

Green in times of COVID-19: urban green space relevance during the COVID-19 pandemic in Buenos Aires City

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Abstract

The COVID-19 pandemic has had a deep impact on the way we perceive our world. This study explores its particular effect on Urban Green Space (UGS) perception in Buenos Aires City (CABA), Argentina. We provide a detailed overview of the distribution of UGS in CABA, along with an analysis of visitors' profile and perception before and during the restrictive measures adopted by the national authorities to contain the COVID-19 outbreak (July to December of 2020). We conducted a series of surveys based on open and closed questions. Before the pandemic, surveys were carried out in situ in eight parks of six districts, randomly chosen. During the confinement, online surveys were conducted. According to our results, the mean UGS density in CABA is $6.09 \text{ m}^2 / \text{person}$, but marked differences between districts exist, ranging from $0.02 \text{ m}^2 / \text{person}$ to $17.68 \text{ m}^2 / \text{person}$. This uneven distribution causes differences in the quality of life of CABA inhabitants, perhaps more pronounced during reduced-mobility situations like COVID-19 confinement. Regarding UGS visitors, before the confinement, the majority of respondents were employees or students; during the confinement, employees and retirees predominated. When asked to choose important attributes to describe their perception about the UGS from a given list, respondents selected "calm," "green," and "sounds of nature," without differences before and during the confinement. However, when asked about the UGS role, the main answer was "a place to be with nature" before the confinement and "an important place in the city" during it. Understanding how society perceives the UGS, especially during crises, is essential to rethink the urban landscape and prepare our cities for a more sustainable future.

Introduction

Urban green spaces (UGSs) offer visual and aesthetic recreation necessary to provide physical and mental health to big cities' dwellers (Groenewegen et al., 2006). UGSs also provide ecosystemic services important to human welfare. For example, they decontaminate air, reduce rainwater runoff, and mitigate temperature rises by lowering the heat islands generated by concrete from constructed buildings. However, these services are usually underestimated in urban design and environmental management (Schroeder, 2009; Ugolini et al., 2020). The COVID-19 pandemic that began early in 2020 has brought up a new appraisal of UGSs (WHO, 2020).

Many authors have emphasized the importance of a friendly environment for urban societies, especially in crisis times (van den Berg et al., 2007; Samuelsson et al., 2020). During the present pandemic, UGSs regained significance as places for shelter, amusement, and social gathering (CDC-USA, 2020a; Baillie, 2020; Barrot et al., 2020; Samuelsson et al., 2020; Shoari et al., 2020; Slater et al., 2020; Ugolini et al., 2020). Baillie (2020) analyzed over 40 million posts published through the social network Twitter, and among COVID-19 related tweets; two trend topics were "enjoying nature from home" and "outdoor exercise." Also, images of perfect blue water, deserted city centers, and clear sky appeared more frequently than before. Other studies showed a notable increase in the download of nature-related cell-phone applications, such as birdwatching apps (Flaccus, 2020).

Buenos Aires City (official name, Ciudad Autónoma de Buenos Aires, CABA) is the most populated city in Argentina, with 2,890,151 inhabitants (INDEC, 2010). As in the rest of the country, an official resolution known as “Preventive and mandatory social isolation” (in Spanish, Aislamiento social preventivo y obligatorio, ASPO), that basically implies home confinement, was established by Argentine authorities on March 19, 2020 (DNU 297/2020 and modifying clauses). Only those considered essential workers (e.g., health, security, food supply workers) or involved in human care tasks (for children, senior citizens, and persons with COVID-19 risk factors) were allowed to leave their houses. The rest of the inhabitants were allowed to move around a radius of up to 500 m from their homes exclusively to buy food and essential items. This strict confinement lasted until July 2020. Then, these restrictions were gradually flexibilized and, by October 2020, the local authorities of Buenos Aires City announced permission to practice outdoor physical activities, following the World Health Organization recommendations (2021). When social meetings were finally allowed, UGSs were indicated as the most suitable places to meet relatives and friends. Similar measures and recommendations were adopted in other countries.

Urban green spaces in CABA, including green corridors and other public green areas, occupy 901 ha. They represent an environmental unit, provide similar ecosystemic services, and mitigate environmental impacts (Programa Buenos Aires Verde, CABA, 2014). The CABA government has launched a program called “*Ciudad Verde*” (“Green City”), aimed at studying and designing green spaces, and elaborated a series of documents (e.g., Chain, 2009; Macri et al., 2011) that specify sustainability criteria for urban design: incorporation of green areas in available spaces, conservation of existing tree specimens, consensus with neighbors by using participative design, among other proposals.

Several studies on environmental perception in Argentina have been published (Faggi et al., 2011; Guida Johnson et al., 2015; Perelman et al., 2012; Madanes et al., 2013; Perelman & Marconi, 2016). In the last study mentioned, the public perception of four parks located in CABA (Saavedra, Avellaneda, Centenario, and Micaela Bastidas) was assessed. This study resumes that research, adding more parks, deepening on the demographic analysis and revealing the revalorization that UGSs experienced during the COVID-19 pandemic.

Methodology

Demographic assessment and people’s mobility analysis

For administrative purposes, Buenos Aires City (Ciudad Autónoma de Buenos Aires, CABA) is divided into 15 districts (specific Spanish name: “comuna”). We analyzed the inhabitants’ density and the surface corresponding to the urban green space at district levels and the whole city. The analysis was carried out using data supplied by Dirección General de Estadísticas y Censos, GCBA (Estadísticas GCBA, 2019).

