecosystem services (Spyra et al., 2019, p. 1733). We understand cultural ecosystem services as a set of services that highly relate to human values and "do not exist *per se*, but are socially constructed" (Bernaud & Antona, 2014, p. 114). As such, they are the results of a constant (re)negotiation and adaptation of practices. Hence, understanding how current crises reshape the perception of CES will contribute to strengthening the resilience of residents. In this sense, Hirons et al. rightly ask how to "widen the range of people, values, and cultural ecosystem services considered in ecosystem valuations?" (2016, p. 566). Here, our study does not give a final answer. Analysing user behaviour and perceptions, however, is one way to understand ecosystem services, and we have shown how to systematically assess these items in a post-COVID-19 setting.

We conducted a standardised survey which implied several limitations. We will briefly list them before we discuss our findings. Firstly, conducting a questionnaire online may provoke a certain technical barrier, particularly for less media-savvy people. This is a limitation that several studies have faced (see for example Noszczyk et al., 2022; Lopez et al., 2021). Secondly, the questionnaire was written exclusively in German, which creates a language barrier. Thirdly, it is also possible that the results are slightly distorted due to changing the park once, as described in Section 3.2. We still decided to keep the 15 questionnaires from Oberer/Unterer Park because the distributed QR codes could not be filtered out afterwards. Fourthly, we also decided not to include cyclists out of safety concerns in the winter weather conditions. We focused only on actual park users as we conducted the survey only in UGS. Hence, we neglected the perspective of residents who at this moment did not use UGS regularly for whatever reason. Fifthly, another distortion might occur due to the ex-post observation. Participants were supposed to assess their behaviour compared to before the pandemic, which could create a recency bias.

5.1 UGS as places of well-being and social interaction

One of our main findings is that in winter 2022/23, the majority of our participants did not perceive the pandemic as having a large impact upon their everyday life. Exploring our dataset on the use of UGS in Leipzig in more detail, however, we indeed see considerable changes in usage behaviour, which might indicate how the shifting preferences are becoming permanent.

Our study found that almost 40% of the participants in Leipzig used UGS more often than before the pandemic. This value is smaller than in other studies, such as Neumann et al. (2022), who reported a figure of 65% in a representative sample in Germany. This study was conducted in autumn 2020. With the pandemic developing and residents adapting to the changing situations, the lower value in our study may indicate a slow return to pre-pandemic habits. Although 94% of our participants confirmed that they would likely or very likely maintain their (new) habits, further studies are necessary to analyse the permanent character of the observed changes in the following years.

Figure 3 shows that a clear majority of participants changed their frequency of using UGS, with the highest increases being for social interactions, well-being, and sports. This is not surprising given that the lockdown protocols particularly affected these functions and activities. It also shows that parks were important places to maintain mental health, supporting the assumption that city residents have developed a higher awareness of CES functions. In this sense, urban green spaces have benefitted from the shift of these functions from other spaces that were shut down during lockdowns (such as fitness clubs, gastronomy, social and cultural infrastructure, libraries). From an urban design perspective, this means that UGS should provide a large variety of structures (to facilitate the access to different CES and uses such as sports, social gatherings, picnics, or barbecuing), given that the diversity of desired functions in UGS comes with different expectations and perceptions (Kühl, 2019).

We interpret this awareness of different social groups' preferences as a question of interactional justice. This includes asking which social groups are being considered, and which are not, and if UGS

enable random encounters between park visitors (Low, 2013). One way to ensure the inclusion of multiple necessities is to let residents participate in park design and development, improving the procedural dimension of justice (Anguelovski et al., 2020) in UGS development. The observed growing importance of UGS also poses the question of who has access to such spaces, and who does not (distributive justice; Soja, 2010, p. 9). For example, residents in neighbourhoods without sufficient access to green infrastructure experienced less opportunities to shift their activities to UGS compared to residents in greener districts and are probably neglected in our study because they are less present in the parks.

The opportunity to visit UGS becomes a question of the socio-spatial conditions in which the residents live, highlighting how environmental injustice and structural inequalities are related to each other. Cole et al. (2021, p. 72) discuss how the pandemic has not only revealed, but also intensified, already existing inequalities and injustices. For example, Jay et al. (2022) found that in neighbourhoods in the U.S. with higher shares of white and a wealthy population, there was a larger rebound effect of using UGS after the first lockdown protocols (from March to April 2020). During the pandemic, we were also able to see how different job profiles faced different levels of exposure to the virus, such as comparing blue to white-collar workers. Working from home is not possible in every sector, and it is particularly common among the households with the highest incomes and university degrees (Neumann et al., 2022). This shift of the workplace to the home has contributed to the growing importance of UGS in residential areas, while also exposing existing injustices.