People’s mobility during the confinement was analyzed based on data obtained from Google (2021) and Apple (2021). Google carries out strategic surveys with datasets gathered from worldwide users, who enable localization through their cell phones. The mobility occurring each day was compared with a

baseline constructed with the reference values obtained for the same day of the week from January 3 to February 6, 2020. Apple obtains information from data collected through its iPhone users and can differentiate between those displacing by vehicle or on foot; it also compares these profiles with that shown by a baseline generated from values obtained before the confinement.

UGS perception surveys

We selected six districts randomly and chose eight parks located at them: Parque Avellaneda (comuna 9), Parque Chacabuco (comuna 7), Parque Centenario (comuna 6), Parque Leonardo Pereyra (comuna 4), Parque Lezama (comuna 1), Parque Micaela Bastidas (comuna 1), Parque Rivadavia (comuna 6), and Parque Saavedra (comuna 12) (Fig. 1). These parks represent 27% of the urban green space in CABA (99.9 ha) and are categorized as “big parks.” During springs and winters comprised in the period 2012–2018, we surveyed 60 adult visitors per visit, park, and year, chosen randomly during each visit following Cochran and Cox (1965) methodology. At the end of the strict confinement (December 2020-January 2021), surveys (298) were performed through online questionnaires (using Google Forms) and distributed initially among the authors’ personal and professional networks (email, WhatsApp) and later posted on Facebook groups. Participants were kindly requested to distribute the survey to their contacts. All respondents participated voluntarily and answering the survey implied their consent to participate in this research.

Surveys included open and closed questions and were divided into two sections: A and B. Section A covered social and demographic data such as age, gender, education level, and occupation. Answering these questions was optional. Section B was focused on the perception that inhabitants have about the UGS: this included three questions about the frequency of visiting UGSs and distance to reach them, and five questions focalized on people’s perception, the reason for the visit, and significance of UGSs. Answering these questions was mandatory.

In section B, respondents had to choose three words out of a list of 20 to define UGS (Table 1). The list included words or expressions describing experimental and experiential attributes (Vouligny et al., 2009). Experimental attributes refer to the cognitive and physical evaluation made by the park visitor such as “birdsongs,” “leaves’ colors,” or “importance as city patrimony.” Experiential attributes refer to how individuals perceive the environment as a whole and define their emotions and expectations, such as “calm,” “peace,” or “harmony” (Vouligny et al., 2009).

Table 1

Landscape attributes included in the survey, according to the classification made by Vouligny et al. (2009).

	<i>Category</i>	<i>Attribute</i>
<i>Experiential</i>	atmosphere	calm, greatness, comfortable space
	admiration	peace, beauty, harmony
	sensorial/	sounds of nature, water, horizon, extension, landscape
	colors/	colors, green
<i>Experimental</i>	scenery	nature, animals
	maintenance	healthy, secure and protected, clean and well-maintained, patrimony conservation

Statistical analysis

Quantitative variables were analyzed using the F test, and univariate and multivariate analysis was performed to detect relationships between them. Binary variables (e.g., Yes/No) were transformed into numbers (0/1). Relative frequencies were calculated in percentages and analyzed with the Chi-square test.

We performed a correspondence analysis to detect associations among variables. Data arrays were constructed by combining gender, closeness to the park, attribute selected, and park. The Euclidean distance was used as a similarity index. Results were analyzed with InfoStat ® software.

Results And Discussion

Demographic background and mobility analysis

Urban green space density in cities is a dynamic process and changes over time. In CABA, this value changed from 6 m²/person in 2006 to 5.9 m²/person in 2014, representing a loss of 1.66%, and then increased back to 6.09 m²/person in 2018 (Estadísticas GCBA, 2019). Along the period covered by our analysis, the mean density of UGS in CABA was 6.3 m²/person. In some districts, UGS decreased. For example, district 1 diminished the UGS density from 24.6 m²/person in 2009 to 22.9 m²/person in 2014 and district 8 from 23.1 m²/person in 2011 to 14.7 m²/person in 2014. During the same period, other districts such as 13 and 14 increased their relative participation in CABA UGS (in our examples, 11% and 38%, respectively).

UGS distribution in CABA is heterogeneous, ranging from 22.9 m²/person in district 1 to 0.2 m²/person in district 5. There is an inverse relationship between the number of inhabitants and the UGS density (Fig. 2). Districts 5 and 6 are densely populated, with high buildings or numerous small habitational units,

and have low UGS area per person. This was also observed in districts 2, 3, and 7. Districts 9 and 12 are less populated, with an array of houses and medium-size buildings (Fig. 2a), and showed a greater UGS area per person (Fig. 2b).

The highest UGS densities correspond to districts 1, 8, and 14. District 1 constitutes a special case, as it includes the protected area called “Reserva Ecológica Costanera Sur,” which covers 350 ha, the financial area of the city, and the exclusive neighborhood “Puerto Madero,” a relatively recent (20–25 years) urbanization with inhabitants of high socio-economical level, offices, and restaurants. These three areas have very few permanent residents. The combination of the additional green space and the low number of permanent residents results in a high UGS density per person (22.9 m²/person).

Districts 8 and 14 have a lower UGS density than district 1 (14.7 m²/person and 12.1 m²/person, respectively), without significant differences between them (Fig. 2b). District 8 contains large public, open spaces like “Parque Indoamericano,” the municipal racetrack, and many public buildings, among other uninhabited large areas.

The rest of the districts have UGS densities lower than 8 m²/person. District 6 has a density of 1.5 m²/person, 15 times lower than district 1 (Fig. 2b). Districts 3, 5, 10, and 15 have UGS densities close or even under that necessary to maintain social distance. In a hypothetical scenario in which all citizens attend to these UGSs at the same time, as mentioned by Shoari et al. (2020), adequate social distancing would not be met.

In districts 1 and 6, parks are close to each other. This generates an overlap in their influence areas and causes differential accessibility to the various UGSs within these districts. Thus, people living within the overlapping influence area have easier accessibility to the green space than people living outside this area (Fig. 3). This heterogeneity in UGS distribution and accessibility is very common in old cities like Buenos Aires and has been observed in previous studies conducted in other countries (Shoari et al., 2020).

During the strict confinement period, which lasted from March 2020 to July 2020, visits to UGS decreased by about 87%. When attending UGSs to practice physical activity was allowed, people visiting UGSs increased, reaching a level 45% below the baseline. Highly populated districts with low UGS densities (e.g., districts 6 and 7) showed the highest mobility rates. As expected, district 1, which includes the financial district and the historical center, showed the lowest mobility rate (Table 2) (Google 2020). Regarding how people mobilized, mobility on foot decreased by 81% and by vehicles 69% compared to the baseline during the strict confinement and slightly recovered during the last months of 2020 to reach values of 66% and 43% under baseline levels, respectively (Apple 2020).

Table 2
Urban green space distribution and people's mobility. Data obtained from Google (2020).

District	Green space m ² /person	Surveyed area (%)	Mobility in UGS (%)
1	22.9	7.1	-60.9
4	3.7	7.1	-51.8
5	1.5	13	-41.1
7	1.8	17.6	-32.3
9	6.8	37	-59.4
12	8.1	11.3	-48.3
CABA	5.8	100	-31

Table 3

Educational level of respondents before and after confinement. Pre-conf., pre-confinement; Conf., confinement. Significant differences (Tukey test, $p < 0.05$) among districts or within districts are indicated by Capital letters and asterisks, respectively.

Education / district	1	4	6	7	9	12	Pre-conf.	Conf.
Elementary	37* A	24.1 B	7.4 A	14.8 A	24 A	7.4 A	7.75 C	0.3 C
High School	57.4 C	75.9 C*	44.4 B	64.8 C	26 AB	35.2 B	34.25 A	13.4 B
University	40 B	11.1 A	50BC*	25.9 B	50C*	59.3C*	13.5 B	86.3 A

UGS perception surveys

The final sample consisted of 1740 surveys, including the *in situ* surveys conducted in the parks before the confinement and the online questionnaires obtained during the confinement.

Section A. Social and demographic data

Most respondents were female (66.8% before the confinement and 76.3% during it), with diverse education levels and occupations (Table 2). Almost half of the respondents before the confinement had a high school diploma (47.9%). A trend for higher education levels was detected in districts 6, 9, and 12 and for lower (elementary school) in district 1 (Table 2). During the confinement, most respondents were university students or graduates. This could be due to a methodological bias, as online surveys required at least basic internet knowledge and computer skills to participate.

Data showed homogeneity regarding respondents' occupation. Most respondents were employees (52% before the confinement and 62% during the confinement). In the surveys conducted before the confinement, district 4 showed the lowest employee proportion (38%) and the highest housewives relative weight (22%). In district 7, the highest students' percentage (21.4%) was found, and in district 12, the

lowest. Students' overall participation in the surveys was significantly lower during the confinement (5%), and this was probably related to the online education imposed by COVID-19 prevention regulations. Retirees represented 11.6% of all respondents before the confinement, with the highest record for retirees' participation in district 6; this value rose to 19.2% during the confinement. Before and during the confinement, the unemployed population was under 5% (Fig. 4a).

Most respondents (80–100%) declared visiting UGSs in several opportunities both before and during the confinement regardless the social and demographic status. Regarding day of the week for UGS attendance, (Fig. 4b) respondents in district 1 showed a clear preference for visiting parks on weekends, which can be explained by the proximity of the protected area "Reserva Ecológica Costanera Sur" and the touristic area. No preference between weekdays and weekends was detected among respondents surveyed in districts 9 and 12. Students, unemployed, and retirees visited parks both on weekdays and weekends. Employees chose weekdays when the UGS was near their workplaces and weekends when they were near their homes. During the confinement, respondents declared visiting UGSs irrespective of the week's day but reported a preference for afternoon visits (53.1%; data not shown).

During the confinement, 98.3% of the respondents visited UGS at least once, and most of them several times. Visits' duration varied: half an hour (22.9%), one hour (43.5%), and more than two hours (21.6%). When the question was "Who did you visit UGS with?", surprisingly, the majority of respondents answered "alone" (29.8%), even though UGSs were the recommended places for social gathering. Respondents also visited UGS "with friends" (21.6%) and "with family" (19.9%), without significant difference between these three answers. Given the mobility restrictions, most of the respondents visited UGS located near their homes (70%).