Apart from that, we would like to highlight the particular role of university students, as they were one of the largest groups in our data sample (39.1%), although they represent only 6.6% of Leipzig's population (Stadt Leipzig, 2023d). The high share of students might be due to the location of the chosen parks in neighbourhoods where many students live (Lene-Voigt-Park in Reudnitz-Thonberg) or study (Lennéanlage, which is near the city centre and the University of Leipzig). Also, students might be more willing to participate in surveys than other groups and prefer online questionnaires (Król & Hernik, 2020).

The personal living conditions of students could be a further explanation for this high share of university students in our sample. On the one hand, some university students might have a more flexible timetable consisting of lectures and self-learning phases. Other authors document that UGS provide a "safe arena" for students to "maintain social contact with friends outdoors, or to escape their home environment" (Collins et al., 2022, p. 1). Our study confirms this argument, as we find that, relatively speaking, students (0.93) increased park usage more for the purposes of well-being compared to other groups (0.62) in our sample.

5.2 Ensuring access to (safe) parks

The changing relationship between UGS and visitors during and after the pandemic is also a question of who has access, and who has not (distributive justice). In our study, we see at least four relevant dimensions to this question, starting with "distance".

The survey results indicate that the importance of park characteristics has changed, with proximity to home, cleanliness, and naturalness gaining the most in importance. This is in line with what other studies have documented, namely an increase in the popularity of parks perceived as "natural" or "nature-like" during the pandemic (Yap et al., 2022). Proximity to home is even the most important characteristic of parks. Yet, 26.9% of participants have to go or choose to go to a park that is not close to their home (> 14 minutes' distance). This could be due to a different perception of distance, or due to a simple lack of UGS within a reasonable walking distance. As accessibility is a dimension of environmental justice (Mohai et al., 2009), close access to parks is of crucial importance, especially for (families with) children and the elderly due to potential mobility limitations. During pandemics in general, close access becomes even more relevant, "as most urban residents globally experienced mobility restrictions that limit their ability to access distant spaces" (Huerta, 2022, p. 2).

Apart from distance, age seems to be a second factor in determining who has access to CES in urban green spaces. In Leipzig, almost a quarter of all residents are aged 66 or older, which is considerably more than the 4.3% of participants in this age group in our study. The share of this age group is lower compared to other research (which relied completely on online tools; 7% in Lopez et al., 2021; 12% in Crossley & Russo, 2022). Still, this does not mean that our combined online/offline approach was not successful in reaching a wide variety of social groups. It may also show that UGS in Leipzig are generally used to a lesser extent by this age group. "Will the elderly be more likely to stay at home?" (Honey-Rosés et al., 2020, p. 3) due to the pandemic, and afterwards, is hence a question that remains topical.

A third relevant aspect that our study has revealed is safe access to UGS. We examined the perceived safety in UGS as a question of gender and found that participants who identified themselves as female felt less safe in parks compared to the male participants, which is in line with comparable studies (Ugolini et al., 2022, p. 6). In Leipzig, the importance of safety has even increased to a significantly higher level for women than for men when comparing the pre- and post-COVID-19 settings. Safety is therefore a fundamental prerequisite: Without (perceived) safety, people will not use the UGS (Lopez et al., 2021). In order to address this, policy makers and urban designers might consider measures such as installing emergency hubs or improving the lighting concept (Federal Ministry for the Environment, 2017; Tandogan & Ilhan, 2016). A lightning concept must be carefully deliberated, considering the negative impact of light pollution on animals and insects (Eisenbeis & Hänel, 2009). Apart from that, ensuring distributive justice does not only imply providing safe (urban green) spaces, but also safe access to them. Given that half of the participants in our study have concerns about traffic problems and safety, planners should also aim for a better access for pedestrians and cyclists. This is particularly relevant as "public spaces are often the only recreational outdoor spaces for low-income residents and provide relief from cramped living conditions." (Honey-Rosés et al., 2020, p. 10), and are "essential for physical and mental health" (Poortinga et al., 2021, p. 9).