Section B. Perception of UGS

When asked for the meaning of urban green space in the surveys conducted before the confinement, respondents associated it with "a place to be in contact with nature" as the predominant answer or "parks of the city," in second place. In districts 9 and 12, the order of these answers was inverted. During the confinement, respondents associated urban green space with "something important" or, significantly less chosen, "a synonym of nature" (Table 4). Before the confinement, only a reduced proportion of respondents (11%) regarded UGS as "something important."

Table 4
Meaning of urban green space. Conf., confinement.

	parks	unknown	important	fresh air	nature	recreation	outdoor	calm
1	20.9	0.0	9.3	9.3	37.2	9.3	7.0	7.0
4	7.4	5.6	20.4	14.8	37.0	3.7	11.1	0.0
6	9.9	1.4	4.2	12.7	42.3	9.9	12.7	7.0
7	17.5	1.6	17.5	12.7	27.0	11.1	3.2	9.5
9	46.2	0.0	15.4	0.0	23.1	7.7	7.7	0.0
12	50.9	0.0	3.8	1.9	17.0	9.4	13.2	3.8
conf.	6.5	0.0	34.9	13.4	25.7	11.6	3.8	4.1

Concerning the reasons for visiting UGS during the confinement, the choices were “to be in contact with nature” (42%), “to see green” (12%), or “because it is close to home” (11%). When inquired about the services provided by UGS, answers were related to “recreation” (44%) and “social gathering” (14%), even though “socialize” was seldom chosen as a reason for visiting green spaces (Fig. 5).

Before the confinement, when asked to choose three attributes to describe the perception of UGS (out of 20, Table 1), respondents chose the experiential attribute “calm” as the most relevant, followed by “green” and “sounds of nature,” both experimental attributes. In districts with high population density (i.e., districts 4 and 6), “calm” reached the highest score. During the confinement, the tendency was inverted, and respondents chose mainly the experimental attribute “green” (18%), followed by “calm” (14%) and “nature” (11.6%) (Table 5 and Fig. 6).

Table 5
UGS perception, % of respondents. Significant differences within the countries were identified by the Chi-square test between coupled options.

District / Attribute	Experimental				Experiential	
	Calm	Harmony	Beauty	Sound of nature	Green	Nature
1	20	7.5	13	9	16.5	12
4	28	8	13	11	20	11
6	27	14	7	8	9	7
7	11	8	17	2	1	18
9	9	3	6	6	4	4.5
12	10	2.5	2	5	9	3
Confinement	14.1	4.2	4.9	11.6	18.3	10.9

Conclusions

Living conditions such as accessibility to UGS, housing, and population density affect daily life and, to some extent, determine how groups within a society cope with the COVID-19 pandemic (Vlahov et al., 2020). For example, some recent studies conducted in the United States show that living in small apartments with several occupants in highly populated neighborhoods predispose the Afro-American community to acquire SARS CoV-2 (CDC, 2020b; Yancy, 2020). In addition to the serious risk that this disease poses on physical health, many studies have related social confinement and distancing (measures widely implemented to reduce COVID-19 propagation) with feelings of loneliness, depression, post-traumatic distress disorder symptoms, confusion, rage, and frustration (Al Sulais et al., 2020; Brooks et al., 2020; Giallonardo et al., 2020; National Academic, 2020; Tee et al., 2020; Samuelsson et al., 2020; Serafini et al., 2020 Saurabh & Ranjan, 2020). In particular, this study presents information on the structure of UGS in Buenos Aires City and its impact on Buenos Aires inhabitants' perception of these green areas before and during the confinement implemented to reduce COVID-19 propagation.

For the past six years, the surface covered by UGS in Buenos Aires City remained stable at about 6.3 m²/person, a value which is nearly at half of that recommended by the World Health Organization (2020): 10 to 13 m²/person. In addition, UGS is unevenly distributed, as expected, given CABA's ancient structure. Buenos Aires (under the official name of "Nuestra Señora Santa María del Buen Ayre") was founded in 1536 and expanded considerably at the end of the nineteenth century in a rather unplanned manner, far away from current urbanization politics (WHO, 2020).

Also, over half of the population (52%) are senior citizens who live alone. Only 1.3% of the inhabitants share their homes totaling three or more occupants (Estadísticas GCBA, 2019). Particularly senior citizens living alone experienced psychological problems derived from the pandemic deepening (Alomo et al., 2020; Ceberio, 2020; Sorbara et al., 2020; Camarotti et al., 2020). In contrast, in houses with several occupants, where close contact becomes unavoidable, the risk of infection increases. Whether to maintain safe confinement or prevent SARS-CoV-2 propagation, UGSs became crucial to safely practice physical activities and recover social interactions. Under these circumstances, can the UGS perception be transformed?

Humans' appraisal of the landscape results from the perception of the surroundings and the individual preference for nature, in contraposition with the urban pattern. This has already been described in pioneer studies in the field, such as that of Appleton (1975), Purcell & Lamb (1998) and Maúlan et al. (2006), and also observed in some preliminary studies carried out by our group (Perelman & Marconi, 2015).

We detected that survey respondents of varied social and demographic status assigned similar meaning to UGSs before and during the COVID-19 confinement, recognizing them as calm and natural landscapes, with abundant vegetation and nature sounds. The UGS meaning was considered as "an important place in the city" only during the confinement. This indicates that the COVID-19 pandemic can be a starting point to rethink the city's landscape and its role in life quality. It is important to point out, that internet-

based technologies were crucial to analyze the actual scenario without breaking the imposed confinement. However, these tools rely on participants who can manage computers or other electronic devices and technologies, generating a potential bias. Our results show that survey respondents visited UGSs located close to their homes, more than once, and alone or with family or friends.

Accessibility to UGS is important under normal conditions and even more during a pandemic. It is vital to address the limitation that heterogeneous access to UGS represents, preventing citizens from their recognized benefits. Large cities like Buenos Aires need to distribute UGS in a more homogenous way, avoiding areas with extreme population densities, networks of overpopulated streets, and mono-functional neighborhoods. It is also important to provide access to integrated spaces for both social interaction and secluded relaxation (Samuelsson et al., 2020).

Understanding public perception of UGS is mandatory to raise awareness in the population about its relevance for the urban landscape and necessary to encourage UGS conservation as part of public policies, working for a more sustainable future.

Declarations

Ethics approval and consent to participate: **not applicable**

Consent for publication: **the authors gives the permission to publish the work**

Availability of data and material: **The datasets used during the current study are under CONICET guard and, also, they are available from the corresponding author on reasonable request.**

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Figures

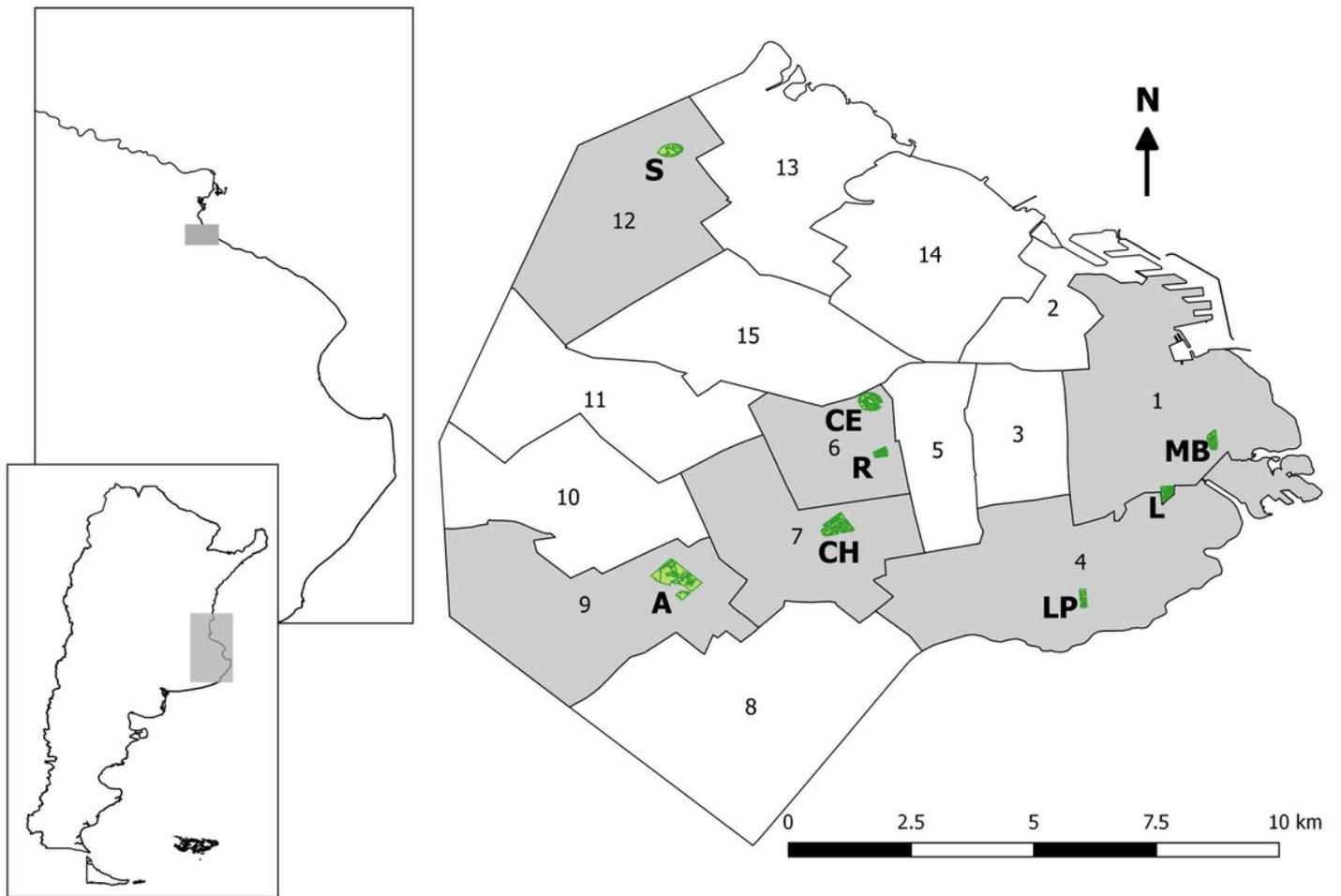
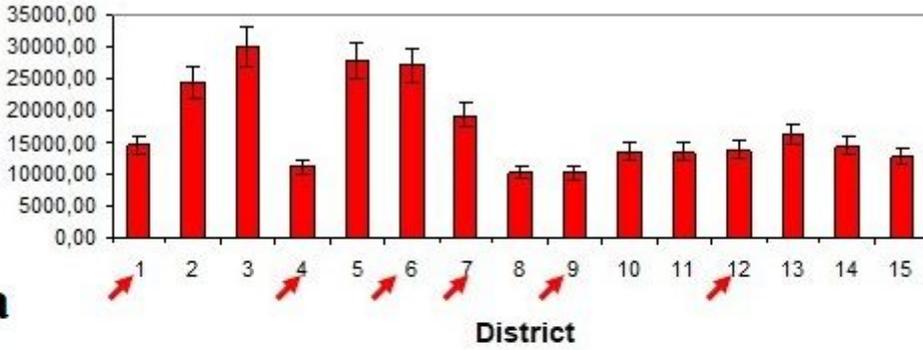