A fourth aspect related to distributive justice is that UGS (under market conditions) are distributed unequally in a city (Kabisch & Haase, 2014). This is because UGS might provoke higher housing prices in surrounding neighbourhoods, as Wüstemann and Kolbe (2017) show in the case of Berlin. Now, with the COVID-19-induced re-evaluation of CES provided by urban green spaces which we observed in our study, we also expect a certain reflection of that in (growing) housing prices. These trends might be overlapped by a growing demand to live in less dense suburban spaces or small and mid-sized cities (Neumann et al., 2022), which would decrease the pressure on inner-city housing markets.

6. Conclusions

The extent to which COVID-19 leads to a (long-term) transformation in the use and perception of urban public (green) spaces is the key question (Honey-Rosés et al., 2020) – and our paper provides some further insights into the early post-COVID-19 phase. Contrary to previous studies which had to rely completely on reaching out to participants online (such as Lopez et al., 2021; Poortinga et al., 2021; Noszczyk et al., 2022), we aimed to explore the users' perspective of green spaces on the ground and achieve a higher representativity. Our most important findings are the following:

- Firstly, despite a strict strategy of approaching potential participants in UGS (weekdays and weekends at different times of the day, addressing every third person met), our sample had a strong bias towards university students (39.1% of the sample). Contrary to that, persons aged 66 or older are underrepresented (4.3%), compared to Leipzig's general demographic structure. This shows who currently predominantly uses UGS spaces and who does not.
- Secondly, an overwhelming majority (94.1%) stated that they did not feel strongly affected by the pandemic anymore with regard to everyday practices. We see this as further indication of a beginning post-pandemic phase.
- Thirdly, it is surprising to see how park visitors still confirm shifts in their behaviour compared to before the pandemic, with 85.2% stating that their new patterns are likely or very likely to become permanent. CES that influence personal "well-being" and "social interaction" were the two aspects that document the highest increase in re-evaluation in our survey. Also, the perception of relevant UGS characteristics has changed, with "proximity to home", "cleanliness" and "naturalness" showing the strongest growth in importance for the participants.

The pandemic is expected to have "positively readjusted the human-nature nexus" (Marais-Potgieter & Thatcher, 2022, p. 101), meaning that the awareness connected to UGS has increased, and our study reaffirms this. We also see how this raises new questions with regard to spatial justice. While this increased consciousness of CES comes with positive impacts for health and well-being for its users, it will also put pressure on the neighbourhoods close to UGS. Although researchers observed a reversed gentrification process during the initial phase of the pandemic (with wealthy urban residents fleeing the overcrowded city centres of Paris or Madrid; Cole et al., 2021), the question now is: How will gentrifiers behave in the long run? With the importance of having UGS nearby growing, we can also expect a certain reflection in urban housing markets, with green gentrification and disparities between green and non-green neighbourhoods. Hence, the growing importance of UGS must be kept in mind when arguing about potential displacement pressures.

Planners and policy makers are well advised to integrate the changing patterns into the design and provision of UGS. For example, to keep current park visitors as users, UGS need to develop according to their needs. At the same time, the needs of potential users who currently do not want to or cannot spend time in UGS should not be neglected. This goes particularly for groups with special needs, such as the elderly or women, for example.

In order to address growing inequality, politicians and urban planners should ensure that every resident has access to UGS in their future planning. In this sense, Huerta (2022) recommends identifying priority areas within the city where action is most needed and we endorse this recommendation. Integrating ecosystem services into planning at different planning levels, to ensure and develop green spaces, can be a valuable approach in doing so (Deppisch et al., 2021).

Based on our study, future research might focus on the following two aspects:

- Firstly, COVID-19 was a turning point that triggered changes in the behaviour and perceptions of park users (Addas & Maghrab, 2022), and our study offers further insights here. The pandemic adds to a larger set of overlapping crises, currently being discussed as a polycrisis (Lawrence et al., 2022). While there have already been several studies on these phenomena during the pandemic, it remains rather unclear which role UGS play during the polycrisis.
- Secondly, we call for larger samples and more comparative research designs. In our study, we addressed park visitors in situ, which is an approach that was not feasible during lockdown protocols. Our method was more labour-intensive and yielded a smaller number of participants compared to surveys conducted exclusively online, however. Further studies that manage to reach out to a larger sample on the ground would be highly desirable in order to achieve an even more representative sample. In addition, a more exploratory qualitative design would help to get to the bottom of some of the patterns which we have discovered. Understanding the strong increase in the demand for safety could be one of the objectives of such qualitative approaches.

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