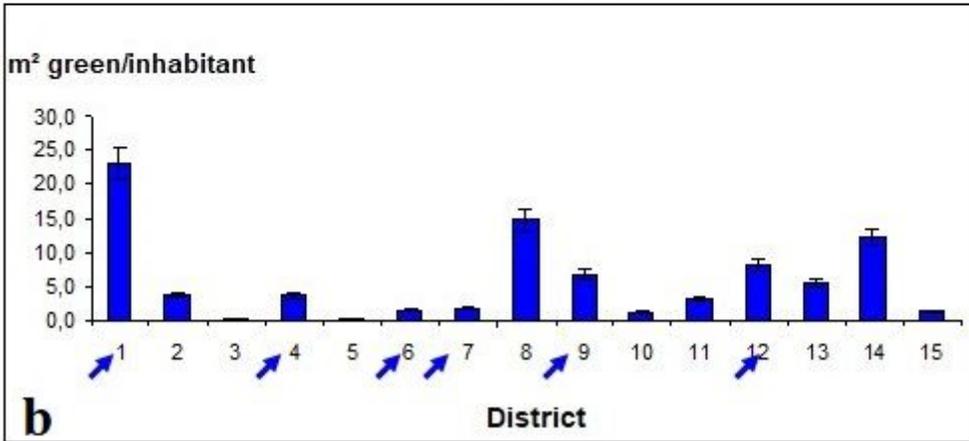
Figure 1

Buenos Aires City districts (“comunas”). In grey: districts selected for the surveys. Parks: A: Avellaneda; CH: Chacabuco; CE: Centenario; LP; Leonardo Pereyra; L: Lezama; MB: Micaela Bastidas; R: Rivadavia; S: Saavedra.

density (inhabitant/km²)



a



b

Figure 2

Buenos Aires City inhabitants and urban green space. a: Total density; b: UGS per inhabitant. Arrows indicate the districts where surveys before the confinement were conducted.

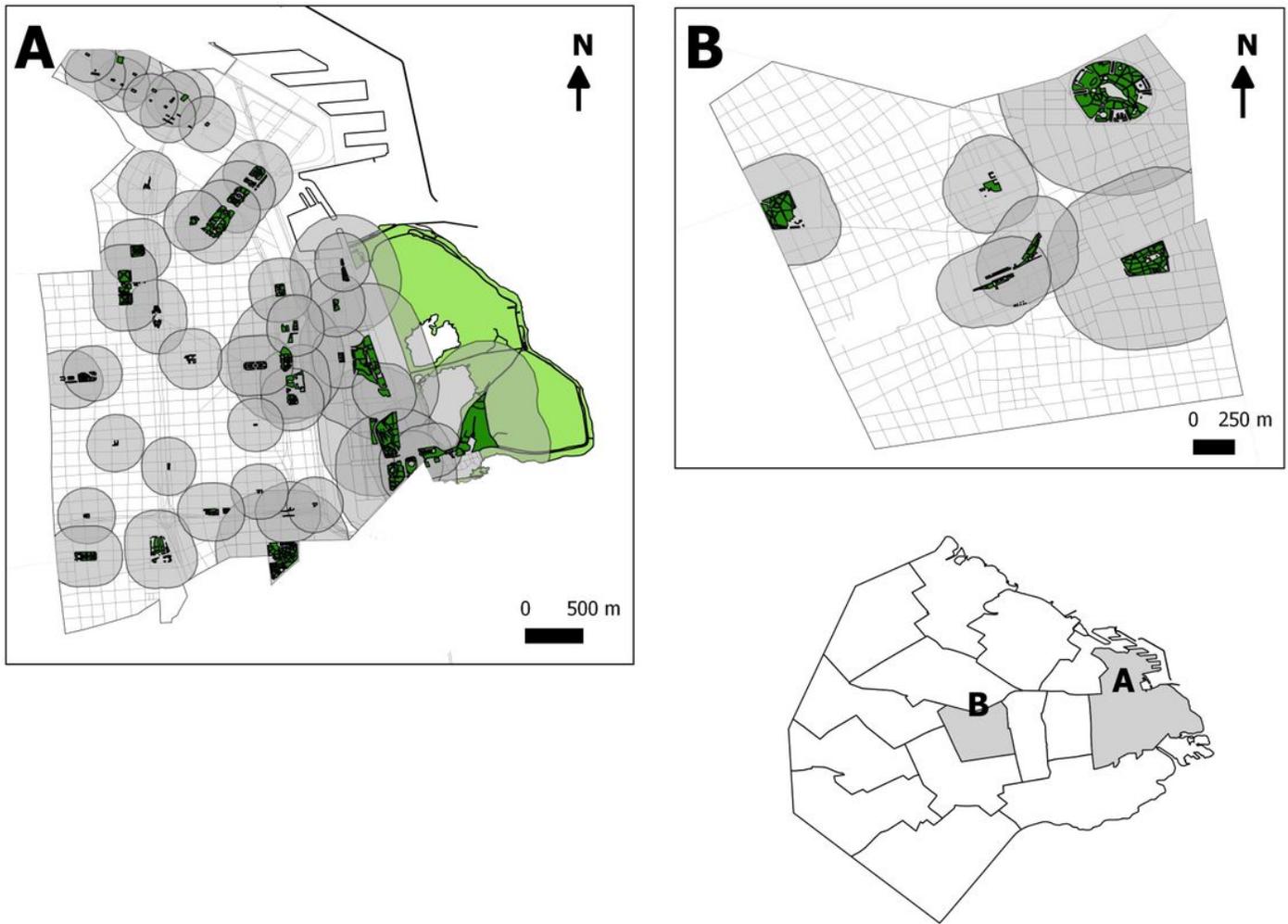
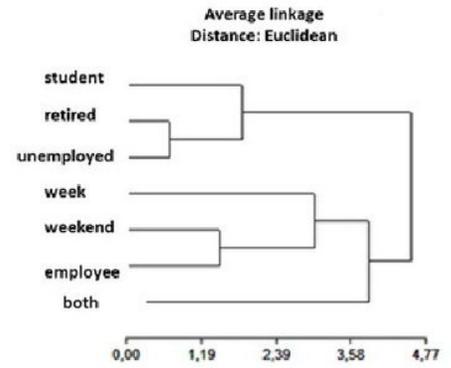
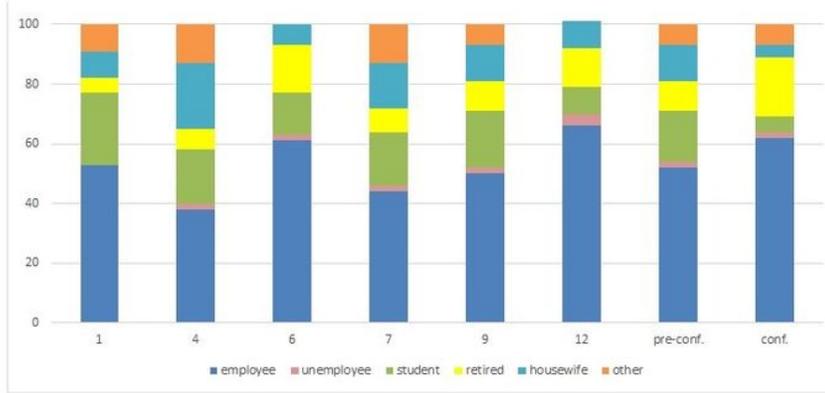


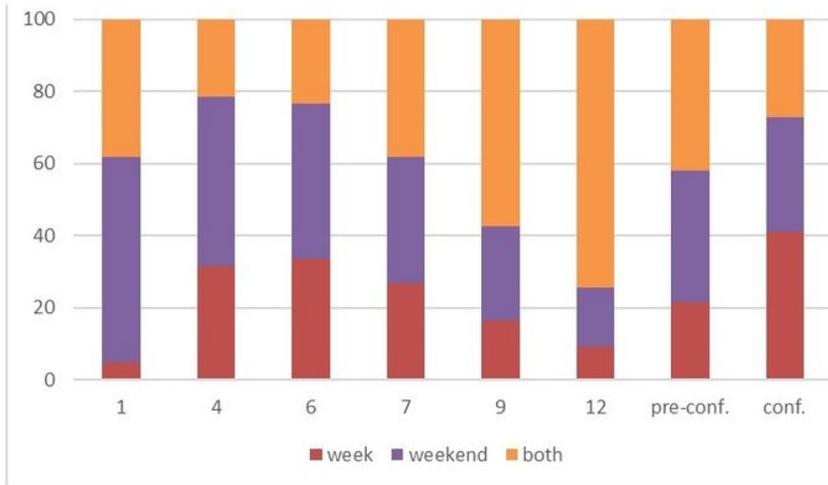
Figure 3

Differential accessibility to urban green space in two CABA districts. In grey: UGS influence area in district 1 (a) and district 6 (b), calculated as a 500-m perimeter or a 250-m perimeter around parks and squares, respectively.



a

c



b

Figure 4

Demographic profile of surveyed people (a) and visit frequency (b). Conglomerate analysis for occupation and visit frequency (c).

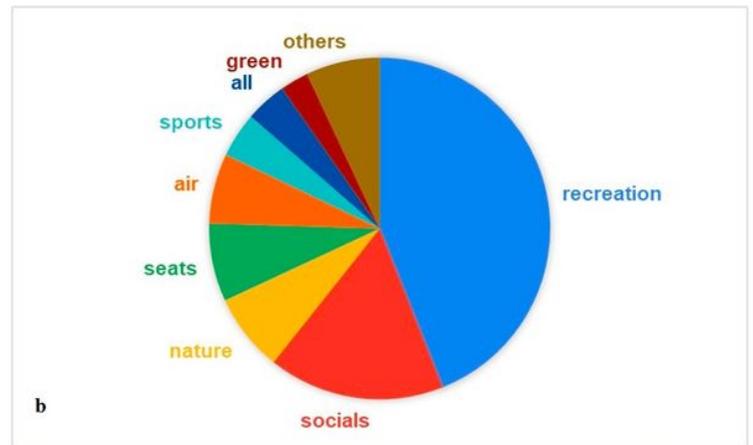
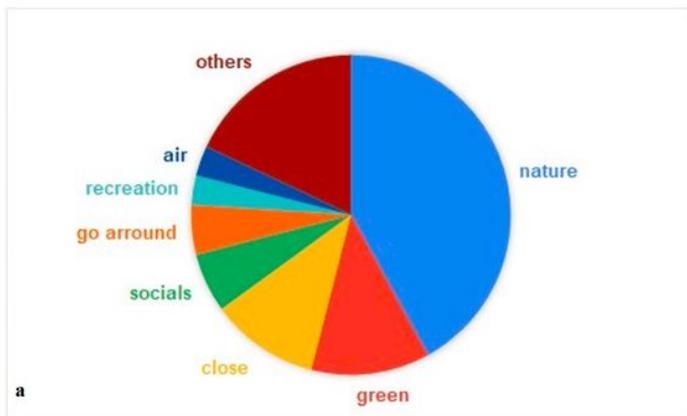


Figure 5

UGS perception during the COVID-19 confinement. Reason for visiting (a); services provided by UGS (b).

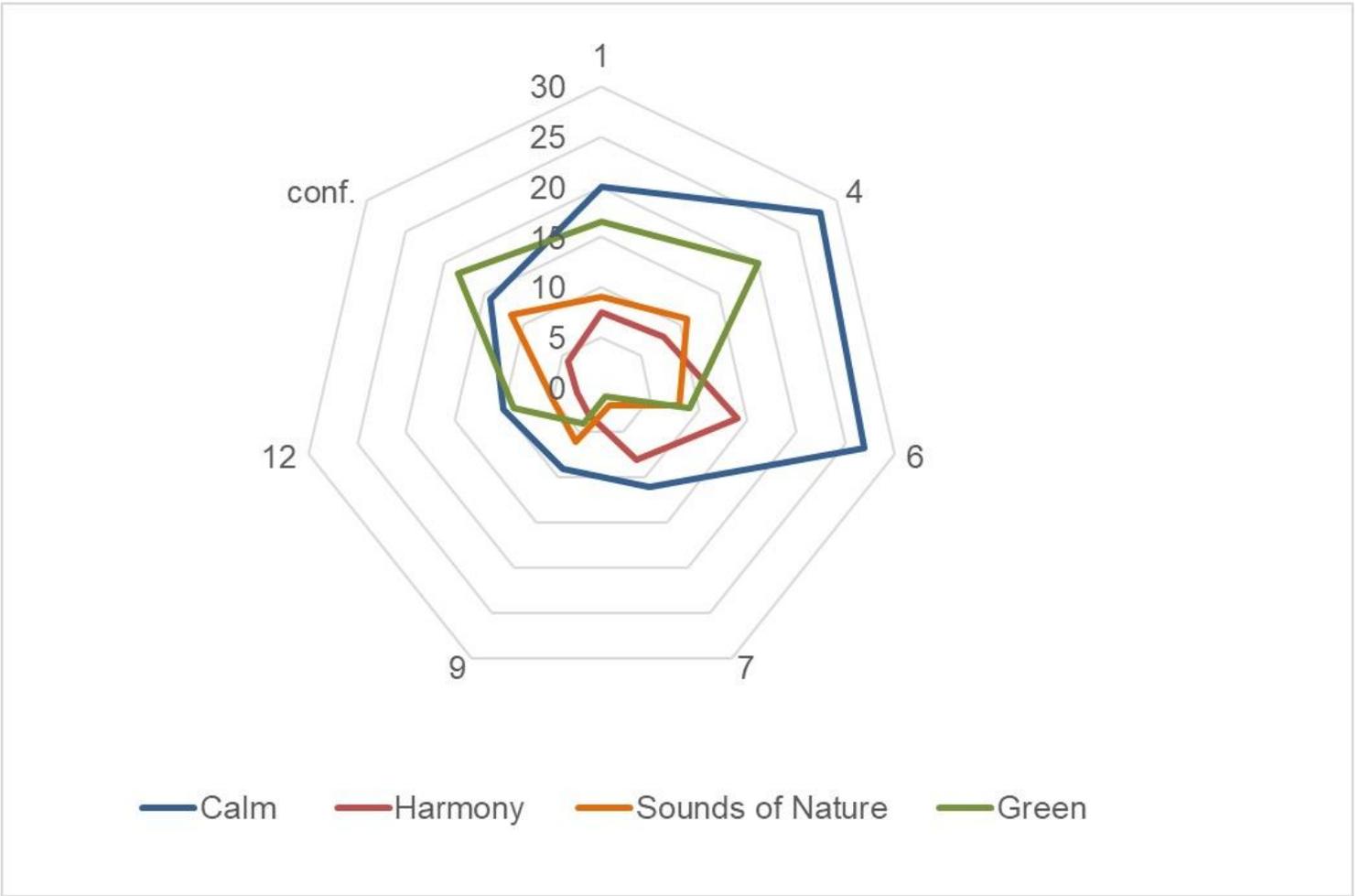


Figure 6

Attributes assigned to UGS with high frequency.